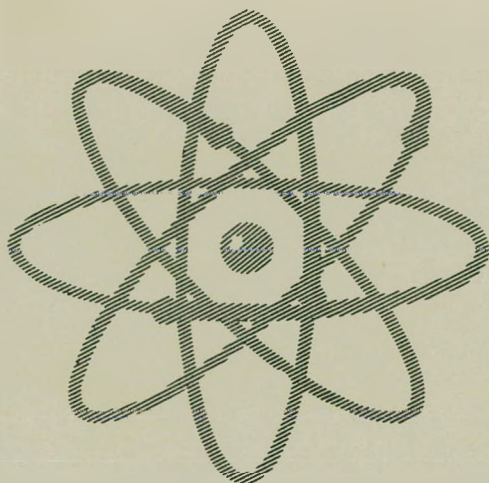


MASTER



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# **RESEARCH and DEVELOPMENT in Progress**

BIOLOGY AND MEDICINE

*July 1963*

Issue No. 1

Abstracts 1-603

**UNITED STATES ATOMIC ENERGY COMMISSION**  
Division of Technical Information

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## INTRODUCTION

The AEC's Division of Biology and Medicine and Division of Technical Information have embarked on a cooperative program for collecting, abstracting, indexing, and publishing information on AEC research projects in the bio-medical sciences. This initial publication identifies and describes approximately 600 projects supported by the Division of Biology and Medicine. The contracts are with universities, research organizations, foundations, and government agencies. Additional projects will be covered in future issuances. The ultimate goal is comprehensive coverage of all AEC-sponsored bio-medical research.

The publication is divided into two sections. The first section provides a scope note (abstract) and identifying information for each project. The second section consists of four indexes—Principal Investigator, Contractor, Subject, and Contract Number Indexes.

A complete list of Biology and Medicine Program Categories is shown on page vii.

Comments and suggestions regarding the publication should be addressed to the Director, Division of Technical Information, U. S. Atomic Energy Commission, Washington 25, D. C.



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## CODES

ALOO	Albuquerque Operations Office
COO	Chicago Operations Office
HOO	Richland Operations Office
MYr	Total Supporting Man-Years
NYOO	New York Operations Office
OROO	Oak Ridge Operations Office
RLOO	Richland Operations Office
SAN	San Francisco Operations Office
SFOO	Albuquerque Operations Office
SP	Number of Supporting Personnel
SROO	Savannah River Operations Office
WASH	AEC Washington Headquarters





## BIOLOGY AND MEDICINE PROGRAM CATEGORIES

- A    **SOMATIC EFFECTS OF RADIATION**
  - A1       RADIATION EFFECTS—GENERAL
  - A1A      Acute Whole-Body Irradiation Effects
  - A1B      Chronic Whole-Body Irradiation Effects
  - A1C      Repair Mechanisms
  - A1D      Gastro-Intestinal System
  - A1E      Hematopoietic and Cardio-Vascular Systems
  - A1F      Nervous System
  - A1G      Reproductive System
  - A1H      Other Organ Systems
  - A1J      Developmental Anomalies
  - A1K      General Physiology and Metabolism
  - A2       **TOXICITY OF RADIOELEMENTS**
  - A2A      Biological Effects
  - A2B      Uptake, Distribution, Deposition and Elimination
  
- B    **RADIATION GENETICS**
  - B1A      Cytogenetics
  - B1B      Microbial and Biochemical Genetics, and Gene Action
  - B1C      Human and Mammalian Genetics
  - B1D      Population Genetics
  - B1E      Molecular Radiation Genetics
  - B1F      Mutation Rate Analysis
  
- C    **COMBATING DETRIMENTAL EFFECTS OF RADIATION**
  - C1A      Protective Agents
  - C1B      Facilitation of Recovery
  - C1C      Removal of Radioactivity
  
- D    **MOLECULAR AND CELLULAR LEVEL STUDIES**
  - D1A      Bioenergetics and Biophysics
  - D1B      Intermediary Metabolism
  - D1C      Macromolecules
  - D1D      Cell Physiology and Biochemistry
  - D1E      Mineral Metabolism
  
- E    **ENVIRONMENTAL RADIATION STUDIES**
  - E1       **TERRESTRIAL AND FRESH-WATER ECOLOGY**
  - E1A      Plant and Animal Systems
  - E1B      Soils, Plants and Soil-Plant Relations
  - E1C      Fresh-Water Systems

- E2 MARINE SCIENCES
- E2A Biological Uptake, Concentration, Distribution and Effects of Radioactive Elements
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- E2C Circulation and Mixing
- E2D Other Oceanographic Studies
- E3 ATMOSPHERIC RADIOACTIVITY AND FALLOUT
- E3A Atmospheric Chemistry
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- E3C Fallout Formation and Source Effects
- E3D Radioactivity in Soil, Food and Man
  
- F RADIOLOGICAL AND HEALTH PHYSICS, AND INSTRUMENTATION
- F1 RADIOLOGICAL AND HEALTH PHYSICS
- F1A Radiological Physics
- F1B Health Physics
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- J CANCER RESEARCH
- J1A Metabolic Aberrations
- J1B Unique Applications of Radioisotopes
- J1C Teletherapy
- J1D High Energy and Neutron Therapy
  
- K SELECTED BENEFICIAL APPLICATIONS
- K1A Medical Research
- K1B Agriculture—Crop Improvement
- K1C Agriculture—Animal Physiology
  
- L FOOD PRESERVATION

## ABSTRACTS

### A SOMATIC EFFECTS OF RADIATION

#### A1 RADIATION EFFECTS—GENERAL

Warren, Shields AT(30-1) 901

##### A1-324 ACUTE AND CHRONIC RADIATION INJURY.

New England Deaconess Hospital. Cancer Research Inst., Boston. NYOO.

Acute radiation injury is being studied largely from the standpoint of chromosomal changes in cultured blood cells from patients irradiated for cancer therapy. A variety of quantitative and qualitative changes appear. The carcinogenic effect of internal point sources of radiation is also being studied with special attention to cancer of the bronchus and cancer of the esophagus. This is the first time that cancer of the esophagus has been induced by radiation. Among the animals used in the experiments have been mice, guinea pigs, hamsters, rats and rabbits. The cocarcinogenic effect of altered hormonal environment and radiation is being studied in parabiont rats. A wide variety of malignant tumors can be obtained, particularly in endocrine organs. The uptake of strontium 90 in apatite crystals and in bone is being considered. Since the ability of tumor cells to adapt their enzyme components to altered metabolic conditions is of much importance in their competitive advantage over normal cells, the studies on adaptive enzymes are continued, particularly with regard to enzyme tryptophan metabolism. A prospective study of dentists in Massachusetts is being carried out to correlate their radiation exposure with life span and incidence of disease.

##### A1A Acute Whole-Body Irradiation Effects

*See also A1E130 and DID191.*

Goff, Richard A. AT(40-1)2850

##### A1A65 A HISTOLOGICAL STUDY OF THE MORPHOGENESIS OF ANOMALIES INDUCED IN THE

##### LIMBS OF CHICK EMBRYOS BY X-RAYS AT DIFFERENT STAGES IN DEVELOPMENT.

Oklahoma. Univ., Norman. Research Inst. and Oklahoma. Univ., Norman. OROO.

X radiation has a teratogenic effect on the limb skeleton of the developing chick embryo. The effect differs with the embryonic stage irradiated and this is interpreted to indicate the occurrence of different morphogenetic processes, (Goff, R. A., J. Exp. Zool., in press). This information serves as the basis for further analysis of limb formation. The present project is concerned with histological study of the development of each characteristic anomaly. Some aspect of limb formation is specifically affected by X radiation at stages 12 (2 days of incubation) to 35 (8 days of incubation), which encompasses the period to be studied. Although incomplete, the findings to date include the observation that cell deaths shortly after irradiation are a conspicuous and common feature at all sites where the ensuing anomaly was the result of a reduction in size or the absence of a part. The union which is induced between parts at joints is the result of the failure of the joint to form rather than a fusion of parts subsequent to joint formation. How this effect was mediated has not been determined.

Dixon, Frank J. AT(04-3)410

##### A1A88 BASIC STUDIES OF THE IMMUNE RESPONSE AND THE EFFECT OF RADIATION ON THIS RESPONSE.

Scripps Clinic and Research Foundation, La Jolla, Calif. SAN. SP 35.

As one of the measures potentially useful in the manipulation of the antibody response, we have been studying whole body x-radiation. In these studies, we have found that enhancement and acceleration of the antibody response can be achieved in some situations with large, cytotoxic doses of whole body x-radiation given after antigenic stimulation. The timing of radiation is critical and varies with the kind and physical form of the antigen. It is postulated that the x-radiation depletes the cells of the lymphoid tissue just prior to the rapid proliferation of the antigen stimulated cells. In this situa-

tion those surviving cells which are stimulated by antigen multiply more rapidly than their non-stimulated counter-parts and disproportionately repopulate the depleted lymphoid tissues. Whether the x-radiation produces other effects contributing to the multiplication of the antibody forming cells could not be determined. Rabbits injected shortly after birth with a serum protein antigen will acquire an immunological tolerance to the antigen in that they will not make an immune response when exposed to the same antigen later in life. Recently we have shown that acquired tolerance to bovine serum albumin (BSA) was terminated following injection of cross-reacting antigens such as serum albumin from other species and certain chemically altered BSA preparations. In addition, it has been possible to terminate the tolerance that a rabbit has for rabbit thyroglobulin.

Quilligan, J. J., Jr. AT(04-3)322-1  
A1A90 IRRADIATION AND INFLUENZA INFECTIONS IN MICE: CONSEQUENCES OF THE DUAL ACTION.

Loma Linda Univ., Los Angeles. SAN.

During the past year, we have continued to study the effects of continuous low doses of cobalt-60 irradiation on mice infected with influenza viruses. We have shown previously that virus tended to grow to high titers in those animals that received doses of between 50 and 100 r/day for 15 days prior to the time they were infected. This dose of irradiation was sufficient to interfere with antibody production and allow for continued growth of virus beyond that observed in control non-irradiated animals.

The avenue of investigation of long-term effects of both influenza and irradiation in mice has shown considerable increase in the amount of activity since our last progress report. There appears to be a large number of the animals, that have been irradiated and that had virus, with some type of pulmonary lesion. These lesions are acute interstitial pneumonia, bronchopneumonia, chronic inflammatory effects, and monocytic infiltrates of the lungs. Some animals showing reticulum cell sarcomas appeared in the irradiated-infected group and some showed what appeared to be leukemic changes. One reticulum cell sarcoma, which looks somewhat like a plasma cell tumor, has been passed successfully in tissue culture and C-57 black mice.

Luick, J. R. AT(11-1)34-69  
A1A218 BIOLOGICAL EFFECTS OF IONIZING

RADIATION ON MILK SYNTHESIS.

California. Univ., Davis. SAN.

The overall objective of this project is to explore the effects of ionizing radiation on milk synthesis. Two, 400 curie, Co<sup>60</sup> sources, emitting 4" x 4" beams, are directed at each other and are used to irradiate the mammary tissue of lactating dairy cows.

Specifically, we plan to study: (1) The conditions under which ionizing radiation increases (or decreases) milk production; (2) The radiosensitivity of mammary tissue and the nature of the dose/response phenomena which presumably will be observed; (3) The effect of ionizing radiation on precursor-product relationships and on the metabolic pathways associated with milk synthesis. Radioisotopes, especially C<sup>14</sup>, will be used in this phase of the study, and; (4) The radiosensitivity of specific enzyme systems, in vivo, that are associated with milk synthesis.

Visek, Willard J. AT(11-1)670  
A1A235 THE BIOLOGICAL EFFECTS OF STRESSFUL AGENTS AS RELATED TO DIET.  
Chicago. Univ. COO. September 1962 - August 1963. SP 1; MYr 1.

The wide range in toxic and biologic response of chicks, mice, rats and guinea pigs will be exploited to explore the role of urease in the physiology of birds and mammals. Work in progress upon the biochemistry and pathology of urease toxicity will be continued. Toxic levels of jackbean urease will be administered to determine their effects upon serum levels of electrolytes, urea, ammonia and blood glucose. Additional work will be done upon the relation of urease to infectious processes and non-specific resistance to bacterial infection. Passive administration of urease antisera will be assessed for its possible beneficial effects in preventing irradiation mortality. Factors influencing urease antiurease reactions will be studied.

Aikawa, Jerry K. AT(11-1)282  
A1A236 IMMUNOPHYSIOLOGIC STUDIES WITH ELECTROLYTES, INCLUDING Mg-28 IN PATIENTS.  
Colorado. Univ., Denver. School of Medicine. COO.

Study of the factors controlling magnesium metabolism in bone will be continued. Experiments will be devised to evaluate the role of the mineral apatite structure, the bone cells, and the connective tissue on Mg<sup>28</sup> uptake in vitro; such results will be compared with in-vivo data previously obtained.

The monograph on the role of magnesium in biological processes will be completed and published during the coming year.

Mg<sup>28</sup> will be used to investigate the nature of intracellular magnesium. Differential ultracentrifugation of tissue homogenate will be carried out to map the subcellular distribution of Mg<sup>28</sup> in representative tissues. The relative concentration of Mg<sup>28</sup> in nuclei, mitochondria, microsomes and cell sap will be determined. The nature of the binding of magnesium, its lability, and the effect of changes in physical conditions and exposure to pharmacologic agents will be tested.

Leone, Charles A. AT(11-1)1073  
A1A241 IMMUNOCHEMICAL STUDIES OF  
RADIATION-INDUCED DAMAGE TO BIOLOGICAL  
SYSTEMS.

Kansas. Univ., Lawrence. COO.

This project is primarily concerned with researches into the effects of  $\gamma$ -rays on the biological and physicochemical properties of proteins and viruses. Proteins (ovalbumin, bovine  $\gamma$ -globulin, and hemocyanins) are irradiated to absorb dosages ranging between  $2 \times 10^5$  and  $2 \times 10^8$  rads. The irradiated systems are fractionated to separate radiation-denatured protein, and partially degraded protein, and partially degraded protein, from unaltered protein. Each fraction is studied serologically to measure its biological correspondence to native protein. Physicochemical properties such as electrophoretic mobility, optical rotation, sedimentation rate of each fraction are also studied. Non-protein fragments, split from the proteins during irradiation, are studied to determine their terminal groups, molecular weight and amounts as related to dose. Anaphylactogenic properties of the fragments, in guinea pigs, are also studied. Attempts will be made to confer in vitro, a new antibody-specificity on  $\gamma$ -irradiated, non-antigenic BCG, by means of ribosomes from immune rabbits.

Kahn, Reuben L. AT(11-1)1172  
A1A243 EFFECT OF IRRADIATION ON THE  
LOCALIZING RESPONSE (TO ANTIGEN) OF DIFFERENT  
TISSUES IN IMMUNITY.

Michigan. Univ., Ann Arbor. COO.

During 1962-1963 antilocalization studies initiated by focal irradiation (1000r, 80 KVP) were continued. The term antilocalization was employed to describe the behavior of X-irradiated skin areas to the injection of protein, bacteria or diphtheria toxin. Whereas the skin of nonirradiated rabbits tends to localize these injected substances to a given degree, the skin in the irradiated areas tends to cause them

to escape rapidly from the injected areas and reach the blood stream. This antilocalizing property of irradiation is believed to be the basis of the clinical finding that irradiation in the treatment of infection is anti-inflammatory, the anti-inflammatory action being the result of a break-through of fresh blood supply into the inflammatory area. Another study was to determine whether the anti-inflammatory action of cortisone is related also to anti-localization. It was found that cortisone does not appear to possess the antilocalizing property of irradiation. A third study was to determine whether antilocalization following irradiation differs quantitatively in the subcutaneous tissue of the hip and the side of rabbits. It was found that the subcutaneous tissue of the hip possesses a stronger antilocalizing response than the subcutaneous tissue of the side.

Roth, Jay S. AT(30-1)2737  
A1A300 A COMPARATIVE STUDY OF THE  
EFFECTS OF RADIATION ON PROTOZOA AND  
MAMMALS.

Connecticut. Univ., Storrs. NYOO.

Protozoa are extremely resistant to radiation, the LD<sub>50</sub> for Tetrahymena pyriformis being in the range of 300,000-500,000 r. It is proposed to study those systems in protozoa that in mammals have been shown to be sensitive to radiation; for example, nuclear catalase activity, phosphorylation by nuclei, etc. Such studies may reveal the biochemical basis for the great radioresistance of protozoa and provide useful principles for developing increased radioresistance in mammals.

Patrick, Homer AT(30-1)2766  
A1A312 THE RELATION OF GAMMA IRRADIATION  
TO MINERAL METABOLISM WITH EMPHASIS  
ON SULFUR-35 AND CALCIUM-45 METABOLISM.

West Virginia. Univ., Morgantown. NYOO.  
SP 1 1/5; MYr 1.

The purpose of this year's research is directed toward two fundamental concepts. 1. Does irradiation bring about metabolic tissue changes which accounts for changes in mineralization, or 2. Does the injury to the digestive epithelial tissue change the absorptive or excretory biological activity of this tissue so as to change its membrane qualities.

Fundamental studies of this type will give information on influence of gamma irradiation on absorption, excretion, and metabolism of calcium and sulfur. Since radioactive sulfur (S<sup>35</sup>), selenium (Se<sup>75</sup>), calcium (Ca<sup>45</sup>) and strontium (Sr<sup>89</sup>) will be used in similar studies data will be obtained so as to demon-

strate the value of elements in the same periodic table group helping to solve a fundamental problem dealing with a required element.

Since the digestive epithelial tissue is damaged easily and heals rapidly these findings may open avenues toward an understanding of how the body actively adsorbs and excretes minerals along with healing of digestive epithelial tissue.

McArthur, William H. AT(40-1)3011  
A1A342 NITROGEN BALANCE, O<sub>2</sub> CONSUMPTION, AND CO<sub>2</sub> PRODUCTION IN MICE GIVEN FOREIGN BONE MARROW.  
Knoxville Coll., Tenn. OROO. SP 2; MYr 1.

Metabolism studies relating to problems of radiation protection in mammals are under way. Using mice nitrogen balance, O<sub>2</sub> consumption and CO<sub>2</sub> accumulation in irradiated animals given foreign bone marrow are being measured. These studies attempt to develop information applicable to increasing our knowledge of the mechanisms involved in the homologous disease syndrome. Irradiated mice given isologous bone marrow are compared with normal mice. Metabolism changes are studied in relation to the homologous disease with special reference to experimental parameters such as N-balance during recovery in treated animals and determination of any influence of the homologous disease development; measurement of O<sub>2</sub> used and CO<sub>2</sub> accumulated by irradiated mice treated with isologous or homologous marrow cells and compared with normal animals. Preliminary and subsequent experiments on Nitrogen balance with isologous and homologous animals show no significant difference in Nitrogen balance. In both groups, the mice are consistently in moderate positive Nitrogen balance. The HBM-treated animals lose weight while the IBM-treated animals gain weight. It is possible that the dietary nitrogen is stored differently in the two groups of animals.

Isologous animals are using less O<sub>2</sub> than normal animals; weight increase of normal mice is much greater than that of isologous animals.

Royal, G. C. AT(40-1)2399  
A1A343 AN INVESTIGATION OF THE THERAPEUTIC POTENTIAL OF HETEROLOGOUS (BEEF) BONE MARROW FOLLOWING RADIATION INJURY IN MICE.  
North Carolina. Agricultural and Technical Coll., Greensboro. OROO. SP 2.

Research will be conducted on the therapeutic use of heterologous bone marrow following production of radiation injury in mice.

Primary parameters to be considered in defining donor-marrow lipid character will include total lipid content, iodine number, saponification number, specific absorption in the UV region, and electrophoretic patterns. Degree of therapeutic value offered by the beef bone marrow seems, in part, dependent upon the quality of marrow lipid, specifically its content of unsaturated fatty acids.

Other aspects of the study will consider certain metabolic reactions of survival animals. Serotonin level in various organs of the body before, and after treatment will be especially followed. Earlier work has shown that brain, though seemingly independent of spleen serotonin, exhibits a 30% reduction during comparable radiation damage of its lipid content. On the other hand, spleen lipid values exhibit a marked increase.

Pietsch, Paul AT(30-1)3027  
A1A351 IONIZING RADIATION AND REGENERATION IN SALAMANDERS.  
New York. State Univ., Buffalo. NYOO. SP 2; MYr 2.

Underlying the project is the desire to appreciate development by identifying the cellular mechanisms crippled by ionizing radiation. Investigations have been carried out on regenerating salamander tails. While this system is adversely effected by x-rays, it was learned in this laboratory that regeneration can proceed for a significant interval of time post-irradiation. During the past few months intensive efforts have been made to account for these tissues produced after exposure to x-rays. An attempt was made to see if post-amputation age of regenerates was a factor in growth characteristic following irradiation. It was learned that, without regard to age, regenerative growth proceeded after irradiation (2000-3000 r) for about two weeks. Upon reaching this peak involution set in to claim all new tissues. Curves showed similar patterns of decline irrespective of age at exposure. It was learned that the presence of non-irradiated, grafted tissue could prevent this involution. Further work is being conducted to assess the effects of x-rays on nucleic acid metabolism in regenerative tissues produced post-irradiation.

Banks, W. C. AT(40-1)2946  
A1A377 CONTINUING STUDIES OF THE EFFECTS OF GAMMA RADIATION FROM COBALT 60 ON CHICKENS.  
Texas. Agricultural Experiment Station, College Station. SP 6; MYr 3.

The objective of the first phase will be to determine the effect of an earlier established mid-lethal dose of gamma radiation from Cobalt 60 at 50r/hr upon different age groups of White Leghorn chickens. Thirty birds from each of the following age groups will be radiated: 4 weeks, 8 weeks, 12 weeks, 16 weeks, 20 weeks, and 24 weeks. Two groups of thirty birds each will be maintained for controls.

The second objective will be to determine the lethal effects of gamma radiation from Cobalt 60 on mature White Leghorn chickens when exposed to 50r, 100r, 150r per day given at the rate of 50r/hr. Birds of 20 weeks of age will be used with three groups of forty birds each radiated at the three levels. Two control groups of forty birds each will be maintained.

Shapiro, Seymour AT(45-1)1732  
A1A421 SOMATIC MUTATIONS AND MORPHO-  
GENETIC EFFECTS OF RADIATION.  
Oregon. Univ., Eugene. SP 2; MYr 1.3.

The work in progress can be separated into two rather distinct and independent lines of investigation. One deals with somatic mutations, largely changes in flower color, and the production and rearrangement of chimeras in asexually propagated plants such as chrysanthemum, rose and geranium. One objective of these studies is to compare the kind and frequency of radiation-induced somatic mutations with those known to have occurred spontaneously. By using important horticultural varieties we have available spontaneous mutations that have been discovered as "sports" by commercial growers over a period of years and involving screening of hundreds of thousands of plants. Our data thus far indicate that several of the radiation-induced mutations have not appeared as spontaneous mutations.

The second line of research is in the area of plant morphogenesis and developmental physiology and at present specifically concerns the effects of radiation upon root development and polarity, with the stem of the Lombardy poplar serving as the experimental subject. These studies involve a synergism between X-rays and visible light; X-ray induced alterations in the polarity of root growth; "protection" of the X-ray induced inhibition of root growth by indole acetic acid; and modification of the root sensitivity to X-rays by low oxygen tension.

Hale, William M. AT(40-1) 1631  
A1A463 A STUDY OF THE EFFECTS OF COBALT-  
60 GAMMA IRRADIATION ON INFECTION AND IM-  
MUNITY.  
Tennessee. Univ., Memphis. Coll. of Medicine.  
OROO. May 15, 1962-May 14, 1963.

The effect of cobalt-60 gamma irradiation on antibody formation. The main emphasis to be on the effect four days after the antigenic stimulus. Formation and release of antitoxin.

Transplantation studies with antibody producing cells of various organs.

Continuing study of organ specific antigen of the human prostate gland.

Continuing the development of a low antitoxin producing strain of mice. Beginning the study of the mechanism involved.

Jones, Arthur W. AT(40-1)1749  
A1A465 A STUDY OF THE EFFECTS OF RADIA-  
TION UPON HOST-PARASITE RELATIONSHIPS.  
Tennessee. Univ., Knoxville. OROO. SP 6; MYr  
3 1/12.

Studies of the effects of repeated doses of gamma radiation upon Hymenolepis diminuta involve cytological analysis of eight mutant strains of this cestode. The karyotype of each strain, if sufficiently distinctive and reliably stable, will be used as a "label" in comparative ecological experiments upon competition for space and nourishment in the same host. Separately, each strain is being analyzed biochemically and biologically (proteins, lipids, carbohydrates; morphology, growth rate, fertility, radioresistance).

In situ observation of Hymenolepis microstoma is continuing, with cinematography of normal and chemically or physically stimulated movement of the cestode in its host's bile duct. After such studies, effects of radiation upon cestode behavior will be observed.

Histochemical studies of the cestode cuticle are continuing, with freezing-drying methods and electron microscopy after the suggestion of Gersh that reactions with anhydrous vapors should prove useful.

Labeling of cestode tissues with tritiated cytidine, tritiated thymidine, and other precursors in biosynthesis is being carried on.

Effects of radiation on the Tribolium-Hymenolepis association are being investigated.

Prehn, Richmond T. AT(45-1) 1383  
A1A474 IMMUNOLOGICAL TOLERANCE IN BONE  
MARROW TREATED RADIATION SURVIVORS.  
Washington. Univ., Seattle. School of Medicine.  
RLOO.

Data thus far obtained indicate that in surviving homologous long-term mouse radiation chimeras true immunologic tolerance is achieved by the donor cells toward the host. However, even after periods of chimerism of as long as 16 months, the graft-



versus host assay of Simonsen reveals a very slight but definite residual graft versus host activity.

Attempts to conduct essentially similar studies in new-born type chimeras have failed owing to technical troubles. It has proven impossible to obtain long-term survivors in the genetic system used with the radiation chimeras. In the new-born chimeras, either rejection of donor cells occurs or the animals die at an early age from runt disease.

Speirs, R. S. AT(30-1)-3021  
A1A504 ACTION OF TRITIATED TETANUS TOXIN AND TOXOID UPON THE ANTIBODY FORMING MECHANISM.

New York. State Univ., Brooklyn. Downstate Medical Center.

Greiff, Donald AT(11-1) 596  
A1A547 RELATION OF RICKETTSIAL AND VIRAL INFECTIONS TO RADIATION INJURY.

Marquette Univ., Milwaukee. School of Medicine. January 1962–December 1962.

The effects of ionizing radiations on the growth of Coxiella burnetii in embryonate eggs will be studied. Embryonate eggs will be irradiated with varying doses of x-rays prior to and subsequent to the inoculation of C. burnetii. Tritium oxide (as a source of beta rays) will be injected in varying activities into embryonate eggs prior to and subsequent to the inoculation of Q fever organisms. As the embryos die or the eggs are sacrificed, smears of the yolk sac membranes will be made and the degree of infection estimated from stained preparations.

The effects of ionizing radiations on the growth of R. mooseri and R. akari in monolayer tissue cultures will be studied. Monolayer tissue cultures of KB cells adapted to calf serum will be irradiated with varying doses of x-rays prior to and subsequent to infections with R. mooseri or R. akari. Tritium oxide (as a source of beta rays) of varying activities will be injected into cell cultures prior to and subsequent to infections with the above organisms. The cells will be infected by centrifuging purified suspensions of R. mooseri and R. akari onto irradiated and non-irradiated cells in monolayer. The degree of infection at various time intervals after infection will be determined by the proportion of infected cells (early infections) and the numbers of rickettsiae (late infections) in fixed and stained preparations.

The effects of freezing slowly and rapidly (–20°, –40°, –63°, –76° and –192°) and drying by vacuum sublimation at several temperatures (+50°, +20°, 0°, –20°, –40°, –63° and –76°) on the infectivity of viruses and rickettsiae following exposure to ionizing radia-

tions will be investigated. Influenza virus (strain A), infectious bronchitis virus and polio virus (Type II) will be the viruses studied; R. mooseri, R. akari, and C. burnetii will be the rickettsiae studied.

Rossi, Harald H. AT(30-1)2740, BP-1  
A1A586 RELATIVE BIOLOGICAL EFFECTIVENESS OF FAST NEUTRONS AS A FUNCTION OF NEUTRON ENERGY. (Cooperative project with Dr. V. P. Bond and co-workers at Brookhaven National Laboratory.)  
Columbia Univ., New York. Coll. of Physicians and Surgeons.

It is apparent from physical measurements that energy density within tissues irradiated by fast neutrons depends markedly on neutron energy and that the most inhomogeneous energy density occurs in the case of neutrons having energies of the order of a few hundred kev. This project is designed to test the assumption that biological effectiveness is also greatest in this energy range. The following biological effects are being studied in the case of CF1 mice:

1. Reduction of spleen weight
2. Reduction of thymus weight
3. Destruction of spermatogonia
4. Cataract induction

The monoenergetic neutrons are obtained from a Van de Graaf generator and are in an energy range between 20 and 2,000 kev.

Rossi, Harald H. AT(30-1)2740, BP-2  
A1A587 BIOLOGICAL EFFECTIVENESS OF RADIATION ON CELLS IN TISSUE CULTURE.  
Columbia Univ., New York. Coll. of Physicians and Surgeons.

In order to provide accurate numerical data for the testing of radiobiological theories, particularly with reference to changes in biological effectiveness with LET, tissue cultures operated according to the Puck technique are to be irradiated. Initial experiments employing x- and gamma rays will be carried out to furnish an adequate base line and in order to determine the precision obtainable. This is to be followed by alpha irradiation utilizing special sources which are being developed. These sources will contain alpha emitting nuclides uniformly distributed in a plastic matrix. These experiments are to be extended to studies of the effect of fast neutrons on these cells.

Caveness, William F. AT(30-1) 3014  
A1A600 DELAYED EFFECTS OF X-IRRADIATION ON THE CENTRAL NERVOUS SYSTEM OF THE MONKEY.

Columbia Univ., New York. Coll. of Physicians and Surgeons. April 1962–March 1963.

To X-irradiate the right hand-face area of the motor cortex of the Macaca mulatta with 3500 R in single and divided exposures at four age levels from birth to adulthood. Prior and subsequent to the exposures, serial electroencephalographic and clinical observations will be obtained. With the advent of any sustained EEG or clinical abnormality in each set of animals, that group will be sacrificed for definitive histological studies.

### A1B Chronic Whole-Body Irradiation Effects

See also A1G10, B1B294, D1B283, and D1D184.

Wood, David A. AT(11-1)34-41  
A1B46 AGE AND VULNERABILITY TO X-RAYS.  
California. Univ., Berkeley. SAN. SP 6; MYr 5.

#### Somatic Effects

The renal histopathology of the mouse is under intensive study. Why are the delayed and late effects much more severe in animals exposed at birth than when exposed at age two weeks or later? These studies consider the following: glomerular development and differentiation; the nature of progressive intercapillary glomerulosclerosis; globulin deposition in the glomerulus as revealed by fluorescence microscopy. The techniques include electron microscopy.

#### Genetic Effects

A preliminary study of the mutation rate at the histocompatibility loci of BALB/c and C57BL/6 mice has been completed, and a large scale definitive study is now under way. Male mice of one line are irradiated (522 rads, 250 kv X-rays), and 3 months later are mated with unirradiated females of the other line. The F<sub>1</sub> progeny are tested with skin grafts. The controls are the progeny of unirradiated parents.

The number of loci which determine the histocompatibility of BALB/c and C57BL/6 mice is being determined.

Polygenic effects of irradiation are being studied in terms of the life span and tumor incidence rate at autopsy of the progeny of irradiated male mice.

Cannan, R. Keith AT(49-7)1906  
A1B49 MORTALITY AND MORBIDITY IN  
RADIOLOGISTS.  
National Academy of Sciences. WASH.

The purpose of this project is to secure, by means of a questionnaire, pertinent biographical and radiological exposure data on all current and new members of the American College of Radiology and the College of American Pathologists, as well as members of their families. It is hoped that the information obtained will provide significant data bearing on the possible biological effects of chronic exposure of radiologists to radiation. Most of the questionnaires have been returned and the data are in process of coding and analysis by Doctors Seltser and Sartwell of the School of Hygiene and Public Health, Johns Hopkins University. The project, designed for an initial five-year period, is jointly supported by the Atomic Energy Commission and the National Institutes of Health.

Overman, Richard R. AT(40-1)1642  
A1B127 THE PATHOLOGIC PHYSIOLOGY OF  
"NON-RECUPERABLE" DAMAGE RESULTING  
FROM X AND GAMMA RADIATION IN DOGS AND  
PRIMATES.  
Tennessee. Univ., Memphis. Coll. of Medicine.  
OROO. SP 10; MYr 0.6.

A broad spectrum of physiologic, biochemical, pharmacologic, isotopic and radio-chemical techniques is being applied to the study of non-recuperable damage from sublethal doses of x and gamma radiation in dogs and monkeys. In addition to the description of physiologic changes in the cardiovascular system, fluid compartment volumes, ionic distribution, renal function, liver function, gastrointestinal system, hematology and adrenal cortical function occasioned by exposure to sublethal doses of whole-body x or gamma radiation, this research is directed as well toward elucidating the effects on functional capacities of organs and organ systems. Whereas the natural physiologic reserves of a given system may mask underlying alterations produced by sublethal doses of ionizing radiation, tests of organ and organ system capability under additional stressful conditions (as hemorrhage, exercise, hyposcopia, hypercapnia, increased water or electrolyte loads, hypoglycemia, dehydration, hyponatremia, hypokalemia, etc.) may well be revealing of functional impairment. If it is possible to quantitate such impairment, then a functional test of prior radiation damage can evolve and, together with comparisons made at different radiation doses, a basis be established for predicting future safe limits of repeated sublethal radiation exposure.

Muller, Harry D. AT(11-1) 1119  
A1B155 STUDY OF THE X-RAY IRRADIATION OF

THE DEVELOPING AVIAN EMBRYO AS A FACTOR OF AGING.

Colorado State Univ., Fort Collins. COO. January 1962–December 1962. SP 2.

This investigation will concentrate its attention on the specific role of single doses of irradiation received during embryonic development upon subsequent aging and other pertinent biological processes.

Avian embryos produced from Single Comb White Leghorn eggs from stock of uniform genetic composition will be irradiated during the third, eighth, and thirteenth days of their embryonic development. At each stage of development, three irradiation treatments will be administered, based upon previously determined LD<sub>50</sub>/full term embryo dosages. Dosages administered will be equivalent to 50 percent, 100 percent, and 150 percent of the LD<sub>50</sub>/full term embryo dosages.

Direct effects upon the survivors of embryonic irradiation will be measured during the growth process, both the rapid early phase and the slower secondary phase which continues for several years, covering the life span of the individual. Records will be maintained of survivors' body weights, from birth, as an index of growth pattern.

As an integrated portion of the study, reproductive investigations will be carried out on survivors of the embryonic irradiation treatments to determine the effects of embryonic irradiation upon fecundity.

It is strongly felt that work carried out using the chicken embryo will offer substantial background information for later work with larger animals concerning the effects of irradiation during early life upon life span and related biological processes.

Ruch, T. C. AT(45-1) 1094  
A1B222 IONIZING RADIATION STUDIES ON MICE.

Washington. Univ., Seattle. School of Medicine. RLOO. SP 3; MYr  $\frac{1}{2}$ .

Studies underway were designed to obtain information on the effects of low level irradiation emphasizing the early physiological changes that may predict the late effects or explain the paradoxical responses noted by some workers.

Individually-caged male mice (C57B1 x 101) are being studied following 100, 200 and 365 day exposures to external  $\gamma$ -irradiation. The facility used for irradiation was a Co<sup>60</sup> source that allowed exposure at levels of 0.1 or 0.2 r/hr for 8 hr/day, in the same room which housed control animals.

The response of animals pre-irradiated for 100 or 200 days (and their controls) to challenging doses

of 300 r of X-rays was evaluated by periodic post-challenge determinations of leucocyte counts, and weight of thymus, spleen, testes, and small intestines. None of these parameters definitely distinguished the pre-irradiated from the control mice, however a slight depression in the weight of the testes in the pre-irradiated animals was noted. The mortality of the mice following a lethal challenge was also used as a measure of the effect of prolonged low-level irradiation. There appeared to be no over-all effect of pre-irradiation with 320 r given over a period of 200 days. There was, however, a suggestion of a "protection" effect in a group pre-irradiated for 100 days (160 r total) and then challenged with an acute dose of 700 r of X-rays. Animals exposed to 0.1 to 0.2 r/hr for 8 hr/day for one year showed a 47% and 54% mortality at 30 months, compared with a 40% mortality in the control animals.

Wood, Vida G. AT(11-1)885  
A1B225 "THE EFFECT OF X-RADIATION ON LONGEVITY IN DROSOPHILA MELANOGASTER."  
Taylor Univ, Upland, Ind. COO.

The objective of the study is to determine the effect of radiation upon the post eclosion length of life of Drosophila melanogaster. The radiation source will be an x-ray machine. Eggs, larvae, pupae and adults of specific ages will be given varying dosages of x-ray and then kept in vials with food for further observation until their deaths. They will be transferred to fresh vials regularly. Both unmated and mated flies will be studied. So far small dosages (1200 roentgen and less) have indicated an extension of life span that is significant, while larger dosages (5,000 roentgen and over) show a decrease in length of life. There is also variation in the effect on sexes, the females having the advantage over the males. Unmated radiated flies seem to live longer than mated. Amounts used so far include: for eggs, 25–500 roentgen; for larvae, 500 and 1,000 roentgen; for imagoes, 250 to 15,000 roentgen. Other amounts need investigation so that a complete sequence may be shown.

We also plan to make comparisons of radiation effects of normal wild type flies with that of a chromosome deficient stock. The purpose of this is to attempt to verify the hypothesis that radiation damage is the result of chromosome damage or loss. The preliminary work with these flies indicates that those with certain types of genetic makeup seem to be more vulnerable to radiation damage than others. Further investigation is necessary to establish consistent results.

Storer, John B. AT (30-1) 2313  
A1B311 REPAIR RATE AND LIFE SPAN IN RADIATION DAMAGED MICE.

Roscoe B. Jackson Memorial Lab., Bar Harbor, Me. NYOO. January 1962-December 1962.

Studies are continuing on determination of the rate at which mice repair radiation damage as a function of age and previous radiation exposure. On the basis of differences in radiation response among inbred strains and differences in their normal life spans, the hypothesis has been advanced that life span is inversely related to cell turnover times. Work proposed includes a more direct estimation of cell turnover times for various inbred mouse strains in order to evaluate this hypothesis. It has also been found that survival under daily radiation exposure is highly correlated with recovery rate as estimated by split dose methods. It is proposed to evaluate this relationship more closely to determine whether such survival times can be used directly to estimate recovery rate. If this method of estimation proves reliable then the recovery rate for various species can probably be established more precisely.

Stein, Otto L. AT(45-1)1302  
A1B473 THE USE OF HYDROGEN ISOTOPES IN THE STUDY OF PLANT MORPHOGENESIS.  
Montana State Univ., Missoula. RLOO.

We propose to continue our studies on the effect of high concentrations of heavy water on root morphogenesis. This involves measurements of growth rates, mitotic activity as well as anatomical and morphological analysis. We will utilize sterile culture techniques in order to obtain better quantitation and this also will permit us to study adaptation of roots under continuous exposure to D<sub>2</sub>O. We will also use tritiated thymidine labeling techniques on this system in order to clarify the cytological effects observed.

Chadwick, Donald R. AT(49-7)1298  
A1B482 ATOMIC BOMB CASUALTY COMMISSION, NATIONAL ACADEMY OF SCIENCES-ATOMIC ENERGY COMMISSION-UNITED STATES PUBLIC HEALTH SERVICE COOPERATIVE STUDIES ON LONG RANGE RADIATION EFFECTS ON HUMAN BEINGS.

Public Health Service, Washington, D. C. WASH. SP 8; MYr 8.

The objective of this project is to provide support of the Public Health Service's participation in the defined continuing ABCC program. Commissioned medical officers are assigned on rotating two-year assignments to Japan. Eight officers have been assigned during the current year at Hiroshima and

Nagasaki and have participated in the medical, clinical and pathological, and epidemiological studies of defined samples of survivors. In addition, they have participated in carrying out special studies to detect physiological and biochemical changes correlated with radiation exposure and ultimate cause of death. The project will continue to provide personnel support to the ABCC longevity, morbidity and mortality studies along with the necessary ancillary supporting programs at ABCC, such as the shielding, dosimetry, statistics, morbidity, demography, pathology, and medical sociology studies currently under way.

## A1D Gastro-Intestinal System

Hampton, James C. AT(11-1)1244  
A1D401 AN ELECTRON MICROSCOPIC AND AUTORADIOGRAPHIC STUDY OF INTESTINAL RADIATION DEATH IN THE MOUSE.  
Northwestern Univ., Chicago. Medical School.

The study to be conducted under terms of contract No. AT(11-1)-1244 is a continuation of work that was initiated under contracts AT(40-1)-2661 and AT(40-1)-2890. Under the above contracts cytological changes in villus epithelial cells of the mouse and alterations in absorptive capacity based upon the absorption of corn oil in the mouse following administration of 3000 rads had been studied. Continuation of the effects of this dose of irradiation, and lesser doses, will be extended to an analysis of the effects of irradiation upon proliferative cells in the neck and upon Paneth cells in the bases of the intestinal crypts. The approach to be used will include correlated electron microscopic and autoradiographic studies utilizing tritium-labelled compounds to follow DNA and protein synthesis in these cell compartments. It is anticipated that histochemical techniques will be applied to ultra thin sections at the electron microscope in studies on the enzymatic activity of intestinal epithelial cells in the normal and irradiated animal.

## A1E Hematopoietic and Cardio-Vascular Systems

See also BIC329.

Zweifach, B. W. AT(30-1) 1680  
A1E129 HISTOCHEMICAL AND BIOLOGICAL AL-

TERATIONS FOLLOWING WHOLE BODY X-IRRADIATION.

New York Univ., New York. Medical Center. NYOO. SP 4; MYr 8.

Vascular and tissue alterations induced by x-irradiation (WBR) were studied in both adult males and pregnant rats. This summary is limited to adult males. Histochemical (dehydrogenase systems) and physiological techniques (direct visualization, blood pressure, capillary resistance (CR), blood counts) were used. (1) Tetrazolium histochemistry and direct visualization indicate that endothelium per se remains unaltered after lethal doses (WBR). Two defects predispose to local hemorrhage: (a) hemostatic—not directly related to the leukopenia or thrombocytopenia, but rather to a proteolytic imbalance which can be "corrected" by injections of 5-HT. (b) defect in basement membrane and its associated intercellular cement complex as demonstrated by the disruptive action of versens, and by negative pressure measurement for CR. (2) Standard doses of WBR were much less lethal in animals preconditioned through a regime of endotoxin "tolerance." (3) Functioning of RES (following WBR) was not significantly impaired with respect to carbon clearance or cell metabolism. Clearance capacity once depressed remained subnormal for unusually long periods. (4) Dehydrogenase activity of liver and spleen homogenates following lethal WBR falls markedly as early as 5-10 minutes p.r. and remains so up to 30 days in the case of 3 Krebs cycle substrates: malate, succinate, isocitrate. Pentose cycle activity was depressed (glucose-6-phosphate, 6-phosphogluconate) within 5-10 minutes p.r. through the fourth day when a rise occurred. A second fall occurred in the third week. (5) There was an obvious difference in the lethality course with reference to seasonal and climatic conditions, as well as weight, age, strain. Resistance was highest during the Spring.

Speirs, R. S. AT(30-1) 2414  
A1E130 ACTION OF TRITIATED TETANUS TOXIN AND TOXOID UPON THE ANTIBODY FORMING MECHANISM.

New York. State Univ., New York. Downstate Medical Center. NYOO. SP 3; MYr 2.5.

This project deals with the origin, function and fate of myeloid and lymphoid cells especially in relation to hypersensitivity, immunity, and radiation protection. Quantitative and qualitative cellular determinations are made of cellular reactions at the site of inflammation produced by injections of tritiated tetanus toxin and toxoid. Studies of DNA and RNA synthesis, chemotaxis, phagocytosis, and cellu-

lar morphology are correlated with measurements of serum antibody titers. In addition suspensions of inflammatory cells are observed with phase microscopy, transferred to irradiated animals or grown in tissue culture.

Consideration of the cellular reaction to antigen has given an insight into the relationship of the myeloid and lymphoid cells to each other, and has led to the development of concepts of hypersensitivity and immunity. It has been observed that components of antigenic material persist for many months in cells capable of moving from one part of the body to another. These cells are hypersensitive. Following re-exposure to antigen they become swollen, highly vacuolated, release biologically active materials, and become chemotactically attractive to lymphocytes and eosinophils. Antigenic material is carried by eosinophils from the original hypersensitive cell to viable macrophages. These macrophages then cease to be phagocytic and their cytoplasm becomes highly basophilic. Concomitantly antibody appears in the exudate and serum.

Further studies are being carried out to extend these observations and to initiate antibody production in vitro.

Osgood, Edwin E. AT(45-1)581  
A1E220 STUDIES OF GENETIC ALTERATIONS IN HUMAN CELLS AND MOLECULES AND FACTORS INFLUENCING THEM.

Oregon. Univ., Portland. Medical School. RLOO.

The primary objective of this program is the structural evaluation of abnormal genetically determined products and their correlation with chromosome abnormalities and genetic pedigrees.

The structural characterization of the mitogenic factor of the phytohemagglutinin that stimulates normal blood leukocytes to divide in in vitro cultures.

Electron micrographs will be made in collaboration with the Pathology Department of the individual fibrils in our uncoiled and dissociated chromosomes. Specific phases of biochemical genetics in both the somatic and germ cell mutations will be studied. The immunohematology section will continue the studies of the fundamental nature of the antigen and antibody reaction.

In collaboration with Dr. Bethard of General Atomics Corporation, the study of the trace elements in normal and leukemic human leukocytes will be continued by the method of neutron activation.

The comparison of P<sup>32</sup> and external irradiation with the various chemotherapeutic agents will be continued. As a result of this study, eventually we

should be able to determine the relative hazards of each of these agents for producing genetic changes in somatic cells as well as their relative effectiveness as therapies compared to titrated total body irradiation.

Everett, Newton B. AT(45-1)1377  
A1E369 LYMPHOCYTE FORMATION, LIFE SPAN, FATE AND POTENTIAL FOR REPOPULATING HEMOPOIETIC TISSUES OF IRRADIATED ANIMALS.  
Washington. Univ., Seattle. School of Medicine. RLOO.

The origin, rate of formation, circulating life span and fate of cells in the lymphoid complex will be studied in guinea pigs of the Hartley strain and in rats of the Lewis strain. Attempts will be made to determine which cell type or types are capable of re-establishing hemopoiesis after destroying or depressing the proliferative elements of the blood forming tissues through total body irradiation.

Donor cells labeled with  $H^3$ -thymidine will be administered to recipients after irradiation with 150 to 800 r from a cobalt 60 source. Labeled cells to be transferred will include lymphocytes from the thoracic duct, thymocytes and cells from lymph node, spleen and bone marrow. Emphasis will concern the possible role of small lymphocytes, particularly those of thymic origin, in re-establishing certain blood cell lines in the respective tissues.

High resolution radioautography will be employed for determining the fate and potential of transfused labeled cells and a particular assessment will be made of possible specific cell line recovery in the irradiated and transfused animals.

Di Luzio, N. R. AT(40-1)1999  
A1E385 RETICULO-ENDOTHELIAL INVOLVEMENT IN RADIATION INJURY AND RECOVERY.  
Tennessee. Univ., Memphis. School of Basic Medical Sciences. OROO.

Previous studies conducted in this laboratory have demonstrated that reticulo-endothelial (RE) hyperfunction is not altered by lethal total body X-irradiation. Normal rats manifest a significant depression in RE activity following radiation exposure. Subsequent studies indicated that the presence of an enhanced phagocytic potential of the RES in lethally X-irradiated mice results in a complete failure in recovery following the transplantation of heterologous and homologous marrow, but normal acceptance of isologous marrow. These studies indicated that early acceptance or rejection of bone marrow

transplants is influenced to a considerable degree by the functional state of the RE system.

The present study will attempt to define further the role of the RES in radiation chimeras. Experiments will be conducted to determine if rejection of transplanted homologous or heterologous marrow can be induced by the administration of RE stimulants after transplantation has been achieved. Studies will also be conducted to determine if RE depression, induced prior to radiation will alter survival to various doses of X-rays. It will also be ascertained whether the response to heterologous and homologous bone marrow transplantation is also altered in RE hypoactive mice. The results of these studies should contribute to the understanding of RE involvement in radiation injury and transplantation.

Sorensen, D. K. AT(11-1)910  
A1E445 BOVINE LEUKEMIA: STUDIES OF OCCURRENCE AND DISTRIBUTION INCLUDING INVESTIGATION OF FAMILIAL AND ENVIRONMENTAL FACTORS WITH SUPPORTING CLINICAL, HEMATOLOGIC AND PATHOLOGIC STUDIES.  
Minnesota. Univ., St. Paul. Coll. of Veterinary Medicine.

We are studying the occurrence and distribution of lymphocytic leukemia in cattle in Minnesota and adjacent parts of Wisconsin in an effort to determine the incidence of the disease in our study area and to determine if the disease is increasing in incidence. Annual reports of the Meat Inspection Division of the U.S.D.A. reveal that cattle condemnations attributed to malignant lymphoma showed an apparent increase from 9.7 to 18.8 per 100,000 cattle slaughtered during the years 1952 to 1962. The total number of cases diagnosed in the 29 months of the study are 688. During the past year the incidence rate of leukemia in female dairy cows two years old or older was 16.1 per 100,000 head as compared to 11.5 the previous year. The incidence rate varied according to the age of the animals from 11.7 in the two to five year old group to 38 in the 10 year old or older group. The incidence rate also varied with the size of the herd from 12 in the 8 to 9 cow herd to 71 in the 50 cow or over herd.

We are compiling data on selected environmental factors and familial factors to determine if any relationship exists between these factors and the occurrence of leukemia.

Studies on leukemic herds will be continued. Hematologic studies on apparently normal herds of cattle reveal animals with definite and consistent quantitative and morphologic alteration of lymphoid cells. Some herds have a considerable number of animals with lymphocyte patterns. It has been postulated that

these animals may be in the prodromal or preclinical stage of leukemia. Selected herds and animals will be studied clinically and hematologically to more thoroughly investigate this phenomenon.

Conley, C. Lockard AT(30-1)1208

A1E550 BLOOD COAGULATION, HEMORRHAGIC DISEASE.

Johns Hopkins Univ., Baltimore. School of Medicine. NYOO. SP 5; MYr 4.

Studies already completed have demonstrated that platelet aggregation, viscous metamorphosis and clot retraction are initiated by thrombin in the presence of divalent cation. The substrate of thrombin in these reactions is fibrinogen which is adsorbed to the surface of platelets. Serum from which all traces of residual prothrombin and thrombin have been removed does not cause aggregation of platelets. Platelets from which the fibrinogen has been removed by trypsin do not react to thrombin, although reactivity is restored when platelets are resuspended in a fibrogen solution. Studies to be performed include the mechanism by which thrombin releases serotonin from platelets and the possibility that this reaction is also mediated by fibrinogen. In addition, a study is to be made of the kinetics of potassium release from platelets by thrombin. Detailed morphologic studies of platelets are to be made during the various stages of viscous metamorphosis. Comparative studies will be made of the reactivity of platelets of animals of other species.

Monasterio, Gabriele AT(30-1) 2648

A1E576 STUDY OF THE HEMODYNAMIC CHARACTERISTICS OF THE PULMONARY CIRCULATION AND THE LEFT HEART BY MEANS OF RADIOCARDIOGRAPHY.

Pisa, Italy. Universita. Centro di Medicina Nucleare. November 1961–October 1962.

The scope of the proposed work is the development of radiocardiography (RCG) into a quantitative method of study of the pulmonary circulation and left heart hemodynamics.

In the first year of operation of the project, progress has been made in the technical aspects of the method: by modifying a commercial ratemeter, an instrument has been developed, the "periodical integrator", which provides direct undamped records of radioactivity changes.

It has also been shown that the RCG curves can be adequately described in terms of an analog model with the following characteristics: right and left ventricles behaving as mixing volumes with constant fractional emptying rates, pulmonary circulation as a system of

parallel channels with different traversal times and relative flow distribution of a Poisson type.

The research program for the next year contemplates:

a) the further development of the "periodical integrator", which should be triggered by an external pulse, represented the R wave of the electrocardiogram thus introducing a further simplification in the analysis of RCG curves.

b) The extensive use of the analog computer for the analysis of RCG curves according to the model described, with the double aim of obtaining values for pulmonary and left heart blood volumes in various conditions, and that of examining the possibility of other distributions of pulmonary traversal times.

Stoloff, I. L. AT(30-1)-2862

A1E599 FRACTIONATION OF THE CELLULAR ELEMENTS OF BONE MARROW AND OTHER HEMATOPOIETIC TISSUES IN AN ATTEMPT TO AVOID HOMOLOGOUS DISEASE AND AID THE ACCEPTANCE OF HOMOLOGOUS TISSUE GRAFTS.

Jefferson Medical Coll., Philadelphia. NYOO.

Attempts have been made to selectively remove cells of mouse bone marrow capable of antibody production by agglutination using specific antisera and phytoagglutinins. The process of preserving cells by freezing in glycerol was shown to destroy antitoxin producing cells, but not selectively. The capacity of marrow obtained from hyperimmunized donors to protect irradiated hosts against tetanus toxin challenge was used to detect antibody producing cells in these experiments.

Studies were made to determine the fate of antitoxin producing cells after transfer to irradiated homologous and isologous hosts. A decline in antitoxin production by donor cells in some hosts with homologous disease suggests a host vs graft reaction. In one strain combination there was little decline in antitoxin production in hosts sick with homologous disease suggesting a graft vs host reaction was responsible for the wasting syndrome.

Further attempts are planned to fractionate marrow in an attempt to prevent a graft vs host reaction in the one strain combination where this type of reaction is suspected.

## A1F Nervous System

*See also DIA192.*

Koolla, Werner P. AT(30-1) 2548

A1F1 USE OF X-IRRADIATION IN THE STUDY

OF FUNCTIONAL ORGANIZATION AND CHEMISTRY OF THE CENTRAL NERVOUS SYSTEM. Worcester Foundation for Experimental Biology, Shrewsbury, Mass. NYOO. April 1962-March 1963.

Recent experiments at this laboratory on the effect of x-irradiation on the permeability of the blood-brain-barrier (B-B-B) to  $P_{32}$  have shown an early post irradiation decrease in brain uptake of  $P_{32}$ . Continuation of this study is planned to:

- (1) Work out dose-time-response relations,
- (2) study the effect on the blood-cerebrospinal fluid barrier, (3) determine localization of permeability changes by autoradiography, and
- (4) study radiation induced changes in intracranial pressure.

Preliminary experiments on radiation induced neurologic deficit and CNS death in mice have made a promising start. The characteristics of this response will be studied by anatomical fraction and time-dose-response relationships. Because our preliminary findings showed a distinct sexual difference in the CNS radiosensitivity we plan to study the effect of castration and estrogen treatment on this response.

We plan to initiate studies on the effect of x-irradiation on the developing cerebellar vermis of the kitten. Both electrophysiological and morphological parameters will be studied. Preliminary studies on the normal ontogenesis of evoked acoustic and optic responses on the vermis will begin shortly as a prerequisite to the irradiation studies.

We also plan to complete our studies on the effect of *in vitro* x-irradiation on the migratory activity of human polymorphonuclear leucocytes (preliminary report to appear in Fed. Proc., April, 1961.)

Smith, James C. AT(40-1)2903  
A1F11 A STUDY OF THE USES OF X RAYS AS MOTIVATING STIMULI.  
Florida State Univ., Tallahassee. OROO. SP 3; MYr 1.

The proposed research is a continuation of the study of the nature of ionizing radiation as a motivating stimulus. The effects of drugs such as atropine, physostigmine, and nicotine on conditioned aversion to saccharin will be studied using x rays as the noxious unconditioned stimulus. Behavioral studies will be continued to more thoroughly investigate the time intervals involved in the conditioning. The temporal thresholds for both the conditioned and unconditioned stimulus will be studied.

In an attempt to investigate the center of receptivity of the x rays, the effects of small doses on

the motility of the intestine will be studied. Using a strain gauge and a linear recorder, movements in the jejunum will be studied during exposure to radiation under the conditions of the above drugs.

Further attention will be given to the possibility of direct perception of radiation. Work will be done using electrophysiological preparations from *Limulus* eye and moth tympanic nerve fiber in observing changes in thresholds and possible direct effects.

James, W. T. AT(40-1)2787  
A1F12 EFFECT OF IONIZING RADIATION ON CONDITIONING.  
Georgia. Univ., Athens. OROO. SP 3; MYr 2.

Ongoing research on the effects of small (5-50/rad) doses of gamma radiation on the formation and maintenance of classical conditioned responses in the dog will be continued. An examination of the relationships between radiation exposure and intracranial self-stimulation will be undertaken.

Adey, W. R. AT(11-1)34-60  
A1F39 IRRADIATION EFFECTS ON BRAIN WAVE CORRELATES OF CONDITIONED BEHAVIOR.  
California. Univ., Los Angeles. SAN. SP 12; MYr 4.

On the basis of studies already completed, which have indicated that x-radiation delivered focally to hippocampal structures of the cat in doses ranging from 100 to 15,000 r produce changes in hippocampal electrical activity and learned discriminative behavior, it is proposed to test the effects of similar irradiation in a different behavioral paradigm, with delayed response performances requiring integrity of recent memory. These studies would involve both x-radiation and particle irradiation from a cyclotron source. Electrographic data will be analyzed by computer techniques already utilized in these studies, including cross-correlation and cross-spectral analysis of hippocampal electrical wave trains occurring in control records and after irradiation, with separate analysis of the "delay" and "approach" epochs of these records for frequency, coherence and phase patterns. These studies would also extend application of a transducing technique newly developed in our laboratory, with impedance measurements in small volumes of cerebral tissue, and which, in preliminary applications, has suggested that it may be a sensitive measure of long-lasting changes in states of excitability induced in cerebral tissue by focal irradiation. Animals have been maintained in good health for periods of two years or more after focal brain irradiation, and will



be extensively studied in an effort to detect delayed and long-term radiation effects.

Clemente, Carmine D. AT(11-1)34-68  
A1F41 ANATOMICAL AND ELECTROPHYSIOLOGICAL STUDIES OF BRAIN RADIATIONS IN ANIMALS USING HIGH-ENERGY IONIZING RADIATIONS.

California. Univ., Los Angeles. SAN. SP 2.

Morphological and electrophysiological effects of ionizing radiation are being examined in the cerebral cortex of rats, cats and monkeys. The lesions being made are (1) laminar lesions (employing the Bragg effect) in a specific layer of the cortex, (2) lesions which destroy all tissue to the end of range, (3) line lesions in the white matter below.

During the current year we have been extending our work to fine structure by electron microscopic analysis of the effects of 48 mev alpha particles at doses of 6,000 to 9,000 rad. at times ranging from 5 days to two years on a series of .50 rat brains.

Line lesions in the cortex and complete destruction down to a given layer is being studied in 6 cats and monkeys with lesions in the primary receiving areas. The electrical response to natural sense organ stimuli and electrical stimulation of the irradiated cortex is being studied in cats and monkeys to check on last year's findings in the rat.

Extensive time and dosage studies for radionecrosis of cerebral neurons in the rat are in the final stages of analysis.

Timiras, P. S. AT(11-1)34-82  
A1F44 THE IMMEDIATE AND LATE EFFECTS OF LOW DOSES OF WHOLE-BODY X-IRRADIATION ON BRAIN EXCITABILITY AND BRAIN METABOLISM IN RATS.

California. Univ., Berkeley. SAN. SP 4; MYR 2.8.

The effects of whole-body X-irradiation in doses of 15 to 500 r on the function of the central nervous system are being investigated in rats of different ages. Threshold for electroshock seizures is lowered transiently by a single exposure to doses of 15 to 250 r and more permanently by 500 r. Patterns of maximal tonic-clonic electroshock seizures are altered by doses of 50 r or above: the duration of tonus is lengthened, that of clonus is shortened and the recovery period following the seizure is prolonged. The evoked potential produced in the rat prepyriform cortex by lateral olfactory tract stimulation has a reduced latency and a smaller amplitude of the second wave in animals exposed to 250 r than in controls. Direct electrical spinal cord stimulation shows a shortening of hind-limb flexion after doses

of 50 r and above. In addition, drugs like reserpine, chlorpromazine and iproniazid have synergistic actions with irradiation on electroshock convulsions. Finally, whole-body 500 r X-irradiation of newborn rats accelerates functional brain maturation during infancy and induces long-lasting brain hyperactivity. The results of these experiments have been interpreted to indicate that the function of the brain and the spinal cord is sensitive to relatively low doses of whole-body X-irradiation both in adult and developing rats. The principal postirradiation changes appear to consist of an increase in neuronal activity associated with a release from normal inhibitory mechanisms. Studies on some aspects of central nervous system chemistry are currently in progress to correlate neurophysiological with neurochemical effects of radiation.

Brownson, Robert H. AT(40-1)2904  
A1F64 ACUTE BRAIN DAMAGE INDUCED BY X-IRRADIATION.

Medical Coll. of Virginia, Richmond. OROO. SP 3; MYR 2.08.

This investigation is designed to determine whether certain drugs (cysteamine, serotonin, colchicine, histamine, and nembutal, etc.) which have been shown to have protective and/or sensitizing action to ionizing radiation on the basis of survival will also prevent, attenuate or, on the other hand, increase the acute alterations of certain glial elements which have been shown in this laboratory to serve as a consistent index to severity of central nervous system radiation damage. The investigation will also include a study of the relation of the age of the experimental animal to the degree of glial cell change resulting from ionizing radiation. This factor is especially significant in light of the close relationship between actively dividing tumor cells (most of which are of neuroglial origin) and young or undifferentiated glial cells of the normal brain. Preliminary evaluations indicate the following:

1. In animals subjected to radiation alone, the maximum number of altered cells was observed after 6 hours. In animals pretreated with either serotonin, nembutal or MEA, the maximum effect occurred in 6 hours, but the total number of altered cells was greater. In animals given AET or cysteine the maximum increase in altered glial cells was observed at 24 hours.

2. Neuroglial radiosensitivity appears to be inversely proportional to age, the 1-week animals demonstrating an extremely high incidence of conspicuous permanently altered cells, with only an

occasional altered cell appearing in the 1-year group.

Lott, James R. AT(40-1)2419  
A1F82 EFFECTS OF X-IRRADIATION ON THE  
NERVOUS SYSTEM.

North Texas State Univ., Denton. OROO. SP 3;  
MYr 2.25.

This program of research is divided into 3 phases:

Phase 1. A study is being made on the effects of x-irradiation on the ventral root potentials in cats. Once an effect has been established, an attempt will be made to alter these effects with various drugs reported to affect spinal cord activity. (Thorazine, Dimethylacetamide, Sinaxar).

Phase 2. This phase concerns the effect of x-irradiation on the permeability of various types of isolated nerve fibers. The movement of  $\text{Na}^{22}$  is being followed before, DURING, and following x-irradiation of rat and frog nerves.

Phase 3. This phase involves a study of the effects of x-irradiation on the plasma corticosterone levels in rats. Samples of blood are taken at various intervals following x-irradiation (whole body and regional) and determinations of the corticosterone levels made using a fluorometric technique. The time intervals are: immediate, 3 hrs, 6 hrs, 12 hrs, and 24 hrs. post-irradiation. Other parameters also measured are leucocyte differentials, ascorbic acid levels, hematocrits, adrenal weights, and cholesterol levels. Data obtained from head-irradiated groups are being compared with data obtained from whole body and head shielded groups of rats.

Arnold, W. J. AT(11-1) 249  
A1F113 PSYCHOLOGICAL EFFECTS OF CRA-  
NIAL X-IRRADIATION ON PSYCHOLOGICAL  
PROCESSES IN RATS.

Nebraska. Univ., Lincoln. COO. SP 1; MYr 0.33.

This project continues the study and report of the effects of 5000 r irradiation of the brains of rats upon a variety of behavioral processes such as emotionality, maze learning and retention, instrumental learning, discrimination learning, concept formation, hunger and thirst motivation, locomotor activity, visual exploratory motivation, abnormal behavior symptoms, and classical (Pavlovian) conditioning. Also included are observations of the effects of cranial irradiation upon life span.

Altman, Joseph AT(30-1)3645  
A1F131 AUTORADIOGRAPHIC INVESTIGATION  
OF BRAIN METABOLISM UNDER NORMAL, EX-

PERIMENTAL AND PATHOLOGICAL CONDITIONS.  
Massachusetts Inst. of Tech., Cambridge. NYOO.  
SP 2; MYr 2.

Objective of the research program is to investigate regional protein, RNA, and DNA metabolism in the central nervous system by means of fine-resolution autoradiography. (a) Using DL-leucine- $\text{H}^3$ , we are preparing autoradiographic maps of the brains of rats, and are carrying out microdensitometric measurements of the regional uptake of this radiochemical. (b) Possible shifts in regional brain metabolism are being investigated by administering DL-leucine- $\text{H}^3$  to animals manipulated physiologically (anesthesia) and behaviorally (forced exercise). (c) Using DL-leucine- $\text{H}^3$ , we also study changes in protein turnover in the brains of unilaterally enucleated rats with varying periods of postoperative survival to throw light on metabolic aspects of regeneration and degeneration in the visual system. (d) RNA metabolism in the brains of cats is investigated by using intraventricularly injected uracil- $\text{H}^3$  and adenine- $\text{H}^3$ . (e) We continue investigation of thymidine uptake by glia cells (and possibly neurons) in rats of different ages and in rats with different periods of survival after injection.

Fernandez-Moran, H. AT(30-1)2278  
A1F132 EFFECTS OF IONIZING RADIATION ON  
NERVE CELL ULTRASTRUCTURE. (Studies of the  
effects of ionizing radiation on the ultrastructure of  
developing nervous tissue as revealed by electron  
microscopy).

Massachusetts. General Hospital, Boston. NYOO.  
SP 4; MYr 2.5.

Electron microscope studies of nerve cell membranes and photoreceptors during development and under controlled experimental modifications, including ionizing radiation, will be continued. Integrated ultrastructural and biochemical studies of the molecular organization of cell constituents will be pursued as part of a comprehensive program comprising the following major aspects: 1) Continuation of correlated electron microscope and biochemical studies of mitochondrial membranes which have resulted in the detection and isolation of a fundamental unit of energy transduction, corresponding to the respiratory enzyme assemblies. Similar integrated studies of related membrane derivatives in myelin and photoreceptors will be carried out, leading to a better understanding of the fundamental principals underlying cell membrane organization in general. 2) Electron microscope and electron diffraction studies of DNA macromolecules in solution will be continued using special techniques (vacuum-tight microcham-

bers, low-intensity illumination with electron microbeam probes measuring only 100 to 1000 Å in diameter, etc.) These techniques will also be applied in systematic studies of other nucleic-acid-containing systems, including ribosomes, nuclear constituents, viruses under conditions approaching the native hydrated state. By means of the described techniques the electron microscope can now be used as a powerful tool both for the controlled production and the direct observation of radiation damage in pre-selected macromolecular regions of hydrated biological observation of radiation damage in pre-selected macromolecular regions of hydrated biological systems.

3) Collateral development work on improvement of preparation techniques and instrumentation for high resolution electron microscopy will include further application of low-temperature methods (cryofixation) using liquid helium II, and design of new types of high resolution "cryo-electron microscopes" immersed in a liquid helium II cryostat, using superconducting electromagnetic lenses.

Werboff, Jack . AT(11-1)821  
A1F149 THE EFFECT OF PRENATAL X-IRRADIATION ON THE BEHAVIORAL DEVELOPMENT OF THE ALBINO RAT.

Wayne State Univ., Detroit. Animal Behavior Lab. COO. October 1, 1962-September 30, 1963.

This current contract is a continuation of previous work in which low levels (100r or less) of X-irradiation were administered to gravid rats on various days of gestation (day 5, 10, 15, or 20) and the surviving offspring evaluated for behavioral alterations on a variety of performance measures.

Currently under investigation, offspring of mothers receiving 0, 25, 50, or 100r on day 5, 10, 15, or 20 of gestation are being evaluated on measures of learning ability early in life and without appetitive reinforcement. The tests are: classical conditioning of a leg-flexion response in the first day after birth, and maze learning ability in Lashley III water maze starting at 30 days of age. In addition, other offspring are being evaluated in an activity wheel over a five-day period, and for sensitivity to electroconvulsive stimulation. These tests are presented in an attempt to define the nature of the behavioral changes previously observed.

Bachofer, C. S. AT(11-1)205  
A1F152 MECHANISMS INVOLVED IN THE ACTION OF RADIATIONS ON LIVING CELLS.  
University of Notre Dame, Notre Dame, Ind. COO. SP 6; MYr 3.5.

The program currently involves a study of radiation effects on electroretinal responses, activities of the central nervous system, and activities of isolated nerves and muscles.

One line of research is concerned with the interrelationships between psychotropic drugs, x-rays, behavior, and electrical activity of the brain. Preliminary experiments indicate that the drugs actually protect the animals against irradiation. A study of the mechanism of action of these drugs is under consideration.

Another line of research is concerned with interrelationships between gamma radiation, visible light, and retinal responses in the frog. One problem to be investigated is the effect of oxygen on the normal electroretinogram and on the electroretinogram during irradiation. Another problem involves the difference between the off response to x-rays as compared to the off response to light.

A study of the effects of x-irradiation on isotonic contraction, isometric contraction, contracture, tetanization, and relaxation time of the isolated rat diaphragm is to be extended into an investigation of chemical protection of the muscle and sources of energy in the muscle.

The enhancement of activity of various isolated nerves, due to irradiation, is under further investigation in an attempt to determine what mechanism(s) might be responsible for this enhancement.

The effect of gamma radiation on synaptic transmission as opposed to axonal transmission is also under investigation.

Roth, Lloyd J. AT(11-1)847  
A1F156 IRRADIATION EFFECTS ON THE CENTRAL NERVOUS SYSTEM.  
Chicago. Univ. COO.

We are investigating the effects of X-irradiation on blood brain barrier (BBB) permeability in rats utilizing radioactively labeled indicators with specific distribution properties ( $I^{131}$ -serum albumin;  $S^{35}$ -sulfate). To date, we have been unable to demonstrate any significant alterations in BBB permeability in head irradiated rats employing methods (radiochemical assay and autoradiography) which are far more sensitive than dye staining techniques. Since we found the BBB in the rat to be more stable to X-irradiation than previously suspected, other indices for measuring CNS impairment are being used with the hope of relating these effects to the subtle alterations in BBB that may be coexistent.

The modification of the response to electroshock as well as the response to pharmacological agents with central action are two of the indices chosen to

examine CNS damage. In irradiated rats, the anti-convulsant action of acetazolamide has been found to be enhanced with respect to intensity, onset and duration of action. The nature of this enhancement will be studied with special reference to BBB alteration by the use of  $S^{35}$  acetazolamide. Other pharmacological agents will also be studied in the irradiated rat.

The results of these investigations should provide further insight into the nature of the BBB damage following irradiation.

Austin, George AT(45-1)1371  
A1F219 "THE EFFECTS OF IONIZING RADIATION ON SYNAPTIC ACTIVITY AND SINGLE NEURONAL POTENTIALS."  
Oregon. Univ., Portland. Medical School. RLOO. SP 2.

Our plan is to continue the same line of investigation which we have been working on for the past three years, mainly that of the mechanism of effect of acute radiation on the central nervous system in producing increased excitability. We plan to investigate the mechanism of increased excitability by studying the effects on the inhibitory postsynaptic potential, the effects on the cell membrane itself by investigation of current voltage relationships through the membrane, and by a combined physicochemical and histochemical study of water and oxygen in the tissue surrounding the neuron membrane. These studies will be based on the same techniques as we have used previously with the exception that we propose to extend our studies to more definite investigation of changes in membrane permeability. These may or may not be important but should the membrane become more permeable to the flow of excitatory current, this would of course make the cell more excitable regardless of the mechanism. There are at least two good methods of studying quantitatively, changes in ionic current with membrane potential. These can be briefly classified as the short-shock technique and the voltage clamp technique. Our plan is to use both of these techniques to try to obtain satisfactory voltage current relationships of single neurons before and after ionizing radiation. The short-shock technique may be peculiarly well adapted toward mammalian work since it might be theoretically used in mammalian dorsal root ganglion cells which are spherical in nature and which are essentially space clamped when one stimulates and records intracellularly.

White, Robert Keller AT(40-1)1982  
A1F276 "THE EFFECTS ON RAT BEHAVIOR OF

DEVELOPMENTAL ABERRATIONS INDUCED BY IONIZING RADIATION IN UTERO."

Texas Technological Coll., Lubbock. OROO. SP 6; MYR 1 3/4.

The current objectives of this research are to clarify the nature of the radiation effects previously reported—especially to low sensitivity to irradiation on the 8th and 9th day of gestation as measured by behavioral anomalies and the sex differences in performance.

A new extremely sensitive scoring system has been introduced that shows that the learning deficit in irradiated Ss is the result of qualitative changes in the manner in which they attempt to learn the Lashley III maze. In some cases even subjects that show no deficit in the rate of learning can be shown to solve the maze in an abnormal manner.

Two different statistical approaches are being used: First, an intercorrelation matrix of 79 dependent variables has been constructed and is being factor analyzed via a principal axis analysis followed by a varimax rotation procedure either of which solution will be used (according to empirical meaningfulness) to find those behavioral measures which can best serve as predictors of specific radiation effects. These 79 variables include Lashley III performance measures, physiological data from repeated EKG measures, activity scores, as well as measures of body weight.

Secondly, three seven factorial analysis of variance studies have been completed that have identified five different factors that significantly affect the strategy of the normal rat in this maze and a number of factors which do not affect its strategy. The basic problem seems to be to identify the task or tasks required for normal performance on this maze which the irradiates have difficulty mastering.

Olds, James AT(11-1)953  
A1F446 "BRAIN FUNCTION, BEHAVIOR AND IRRADIATION."  
Michigan, Univ., Ann Arbor. COO.

Doses of radiation are applied by implanted gold wires directly to hypothalamic points involved in approach and escape mechanisms to study modifications of hypothalamic thresholds, and disorganizing effects on subtle hypothalamic behavior mechanisms. In these tests, the animal presses a lever to turn stimulation off or on depending on the position of the electrode and the nature of the test. After several control series, a gold wire, whose last mm has been activated, is inserted through a pre-implanted closed steel tube. It delivers directly to the stimulated point in the hypothalamus a gamma dose which can be made to cumu-

late at rates of 10, 100, or 1000 R per hour over the 1 mm sphere proximal to the electrodes.

Studies so far indicate that a clearly visible histological lesion must cover the whole stimulated area in order for the irradiation to abolish the effects of local electric stimulation. It requires about 4,000 to 8,000 R applied in a 6-hour period to make a lesion capable of blocking rewarding or aversive effects of a 50 microampere electric stimulus. Previous tests suggested that the suprathreshold electric field of such a stimulus was approximately 1 mm in diameter.

Hicks, S. P. AT(11-1)-1201  
A1F503 THE EFFECTS OF IONIZING RADIATION AND RELATED FACTORS ON THE DEVELOPING AND ADULT NERVOUS SYSTEM.  
Michigan. Univ., Ann Arbor.

### A1G Reproductive System

*See also A1B155, A1J102, and B1C329.*

Krise, George M. AT(40-1)2849  
A1G10 THE EFFECTS OF PRE- AND POST-NATAL GAMMA IRRADIATION ON REPRODUCTION IN THE ALBINO RAT.  
Texas. Agricultural and Mechanical Coll., College Station. Research Foundation. OROO. SP 5; MYr 1.5.

Albino rats will be exposed to chronic gamma irradiation (0, 1, 2, 5, 10, 20 and 40 r per 23 hour day) from the 15th day of gestation to the 23rd postparturition day and to acute gamma irradiation (30, 60, 150, 300, 600 r per 16 hour day) on the 15, 17, 18 and 20 days of gestation. The criteria which will be used to ascertain these effects are: the ability of the irradiated animals to continually reproduce; the litter size produced; the weights of the litters produced; histological appearance of gross abnormalities in the litters produced; histological manifestations of gonadal injury; gross manifestations of damage to the accessory reproductive organs and related systems, i.e., adrenal, liver, kidney and spleen and bioassay of pituitary gonadotrophins. Results to date indicate that the testes of males exposed to rates of 20 and 40 r per 23 hour day are unable to regenerate and should prove sterile when mated with unexposed females.

Carlson, W. D. AT(11-1)895  
A1G177 THE EFFECTS OF IONIZING RADIATION ON THE FUNCTIONAL AND STRUCTURAL STATUS OF THE BULL TESTICLE.  
Colorado State Univ., Fort Collins. COO. SP 3; MYr 3.

In previous work at this institution, the effects of single exposures of 50 r to 800 r x-radiation to the testicles of bulls have been studied. A 400 r exposure was found to be in the mid-effect range as shown by changes in semen quality. Increases in numbers of morphologically abnormal sperm were seen as early as four to five weeks after irradiation. Decreases in sperm numbers were seen as early as seven weeks after exposure to 800 r with longer periods of time required to observe changes in sperm numbers from bulls exposed to lower radiation levels. Radiation depressed fructolysis rates and oxygen consumption for indefinite periods in semen from all bulls. An increase in the amount of initial fructose in semen was found to correlate with decreases in sperm numbers. Seminal free amino acids and ascorbic acid levels remained relatively unchanged throughout the experiment. The study has been continued on the effects of 0 r, 25 r, and 50 r exposures.

The proposed work is designed to compare the effects of a single exposure of the testicles to 400 r of x-radiation to a 400 r fractionated exposure of 80 r daily for 5 days. The amount of recovery which occurs each day will determine whether irradiating a greater percentage of spermatogenic tubules during stages which contain the most radiosensitive cell types will have a greater or lesser effect than a single exposure equal to the sum of the daily exposures which would irradiate only approximately one half of the tubules in their most radiosensitive stages.

Carlson, W. D. AT(11-1) 1202  
A1G180 "THE EFFECTS OF IONIZING RADIATION ON THE CANINE OVARY."  
Colorado State Univ., Fort Collins. COO. June 15, 1962-June 14, 1963.

The proposed study is aimed at finding: 1) the effects of direct single acute doses of ionizing radiation on the canine ovary, 2) the median ovarian sterilizing dose for the canine, and 3) the histopathological changes in the irradiated ovary. Plans call for the use of 50 Beagles. Each bitch will be allowed to have one estrous period prior to irradiation. During anestrus a laparotomy will be performed on the dog and both ovaries irradiated individually. Following irradiation each bitch will be examined every ten or fourteen days for signs of estrus and those which come into heat will be bred and allowed to whelp. Pups will be saved for six days to determine viability. Histopathological examination of the ovaries will be made after whelping for those which conceive and after a one year interval for those which do not show evidence of estrus.

Soderwall, A. L. AT(45-1)1378  
A1G221 EFFECTS OF RADIATION ON AGING  
AND REPRODUCTION IN THE FEMALE GOLDEN  
HAMSTER.

Oregon. Univ., Eugene. RLOO.

The effects of graded amounts of whole body X-ray irradiation upon the reproductive pattern in the golden hamster have been investigated. A study of gestation lengths and litter size shows a correlation existing between the effects of X-ray irradiation upon tissue and normal aging processes. A series of 700r, 300r, and 100r dosages have been administered with a check of resultant litter size and gestation length compared with normal and aged animals. Similarities to the aging process appeared in all of the groups administered. 700r caused almost complete arrest of the reproductive capacity within 50 days post X-ray. 300r dosages caused severe impairment of the reproductive function immediately and the appearance is that of an aged animal. The latter included depigmentation of the hair coat and general debility. 100r dosages also caused decrease in litter size and increase in gestation length paralleling the aging phenomenon. It may be concluded that X-ray irradiation induces aging-like effect in normal tissue and reproductive phenomena in the female golden hamster. Continued attention will concentrate on still lower dosages of 50r, 25r, and 10r. Associated with these studies will be investigations on the histochemical aspects and blood serum proteins hormone.

#### A1H Other Organ Systems

See also D1D303.

Dobyns, Brown M. AT(30-1) 1243  
A1H98 "A STUDY OF THE PHYSIOLOGICAL  
FUNCTION AND HISTOLOGICAL CHANGES OF  
THYROIDS IRRADIATED WITH RADIOACTIVE  
IODINE."

Western Reserve Univ., Cleveland. School of  
Medicine and Cleveland Metropolitan General  
Hospital. COO. January 1962-December 1962.

The work here represents long term studies.  
The general pattern remains the same as pre-  
viously reported.

This project has been in progress for quite a  
number of years. It consists of two parts. The  
first concerns the immediate and long term ef-  
fects of a single therapeutic dose of  $I^{131}$  for treat-  
ment of hyperthyroidism in man. A series of quan-  
titative chromatographic fractionations of the  
iodinated compounds in the blood are made be-  
ginning shortly after the  $I^{131}$  administration and

repeated thereafter as long as the radioactivity  
is measurable. The changing amounts of  $I^{131}$  in  
the various compounds in the blood are related  
to the rate of disappearance of  $I^{131}$  from the thy-  
roid, the compounds appearing in the urine, and  
the results of various other clinical and laboratory  
tests. All results are ultimately considered in the  
light of physiologic changes in the thyroids there-  
after. When a second treatment dose of  $I^{131}$  is  
needed, a special opportunity for repetition of the  
studies is afforded and gives a more precise meas-  
ure of the effects of the first radiation.

The second part of the study concerns the mor-  
phologic changes in the thyroid of animals and man  
following  $I^{131}$  administration. Desoxyribonucleic  
acid (DNA) determination in the individual nuclei  
of the cells is being made by histochemical and  
spectrophotometric methods. This is an effort to  
further explore the nature of the cells with the  
bizarre nuclei which are found long after the dam-  
aged cells would have been expected to survive.  
The nature of these nuclei is being studied with  
tritiated thymidine in order to learn more about  
the normal mitoses that develop following radia-  
tion.

Kinsey, V. Everett AT(11-1)152  
A1H114 EFFECT OF NEUTRONS AND OTHER  
RADIATIONS ON OCULAR LENS.  
Kresge Eye Inst., Detroit. COO.

The scope of this project has been broadened  
during the number of years of its existence. It now  
includes studies of the physiologic requirements  
and metabolic processes of normal lens and lenses  
undergoing changes which lead to cataracts. Through  
an understanding of the vital processes of the ocular  
lens and aberrations associated with cataract forma-  
tion it is believed possible that therapeutic measures  
may be instigated for its prevention.

Presently emphasis has been placed on the trans-  
port of amino acids into the aqueous of the posterior  
chamber thence into the lens in eyes of normal and  
diabetic animals.

Riley, E. F. AT(11-1) 1024  
A1H153 A COMPARISON OF THE CYTOLOGI-  
CAL EFFECTS PRODUCED BY IONIZING RADIA-  
TIONS OF DIFFERENT L.E.T.  
Iowa. State Univ., Iowa City. Radiation Research  
Lab. COO. SP 1; MYr 0.75.

The major objectives of the proposed research will  
be: (1) to compare the changes produced in a popula-  
tion of cells by exposure to radiations of different  
LET (Linear Energy Transfer), and (2) to compare

the changes produced when half of the cell population is shielded and half irradiated with changes produced when all of the cells are irradiated. The cell population to be studied will be the cells of the lens epithelium of rat, rabbit, and mouse eyes. Whole mount preparations of lens epithelia,  $H^3$ -thymidine labelling and radioautographs, and perhaps conventional sections or ultrathin sections for electron microscopy will be utilized to study changes in the cells.  $Co^{60}$  gamma, 250 kvp X-ray, and fast neutron radiations will be employed. Observations will cover a period from 15 minutes after irradiation to as much as one year post-irradiation.

Chase, Herman B. AT(30-1)2018  
A1H293 FURTHER INVESTIGATIONS CONCERNING THE EFFECTS OF COSMIC RAY HEAVY NUCLEI AND OF MICROBEAMS ON MAMMALIAN SKIN.

Brown Univ., Providence. NYOO. SP 2; MYr  $1\frac{1}{2}$ .

In relation to the effects on skin already observed from our studies with exposures to cosmic ray heavy nuclei, the Berkeley HILAC, and exposures to an electron beam through small apertures, there are certain additional investigations which are proposed. Hair follicles can now be exposed individually to calibrated millibeam slits such that only a part of the follicle is irradiated at a time. In certain important respects this simulates the possible thindown track of a cosmic heavy ion. The oxygen effect will also be examined by this technique to determine critical sizes for certain effects. With the HILAC it is proposed to evaluate the LET effects on ulceration, epilation, and greying by using absorbers to equalize the range in tissue of carbon, oxygen, and neon ions. With regard to hair epilation and the greying effect, it has just recently been observed that so-called subthreshold doses of x-rays cause extensive damage in the growing hair bulb but that recovery is rapid from 20-36 hours after exposure to doses of 200 rads. Even lower doses will be used to determine the details of type of tissue damage and the sequence of events in repair. Since our accelerated carbon ions have a lower threshold for greying (50 instead of 250 rads), observations should be made to determine if this is due to a difference in damage or to a difference in capacity to repair.

Herranen, Ailene AT(30-1)2565  
A1H313 A STUDY OF THE EFFECT OF IONIZING RADIATION ON LYMPHATIC TISSUE.  
Worcester Foundation for Experimental Biology, Shrewsbury, Mass. NYOO. March 1, 1963 - February 29, 1964.

Initial studies have measured the effect of 650 r whole body x-irradiation on the ability of rabbit thymus nuclei and cytoplasmic fractions to incorporate leucine- $C^{14}$  in vitro at 4, 6 and 18 hours after irradiation. Incorporation by intact nuclei is inhibited 35, 80 and 90% respectively 4, 6 and 18 hours after irradiation. Incorporation by the microsomal fraction shows 50% inhibition at 4 and 6 hours and 85% at 18 hours after treatment. No inhibition of incorporation is found with the ribosomal fraction from tissue 4 hours after irradiation but inhibition is found at 6 and 18 hours after treatment. At 4 and 6 hours after irradiation, DNA, removable by deoxycholate treatment, was found in the microsomal fraction. DNA is also found in sRNA extracted from cytoplasmic 5.1P. When a colorimetric method is used for RNA analysis in the assay procedure, no inhibition of labeling of sRNA is observed. Studies are in progress on the nature of the DNA material and on the chemical and physical properties of the cytoplasmic 5.1P, microsomal and ribosomal fractions at 4 and 6 hours post-irradiation. The reason for the radiosensitivity of lymphocytes and the question of a cytoplasmic or nuclear site of radiation damage are of fundamental importance in radiobiology.

Ham, William T., Jr. AT(40-1)2452  
A1H416 "A STUDY OF THE COMPARATIVE EFFECTS OF IONIZING RADIATION AND AGING ON THE MAMMALIAN LENS OF THE EYE."  
Medical Coll. of Virginia, Richmond. SP 13; MYr 2.5.

This work has been completed and the contract will terminate as of March 15, 1963. A final report is in preparation and will be available shortly. The major findings of the program are being reported before the Health Physics Society meeting in New York in June. An abstract of this paper is as follows:

The eyes of 120 rabbits, 8-10 weeks of age, received radiation doses of 0, 200, 600, 1000 rads from a 1 Mev x-ray machine. The x-ray dose was delivered either to the whole eye (15 mm. diam beam) or to the central axis of the eye (3 mm. diam. beam). All animals received a thorough slit lamp examination before irradiation and at 6 month intervals thereafter until death or sacrifice intervened. The colony of 120 rabbits was divided into 6 groups according to a balanced incomplete block arrangement designed statistically for maximum information. Animals were sacrificed, 4 at a time, at 6 month intervals until each of the 6 groups was depleted.

The relationship, if any, between ionizing radiation exposure and aging will be discussed in the light of physical data involving the mass, volume, density, hardness, and light transmission of the rabbit lens, and in terms of the clinical findings with the slit lamp. Current data indicate that changes in the physical properties of the lens seem primarily dependent upon age, whereas clinical findings seem most affected by radiation dose and method of exposure. Chemical changes in the lens proteins are detectable after exposure to 200r. In general, the data do not seem to support the hypothesis that there is a well defined relationship between radiation damage and aging in the rabbit lens.

Hirschman, Albert AT(30-1)2960  
A1H434 RADIOAUTOGRAPHIC, HISTOCHEMICAL,  
AND BIOCHEMICAL STUDIES OF THE EFFECTS  
OF IRRADIATION ON CARTILAGE AND BONE.  
New York. State Univ., Brooklyn. Downstate Medi-  
cal Center.

The effects of irradiation on the intracellular synthesis of sulfated mucopolysaccharides in epiphyseal cartilage was studied radioautographically. There was decreased uptake of labeled sulfate in the irradiated tissues, primarily due to a decrease in the number of viable cells. The irradiated sections also showed a relative increase in extracellular label.

The uptake of tritiated proline and cytidine was studied by means of radioautographs in normal rats. Soon after injection, maximum uptake in young animals was in the proliferative zone of epiphyseal cartilage, and later in the hypertrophic zone. In older, mature animals maximum uptake was always in the hypertrophic zone.

Mucopolysaccharides from cartilage and bone of rats previously labeled with  $S^{35}$ -sulfate were separated into three groups of successive extraction in water, 20% KCl, and 2% NaOH. The specific activities of these groups differed quantitatively and had different modes of variation with time.

Objectives for the following year include: (1) Completion of development of a rapid method for the preparation of histological sections of tissues with minimal alteration, and application of this method to studies of mucopolysaccharides of cartilage and bone; (2) Radioautographic studies of the effects of irradiation on the uptake of tritiated proline, cytidine, and thymidine in epiphyseal cartilage; (3) The effect of irradiation on the vascularity of bone; and (4) Effect of irradiation on the metabolism of the three groups of mucopolysaccharides in epiphyseal cartilage.

Wyman, Leland C. AT(30-1)1354  
A1H453 THE EFFECT OF IRRADIATION ON THE  
GROWTH AND FUNCTIONING OF TRANSPLANTED  
OR REGENERATED ADRENOCORTICAL TISSUE IN  
THE RAT.  
Boston Univ. NYOO.

We are investigating the quantitative and qualitative effects of X-irradiation on the corticosteroidogenic capacity of rat adrenal autografts by means of microchemical methods, and the effects on revascularization of the regenerating grafts. The corticoids in adrenal transplants are being characterized qualitatively by means of chromatographic techniques and the secretory behavior of the grafts is being studied by analyzing whole blood. Revascularization is being studied qualitatively by the visualization of small blood vessels by intravascular precipitation of lead chromate, and quantitatively by studying blood flow using red blood cells labelled with radio-active iron and plasma albumin labelled with radio-active iodine. We propose to determine plasma and adrenal corticoids and adrenal blood volume changes during stress when major changes in vascular behavior should be occurring, and to study blood shifts within the gland by determining cortical and medullary blood volumes. Blood flow rates will also be examined. We also propose to supplement our biochemical and light microscopy studies of regenerating and X-irradiated adrenal tissue with fine structure studies employing the electron microscope. The vascular elements in transplanted adrenocortical tissue will be observed and compared with those in normal tissue and then the effects of various agents known to influence vascular function, including irradiation, will be studied.

Cope, Oliver AT(30-1)-667  
A1H502 EFFECTS OF RADIOACTIVE IODINE ON  
BIOLOGY OF THE THYROID GLAND.  
Massachusetts. General Hospital, Boston.

## A1J Developmental Anomalies

*See also A1B155 and D1D289.*

Glass, Laurel E. AT(11-1)34-53  
A1J42 IMMUNOCYTOLOGICAL STUDIES OF X-  
IRRADIATED MOUSE EMBRYOS.  
California. Univ., San Francisco. Medical Center.  
SFOO. SP 3-5; MYr 2.25.

This project is concerned with (a) an attempt to distinguish between the effects of irradiation on maternal and embryonic tissues, and (b) determination of the cell types and developmental stages which are peculiarly sensitive to radiation damage. Fluorescent



antibody techniques may allow differentiation of types of injury which result in embryonic or fetal abnormality.

In recent work, unfertilized donor eggs were X-irradiated in vitro and then transplanted to non-irradiated or X-irradiated, mated, recipient females to permit fertilization and development.

The percent of native pregnancies decreased as irradiation dose to maternal recipients increased. There was a straight line decrease in the number of native fetuses in females irradiated with 0, 100, or 250 r; in the same animals the number of transplanted fetuses remained the same or increased slightly. The proportion of uteri containing only transplanted fetuses increased. In vitro irradiation was apparently less damaging than that given in vivo.

Larsen, Wesley P. AT(11-1) 1030  
ALJ67 THE EFFECTS OF X-IRRADIATION ON  
THE EMBRYOS OF INVERTEBRATE ANIMALS.  
College of Southern Utah, Cedar City. COO.

To date it has been found that embryos of the cockroach, Blaberus crantifer, show a sudden resistance to X-irradiation at the stage just prior to dorsal closure. Extra-embryonic tissues also appear to be more resistant to irradiation than embryonic cells. Isolated embryonic insect tissues, maintained in synthetic media, were subjected to irradiation from X-rays and Co-60. Heart fragments beat for 120 days after X-irradiation in excess of 10000r. Malpighian tubules continued to pulsate for 15 days, heart fragments to beat for 23 days, and hindgut portions to move for 60 days following Co-60 dosages up to 93000 rads.

Future work will be planned along the following lines:

1. To find the type of respiration in the early non-resistant stages of insect development and see if there is a shift in respiratory systems coincident with sudden resistance to irradiation.
2. To maintain and grow cell suspensions of disaggregated insect tissues. Liver extracts, yeastolate, and hydrolysates added to medium TC 199 will be used as growth stimulants.
3. To compare the effects of irradiation on various types of isolated embryonic insect tissues grown in vitro.
4. To study the effects of irradiation on the cleavage stages of snail development.

Brent, Robert L. AT(30-1)2071  
ALJ101 THE EFFECT OF EMBRYONIC IRRADIATION

ON ADULT LIFE EXPECTANCY AND ADULT PATHOLOGY.

Jefferson Medical Coll., Philadelphia. NYOO.

The objectives of this project include determination of the life shortening effect and tumor incidence in animals irradiated during embryogenesis at the following stages: (a) early implantations ( $1\frac{1}{2}$ - $4\frac{1}{2}$  days), (b) early organogenesis (7, 8 days), (c) fetal stage (12, 16 days), and (d) adult rat (60 days). The dose of irradiation used was 30, 60 and 90 r.

The current year's work has been concerned with the above objective plus (1) the importance of ovarian irradiation as a contributing factor to whole litter resorption when the young zygote is irradiated and (2) the effect of vascular clamping of the pregnant rat uterus when combined with irradiation. The results of these projects indicate that as yet our results cannot rule out ovarian irradiation as a contributing factor to whole litter resorptions and uterine vascular clamping of the pregnant rat uterus protects against the lethal and growth retarding effects of x-irradiation.

Chang, M. C. AT(30-1)1943  
ALJ102 EFFECTS OF RADIOCOBALT IRRADIATION OF GERM CELLS AND EMBRYOS.  
Worcester Foundation for Experimental Biology,  
Shrewsbury Mass. NYOO.

For the advancement of our understanding of the radiation damage to the germ-cells and early embryos, spermatozoa of rabbit, and eggs before or after ovulation of rabbits and hamsters were irradiated. It was found that the fertilizing capacity of sperm and the fertilizability of eggs are very radio-resistant but the development potential of such fertilized eggs is very limited. Ovarian eggs of hamsters were more radiosensitive at the time of maturation division than at an earlier stage. Irradiation of ovarian eggs of rabbit from 6 hours before ovulation to 2 hours after ovulation resulted in the failure of division following fertilization. Irradiation of embryo at the stage of primitive streak increased the mortality of fetuses while irradiation at the stage of organogenesis resulted in the abnormality of fetuses. Fractionation of radiation dosage, irradiation at a very short interval of embryonic development, irradiation of sperm, and/or eggs of rabbits, DNA determination of irradiated sperm and eggs, and the metabolism of sperm following irradiation are under investigation.

Rossi, Harald H. AT(30-1)2740,B-4  
ALJ585 HISTOPATHOLOGY OF THE MOUSE EMBRYO AT VARIOUS STAGES OF DEVELOPMENT FOLLOWING LOW LEVELS OF X-IRRADIATION.

Columbia Univ., New York. Coll. of Physicians and Surgeons.

Most histopathological studies involve exposure to x-rays and examination of the fetus at delivery or thereafter. This delay in examination allows for some so-called "recovery", so that it is not possible to determine accurately at each stage of development which tissue or organ systems are the most radio-sensitive, and thereby render the embryo at those stages most vulnerable. Further, such studies do not reveal the sensitivity or resistance of the various developing systems to x-ray insult, since the study is made so much later than the exposure.

It is proposed that mouse embryos be exposed to damaging levels of x-rays at various known critical stages of development, and be examined histologically and cytologically at intervals of 4, 24, and 48 hours thereafter. This should reveal exactly what developing systems at each stage of development are truly radio-sensitive as determined by the percentage of necrotic and pyknotic cells in each of the developing systems.

## A1K General Physiology and Metabolism

*See also A1A351, A1F44, D1B202, D1B307, D1B345, and D1C306.*

Kundin, William D. AT(11-1) 1179  
A1K240 A PILOT STUDY TO INVESTIGATE THE EFFECTS OF X-IRRADIATION ON THE COURSE OF PATHOGENESIS OF VIRAL DISEASES, AS STUDIED BY IMMUNOFLOUORESCENCE.  
Kansas. Univ., Kansas City. School of Medicine. COO. June 1962-May 1963. SP 4; MYr 1 3/4.

The effects of x-irradiation on the course of pathogenesis of reovirus 1 will be studied. Irradiated and non-irradiated adult and suckling mice will be inoculated by various routes with the Lang strain of reovirus. Pregnant mice will be irradiated and their offspring infected. Mice will be sacrificed at daily intervals. The appearance of infectious virus will be determined by infectivity titrations of the various tissues and organs. The appearance of viral antigen will be determined by fluorescent antibody staining of whole-body cross sections of mice cut on a microtome at  $-20^{\circ}\text{C}$ . If time permits, the study will also include other animal hosts as well as variations of treatment, x-ray or virus dosage.

In addition mice and perhaps monkeys will be irradiated to determine if their defensive mechanisms can be sufficiently disrupted that the patho-

genesis of poliovirus can be studied by immunofluorescence. We have in the past failed to find viral antigens in untreated monkeys and mice inoculated with poliovirus.

Time permitting, other enteroviruses, e.g., Cocksackie A-9, B-6, and ECHO 9 viruses will be similarly studied.

Bennett, L. L., Jr. AT-(40-1)-3093  
A1K426 ATTEMPTS TO DEVELOP MAMMALIAN SYSTEMS RESISTANT TO IONIZING RADIATION AND THE USE OF SUCH SYSTEMS IN BIOCHEMICAL STUDIES OF RADIATION EFFECTS.  
Southern Research Inst., Birmingham, Ala. SP 2; MYr 1.

Attempts will be made to develop a mammalian cell culture system or an animal tumor system resistant to ionizing radiation; the initial effort will be concentrated on cells in culture. Cell lines that may be used in these studies are H.Ep. No. 2 (a human epidermoid carcinoma), Ca755 (a mouse adenocarcinoma), KB (a human adenocarcinoma), and D-98 (a human bone marrow line). Cultures of cells that have been grown in suspension will be spun down, and the isolated cells will be resuspended in physiological saline. This cell suspension will then be subjected to x-radiation at various levels and surviving cells will be allowed to grow on glass or in suspension, after which they will again be spun down and subjected to a higher level of radiation. After this process has been repeated several times, individual clones will be isolated and propagated to see if any significant degree of radiation resistance has developed. Attempts may also be made to produce a radiation-resistant animal tumor by serial transplantations with gradually increasing doses of radiation after each transplantation.

If cell lines or tumors with significant radioreistance are obtained, studies will be undertaken to attempt to define the biochemical basis for resistance.

## A2 TOXICITY OF RADIOELEMENTS

### A2A Biological Effects

*See also A2B251.*

Andersen, A. C. AT(11-1)GEN 10-6  
A2A40 THE EFFECTS OF CONTINUAL  $\text{Sr}^{90}$  INGESTION DURING THE GROWTH PERIOD OF THE BEAGLE AND ITS RELATION TO  $\text{Ra}^{226}$  TOXICITY.  
California. Univ., Davis. School of Veterinary Medicine. SAN. SP 32; MYr 31.50.

Sixty Beagles have been receiving 5 dose levels of Sr-90 daily in their feed ( $\mu$  Sr-90/g Ca). Sr-90 skeletal uptakes have been determined by whole-body counting and radiochemical analyses. These data indicate that the Beagle discriminates against Sr-90 as do other species—the observed ratio ( $OR_{\text{bone-diet}}$ ) is 0.4 to 0.5. The dietary level of stable strontium fed is about 1800  $\mu$ g/g Ca; a 1% calcium level in the diet has proven satisfactory. Although some congenital defects continue to be recognized in this colony, nutritional deficiency has not been observed. Breeding colony production continues at the rate of about 4 pups weaned per year per dam. Our Sr-90 waste treatment facility has proven satisfactory for the expeditious disposal of biological wastes. Thus, 160 additional Beagles on Sr-90 feeding can be handled when construction of the expanded facilities is completed. By early 1963, treatment facilities will be able to accommodate a total of 320 dogs on Sr-90 feeding, 20 dogs for Sr-90 injection, and 200 dogs for the Ra-226 injection program. The permanently installed cages in the new facilities are more economical to construct than those previously designed, and they should be more efficient. Each cage is provided with a light, self waterer, and an air exhaust vent. An adequate number of experimental dams, 14 or more months of age, will be available for simultaneous treatment of both Sr-90 and Ra-226 at all experimental dose levels.

Vorwald, Arthur J. AT(11-1)1181  
A2A150 THE RESPONSE OF THE RESPIRATORY TRACT AND LUNG TO INHALED STABLE AND RADIOACTIVE ISOTOPES OF CERTAIN ELEMENTS. Wayne State Univ., Detroit. COO.

Studies concerned with radioactive isotopes of europium, scandium, thorium, yttrium, and cobalt as well as the stable forms of these and other elements will be continued. New studies will be undertaken using the stable isotope of cobalt, and in addition, a radioactive isotope of strontium, probably strontium<sup>90</sup>. We intend to obtain strontium<sup>90</sup> as a titanate, if possible, which is an extremely insoluble compound, and which may be expected to remain in the lungs of experimental animals for a longer period of time than any other compound of this element.

In the past, our research on radioactive materials has been carried out using albino rats and mice as the experimental animals. We are now ready to begin long-term inhalation studies upon dogs, and are currently preparing our facilities for the handling of this species. The use of dogs will permit more comprehensive corollary physiological studies to be performed. Specifically, we intend to begin pulmonary

function studies upon the experimental dogs and their controls using the capacitance respirometer which was developed in our laboratory and which is currently being patented by the A.E.C. The studies of pulmonary compliance should give us information concerning the onset of pathological changes in pulmonary tissue well in advance of actual anatomical alterations.

Since several of the radioactive isotopes to be studied or already under study are known to be stored in bone tissue, we intend to expand our investigations upon the hematopoietic activity of the experimental animals. In addition to the routine hematologic studies already under way, we are developing experience with the techniques of conducting bone marrow studies and will soon be performing these studies on a routine schedule.

Evans, Titus C. AT(11-1)291  
A2A154 RADIOIODINE STUDIES OF FETAL AND OTHER THYROIDS. Iowa. State Univ., Iowa City. COO. May 1962–March 1963.

In general, we intend to continue studies which will contribute to a better understanding of the maternal-fetal relationships regarding thyroid growth and functions of the human fetus. These include determinations of percentage uptake by the thyroid; uptake in thyroid relative to blood and other tissues; electrophoretic and chromatographic studies of thyroid and plasma; erythrocyte binding *in vitro* of I-131 triiodothyronine as an indication of thyroxine level in plasma of fetal and maternal placental blood; histological, radioautographical, cytological, and electron microscopical studies of thyroids at different stages of development; studies of possible transport of I-131 thyroxine and triiodothyronine across the placenta; and studies with fetal rat thyroids to precede as well as supplement the studies of the human fetus.

White, C. S. AT(29-2)1013  
A2A168 THE BIOLOGICAL EFFECTS OF EXPOSURE TO FISSION PRODUCTS. Lovelace Foundation for Medical Education and Research. Albuquerque, N. Mex. ALOO. SP 37; MYr 30<sup>5</sup>/<sub>6</sub>.

The Fission Product Inhalation project will study the biological consequences of inhaling fission products singly and as mixtures in a quantitative manner so that various levels of exposure may be related to biological effect. The latter will include initial deposition as it varies with the physical parameters characterizing soluble and insoluble aerosols of various sizes, and pathophysiological

responses as they are governed—among other things—by decay, excretion, translocation and depoting of inhaled material administered to four mammalian species in doses chosen to produce life-span shortening by various amounts; i.e., by three-fourth, one-half, one-fourth and less (LD<sub>50</sub>/30-60 days).

While awaiting construction of permanent facilities, development of an interim operating capability has included low-level exposure of animals to soluble materials using miniaturized and improved methods for producing, sampling and characterizing aerosols; a means of recording respiratory rate and volume; and whole-body and organ counting to determine distribution and excretion patterns. Also, 18 of 30 ultra-micro biochemical techniques have been established and employed as have methods for following the viral, bacterial and fungal flora of experimental animals, assessing their immunological status and culturing liver, lung and renal tissues. Finally, pathological techniques, including histochemistry and autoradiography, are under development and use in exploratory experiments along with standard hematologic observations.

Evans, R. D. AT(30-1)952  
A2A452 RADIUM AND MESOTHORIUM POISONING AND DOSIMETRY AND INSTRUMENTATION TECHNIQUES IN APPLIED RADIOACTIVITY. Massachusetts Inst. of Tech., Cambridge. Radioactivity Center. NYOO.

Continuation of studies of humans who have carried body burdens of Ra and/or MsTh over a period of years, and some Thorotrast cases. Measurements will be done on exhaled breath samples, and quantitative  $\gamma$ -ray spectrometry on living persons, on bone samples, and paint samples will be made in our controlled background facility. Collection of data on all known human cases will continue and be kept in a central catalog. Data on human bone samples will be compared to dog samples in conjunction with the University of Utah in the hope that a comparative link to human response to Pu and Sr-90 can be evolved. Relative uptake and absorption by the human gut for elements 88 and 90 is to be studied in detail to determine the relative importance of RdTh which may be initially present in the paints.

Whole-body neutron activation is being studied from the point of view of determining neutron exposure to individuals, the composition of certain elements in the body (particularly Ca for use in the Ra toxicity studies), and possibly for certain physiological studies.

A detailed study of the body burden of Cs-137 of selected individuals is being made.

Alpha-gamma angular distribution studies are being extended to include levels weakly populated by alpha decay.

Studies of ground Rn concentrations and their relation to varied meteorological conditions are being made.

Nuclear instrumentation studies are being continued and increased attention is being given to data reduction and processing.

Dudley, Robert A. AT(30-1)2819  
A2A457 DOSIMETRY IN HUMAN RADIOEPIDEMIOLOGY, WITH SPECIAL REFERENCE TO SKELETAL DOSE RATES IN THOROTRAST CASES. International Atomic Energy Agency, Vienna. NYOO. SP 4; MYr 1.5.

Persons containing Thorotrast (colloidal ThO<sub>2</sub>) constitute one of the largest single groups of people who have been subjected for many years to continuing internal irradiation at a toxicologically interesting level. Liver and spleen receive the highest radiation doses. It is thought that the skeleton also may receive doses from the internally translocated radium daughter products of thorium, at levels not much lower than in persons containing 0.1  $\mu$ c Ra-226. Thorotrast cases may therefore supplement, in significant numbers, Ra cases at the most interesting dose level of radioepidemiology, namely the vicinity of the maximum permissible body burden. Studies are being started to quantify skeletal dose rates in Thorotrast cases. Body burdens of the most significant members of the Th decay series are being determined by gamma spectroscopy. Excretion of these isotopes will also be examined, and the results, in conjunction with the measured body burden and the known metabolism of these elements when introduced into the blood, will be used to infer the magnitude of Th series translocations. External gamma ray scanning of liver and extremities is also used to estimate translocation. When tissue samples become available at autopsy, the concentration of the various isotopes is determined by gamma counting. It is expected that chemical techniques will also be applied in these observations.

Mewissen, D. J. AT(30-1)2881  
A2A458 RADIUM-INDUCED BONE TUMORS IN HUMAN PATIENTS. Belgian Cancer Society, Brussels. NYOO.

The scope of the proposed research is: a) Identify all workers who were employed for the past thirty years in the radium processing industry in Belgium. This industry is known to be located in two sites: Olen (Province of Antwerp) and Brussels (Province of Brabant). Both plants are operated by the Company

Union Miniere du Haut Katanga. It is our purpose to identify, among former or present radium workers in Belgium, any patient (dead or alive) who might have developed tumors of the bony structures of the face and more specifically mastoid carcinomas. b) Interview living cases: 1. expand the medical history of the patient, 2. assess the possible exposure to ionizing radiation, and 3. other positive pertinent pathogenic information. The objectives are to obtain conclusive evidence as to whether mastoid carcinomas might have developed in radium workers as a result of exposure to radiation from body burden. c) Investigate any other malignant tumor which might possibly have developed in these radium workers and analyze the incidence of cancer among them in comparison with the incidence in the Belgian population.

Barrer, L. A. AT(30-1)-2181  
 A2A505 EPIDEMIOLOGICAL INVESTIGATION OF THE RADIUM DIAL PAINTERS.  
 New Jersey. State Dept. of Health. Radium Research Project, West Orange.

Eisenbud, Merrill AT(30-1)-2896  
 A2A506 DOSIMETRIC ASPECTS OF THE EPIDEMIOLOGY OF RADIUM POISONING.  
 New York Univ., New York.

Edwards, R. R. AT(30-1)-3049  
 A2A507 SURVEY OF IODINE-129 CONCENTRATIONS IN AND RADIATION DOSAGE TO HUMAN THYROID GLANDS.  
 Nuclear Science and Engineering Corp., Pittsburgh.

## A2B Uptake, Distribution, Deposition and Elimination

*See also A2A150, A2A168, B1B376, and K1C264.*

Bohman, V. R. AT(04-3)34  
 A2B25 PART A. THE RELATION OF FALLOUT AND OTHER FACTORS TO PLANT CONTAMINATION AND THE ASSIMILATION OF FISSION PRODUCTS. PART B. RADIOCHEMICAL ANALYSES ASSOCIATED WITH PART A.  
 Nevada. Univ., Reno. SAN.

Biannually five animals from each of three areas on and at varying distances from the Nevada Test Site will be slaughtered. Selected tissues will be analyzed for fallout Zn-65, Sr-89-90, I-131, and Cs-137. The distribution of stable and fallout strontium will be studied in cattle of varying ages. The strontium

balance of bovines at various levels of dietary strontium will be studied. The effect of dietary stable strontium on the skeletal system of rats and domestic animals will be studied. Studies will include bone composition, deposition of radiocalcium and deposition of radiostrontium. Investigations of promising new methods for fallout analysis will be made.

Nussbaum, Elmer AT(11-1)649  
 A2B151 DIFFUSION OF RADON AND TRITIUM THROUGH SEMI-PERMEABLE MATERIALS.  
 Taylor Univ., Upland, Ind. COO. SP 1; MYR 1/2.

Experimental studies continue on the rates of diffusion of radon, tritium and tritiated methane through semi-permeable sheet materials (e.g. rubber vulcanizates and plastic films). Experiments are conducted at room temperature, 0° and 100°C. Studies continue on the changes in gas transmission rated as a function of temperature. Temperature dependence is found to vary widely for various rubber vulcanizates. Particular attention is being given to the silicone rubbers which possess some highly desirable physical characteristics but which, in many cases, are poor barriers to gases.

At a given temperature the diffusion of tritium proceeds more slowly than radon through all rubber vulcanizates tested to date. However radon is found to diffuse more slowly than tritium through certain plastic films (e.g. mylar and polypropylene). Transmission rates of radon at 0°C through various silicone rubbers range from 0.65% to 11% per hour per mm thickness. Corresponding transmission rates for tritium at room temperature through the same materials range from 0.34% to 4%. The transmission rate of tritium at 25°C through polypropylene (0.035mm) is 0.19% per hour. The corresponding value for radon is 0.03%.

The results obtained in these studies are useful in the selection of appropriate materials for personnel protection when radioactive gases are encountered. Data also prove helpful in the selection of components for closed systems utilizing radon or tritium. The utility of radio-tracer gases is being assessed for industrial applications involving studies of gas transmission rates. Tritium-labeled methane has been selected as a radio-tracer to initiate studies of diffusion rates of organic gases.

Rust, John H. AT(11-1) 1184  
 A2B179 NATURALLY OCCURRING RADIUM 226 IN FOOD PRODUCING ANIMALS.  
 Chicago. Univ. COO. SP 2; MYR 1 1/6.

The purpose of this project is to follow the metabolism of naturally occurring radium-226 in the food producing domestic animals. Studies will be conducted to measure the discrimination which occurs at various physiological steps from digestion of feed stuffs to the production of meat and milk. A correlation will be made between geological formation over which the animals are kept and their body burden of radium-226.

Animal tissues and animal feed stuffs and waters from various areas in Illinois and nearby states will be collected and assayed for radium-226 and calcium. Site selected will be based upon a range of known ambient radium-226 levels. The radium-226 levels in some Illinois farm lands, and nearby states, is often well above the national average. These high levels are closely related to the St. Peters and Galesville aquifers in the Ordovician and Precambrian geological formations, either as buried layers or as outcrops in Central Illinois. Husbandry practices will be determined at the collection points and the selection of samples will be made in order that they can be an evaluation of the influence of the various practices.

Johnson, George T. AT(40-1)3021  
A2B251 FISSION-PRODUCT METABOLISM IN  
MICROORGANISMS.  
Arkansas. Univ., Fayetteville. OROO. SP 2;  
MYr  $\frac{1}{2}$ .

The metabolism and gross effects of six to ten rare earth elements and yttrium will be studied in a number of different microorganisms. The study will include (1) a survey of the gross action of rare earth elements and yttrium on organisms such as Escherichia coli, yeasts, Rhizopus and Aspergillus species, plus such other molds as may be appropriate to determine growth changes, inhibition of respiration, morphological changes, changes in development and the life cycle, etc., and (2) the binding and adsorption of the rare earth elements and yttrium in the various species studied. Elements such as cerium, neodymium, promethium, europium, dysprosium, holmium, erbium, lutetium, etc. will be utilized in the investigations.

Comar, C. L. AT(30-1)2147  
A2B390 FISSION PRODUCT METABOLISM AND  
RESPONSE IN LABORATORY AND DOMESTIC ANI-  
MALS AND PLANNING STUDY FOR EVALUATION  
OF RADIOACTIVE CONTAMINATION OF THE FOOD  
CHAIN.  
New York State Univ. Veterinary Coll., Ithaca.

It is planned that the following lines of work will be undertaken: (a) studies of movement of ions of alkaline earths and alkaline metals across membranes from standpoint of mechanisms, interactions, and factors that affect such movement, with application to transport across membranes of the gastrointestinal tract, kidney, mammary gland and placenta, (b) time course and mechanisms of adaptation of animals to low and high calcium diets with special emphasis on relative contributions of skeletal calcium and strontium to milk and fetuses as a function of dietary changes, (c) study of cesium deposition and removal from bone and cartilage, (d) use of radioiron and the whole body counter to assess parasite infestation, (e) thyroidal uptake of I-131 and factors affecting it, (f) effect of gamma radiation on deposition and retention of various fission products, (g) continuation of planning studies on evaluation of food chain contamination and development of special survey methods, particularly the use of integrating samples such as urine and milk.

Reece, Richard J. AT(11-1)778  
A2B441 COLORADO STATE DEPARTMENT OF  
PUBLIC HEALTH WHOLE BODY COUNTER.  
Colorado. State Dept. of Public Health, Denver.  
SP 1; MYr 1.

This project applies whole body counting and low level gamma spectrometric techniques to problems in public health. Two areas are particularly emphasized (1) fallout and (2) uranium mining. In the field of fallout surveillance we are counting periodically a group of twenty people to determine their changing body burdens of Cesium 137, Iodine 131, and other fallout isotopes. In addition, we are counting isotope levels in environmental samples such as water and milk and correlating these with the human counts. Finally, we are counting workers with laboratory isotope exposures and studying ways to minimize their body burdens. In the field of uranium mining, we are developing methods to study deposition and retention of radon daughters resulting from mining exposures. This involves setting up a mining area which can be used for research purposes, exposing a subject to known radon levels under controlled environmental conditions, and localizing and counting very rapidly the short-lived radon daughters in the lungs. The goal of this research is to develop a project that will measure the effect of different environmental mine conditions in determining actual lung exposures. We are also counting miners, looking for unusual spectra that might help us measure total exposure over a period of time.

Belerwaltes, W. H. AT(11-1)1203  
A2B450 EFFECT OF I-131 ON THE FETUS.  
Michigan. Univ., Ann Arbor. Medical School. COO.  
Monitoring of  $I^{131}$  concentration from fallout in commercial cow's milk, human breast milk, human adult and fetal thyroid glands, and hog thyroid glands, has been continued since our previous publication up to July, 1959. Since July, 1959, we have counted an additional 139 fetal, 87 adult, 12 child and 154 hog thyroid glands using a more sensitive transistorized scalar spectrometer with a well-type scintillation counter having a 3" x 2" crystal enclosed in a lead cave. With this modification it was possible to detect concentration of radioiodine in tissue as low as 3  $\mu\mu\text{c}$  per gram. From the hog data it was evident that radioiodine activity appeared within a 50 mile vicinity of Ann Arbor within approximately 1 month after large series of explosions in September, 1961, through December, 1961, and again in October, 1962. Human adult thyroid and fetal thyroid followed approximately the same rate of build-up and fall-off but showed considerably fewer counts than hog thyroid tissue. It is concluded that hog thyroid tissue can be followed without counting human tissue until there is an appreciable build-up in hog tissue.

Eisenbud, Merril AT(30-1)3086  
A2B460 DISTRIBUTION OF RADIONUCLIDES IN HUMAN TISSUES.  
New York Univ., New York. Medical Center. NYOO.  
August 1, 1962-July 31, 1963.

The purpose of this investigation is to determine the extent of uptake of radioactive debris of nuclear weapons tests by residents of New York. Samples of fourteen different organs from fifteen cadavers of New York City residents are being analyzed for fission products by gamma spectrometry. In addition, the lungs will be analyzed chemically for plutonium.

All tissues have been reduced to ash at 400°C. The fifteen samples of the same organ are then placed, each in its own vial, on the periphery of a four inch sodium iodide crystal and a spectrum of the composite is prepared from a 900 minute count. This composite count is then followed by individual counts on each separate sample.

Van Middlesworth, L. AT(40-1)1643  
A2B464 STUDIES IN IODINE METABOLISM.  
Tennessee. Univ., Memphis. OROO. SP 5; MYr 4.

One of the results of our nine years of study of I-131 fallout has resulted in obtaining thyroids from an endemic goiter area of Colombia, South America. Twenty percent of these goiters contained much more iodine than normal. We have never been able to produce ex-

perimental high iodine goiter such as those from Colombia. We will attempt to determine some of the mechanisms by which the endemic goiter of Colombia could be produced. We will study:

A. Iodine depletion followed by iodine loading of experimental animals.

B. Natural goitrogenic agents.

C. Fecal depletion of thyroid hormone by intestinal irritants.

It has been recently shown that thiocyanate is a natural metabolite in the body and we expect to study the metabolism of tracer quantities of thiocyanate in normal experimental animals. In presence of low iodine intake we suspect thiocyanate may be a natural control on thyroid function. We expect to study the influence of milk on thyroid function and we will measure the iodide, PBI, and  $\text{SCN}^-$  present in milk from cattle, goats, and human beings.

We have found that liver function can be determined in human beings by administering I-131 thyroxine and scanning the abdomen after 6 and 24 hours. We will investigate the possible usefulness of I-131 thyroxine as a liver parenchymal cell function test, and in experimental animals we will investigate the effects of thiouracil, salicylic acid and liver toxins on thyroxine metabolism. We will continue to measure I-131 fallout in thyroid glands of animals grazed in North America, South America, Europe, Asia and Australia. These observations will continue to be entered onto IBM punch cards.

Gunn, Samuel A. AT(40-1)2023  
A2B466 A STUDY OF FACTORS CONCERNED IN THE UPTAKE, PHYSIOLOGY AND RETENTION OF Zn-65 IN THE MALE REPRODUCTIVE SYSTEM OF THE RAT.  
Miami, Fla. Univ., Coral Gables. School of Medicine. OROO. SP 2; MYr 1.5.

Studies on the rat prostate have shown that administered Zn-65 concentrated in the dorsolateral lobes of the gland, paralleling their rich, natural zinc content and that this degree of Zn-65 concentration is hormonally controlled. It has also been shown that there are seasonal variations in the amount of Zn-65 taken up by the gland. It is postulated that this seasonal pattern detected in the prostate of laboratory rats represents an archaic breeding cycle in the male. Studies have also been expanded to include the role of zinc in the entire male reproductive tract, with particular emphasis on spermatogenesis and interstitial tissue function. Investigations are also in progress on the effect of long-term Zn-65 radiation on the male reproductive tract.

Related studies are in progress on zinc transfer via fertilization, placental barrier and lactation, and on retention of Zn-65 in the newborn, in young progeny and in pregnancy and lactation states. Work is in progress on electrophoretic separation of various zinc complexes of prostatic secretions, serum and sperm.

Krane, Stephen M. AT(30-1) 2183  
A2B558 MECHANISM OF DESTRUCTION OF BONE.

Massachusetts. General Hospital, Boston. April 1962-March 1963. SP 2; MYr 2.

The mechanism of calcification of bone is being studied in order to understand problems of resorption. Previous work has demonstrated that collagen fibrils react with inorganic orthophosphate *in vitro* to form covalently-bound phosphate. The nature of the bond and the site in the collagen molecule to which the phosphorus is attached is presently being studied by means of proteolytic digestion and isolation of P<sup>32</sup>-labeled compounds. In the proposed research rat rachitic cartilage will be used in an attempt to isolate the phosphate-collagen complex from *in vivo* preparations within hours after treatment with Vitamin D. It is now possible to isolate phosphogelatin after treatment of bone and cartilage with ethylenediamine tetra-acetic acid, purification of the gelatin by salt and acid precipitation and column chromatography. The phosphorylated intermediates will be analyzed in these preparations after administration of P<sup>32</sup>-labeled orthophosphate to the animals. Special effort will be made by the use of luciferin luciferase assays to measure the levels and specific activities of P<sup>32</sup>-labelled adenosine triphosphate since this appears to be a possible precursor of the phosphate bonded to the collagen. Further investigation into the relationship of glycolysis to ATP generation and calcification will be carried out.

## B RADIATION GENETICS

### B1A Cytogenetics

See also *D1A257, D1A316, and D1C21.*

Brewbaker, James L. AT(04-3)235-3  
B1A24 RADIOBIOLOGICAL STUDIES OF POLLEN CELL ELONGATION AND POLLEN CYTOGENETICS.

Hawaii. Univ., Honolulu. SAN.

Instantaneous radiation death and cytogenetic effects of radiation are to be studied using pollen grains. We have found lethal doses to vary from

30 kr to 800 kr for different plant species, and reasons will be sought for these variations. Species having pollen which differ in nuclear and cellular volumes, chromosome numbers and polyploidy levels have been collected. Ionizing and non-ionizing (UV) radiations will be compared for all studies.

Full desiccation of pollen has been found to enhance radiosensitivity by a factor of 2 or 3, and detailed studies of this phenomenon are projected. The effects of storage, calcium depletion, and anoxia on killing curves and extrapolation numbers will be sought. Related physiological studies have led us to suspect that ion-transport systems in cell membranes are the prime targets in instantaneous or storage death: studies of labelled-ion uptake in irradiated pollen are therefore planned.

Cytogenetic studies are concentrated on the effects of pollen storage, calcium depletion, and desiccation (all interrelated?); both X-ray and UV will be used, with ultimate interest in improving yields of desired types of aberrations in plants following pollen irradiation.

Burdick, A. B. AT(11-1)856  
B1A205 THE RELATIONSHIP BETWEEN SOMATIC AND GENETIC RESPONSE OF TOMATO SEED AND POLLEN TO X-IRRADIATION USING "WATER PROTECTION" AND MUTATIONS AT SPECIFIC LOCI.  
Purdue Research Foundation, Lafayette, Ind. COO. SP 2; MYr 3/4.

We are working on the question of whether the somatic response of irradiated seed and pollen is the result of events that take place in the genetic material. Using "partial hydration protection" we have established that specific genes suffer less than half the induced mutation rate when they are "protected" in the seed. Similarly, the genetic material in pollen is protected by partial hydration- or perhaps sensitized by drying. We are able to identify three sugars produced in the early stages of pollen germination, and several ninhydrin-positive substances that gradually disappear during pollen germination. We will soon be able to assess the effect of irradiation on this biochemical system in germinating pollen.

Foard, Donald E. AT(11-1)34-94  
B1A217 USE OF RADIATION-INDUCED MITOTIC INHIBITION IN STUDIES OF PLANT GROWTH AND DEVELOPMENT.  
California, Univ., Los Angeles. SAN. SP 1; MYr 0.5.



Radiation-induced mitotic inhibition is used to study the growth and development of wheat seedlings in the absence of concurrent cell division and the effects of growth regulators on such growth. These seedlings ("gamma-plantlets") are grown from air-dry grain given 800 kr gamma-irradiation just before sowing. Because of the great extent to which they exhibit characteristics of normal growth and development, gamma-plantlets are useful for obtaining evidence on the role of cell division in growth and development. We can observe directly formative effects of growth regulators on the development of organs of an intact plant growing without tissue-cell division. Gibberellins greatly stimulate the basal portion of the first leaf and the sub-apical region of the stem of gamma-plantlets, regions of great meristematic activity in unirradiated plants. This suggests that meristem activation may be a secondary consequence of a primary effect of the growth regulator on expansion. High concentrations of auxin inhibit the elongation of gamma-plantlet roots, simultaneously causing cells of the parenchymatous cortex to enlarge abnormally. This is similar to the response to auxin of the non-vascularized, parenchymatous epiblast-coleorhiza. We are comparing the disorganized growth of these structures in order to discover if auxin has a similar anatomic effect on parenchyma in vascularized and non-vascularized structures.

Beatty, Alvin V. AT(40-1) 2669  
B1A253 RADIATION RECOVERY AND CELL METABOLISM.  
Emory Univ., Atlanta. OROO. December 15, 1961 - December 14, 1962. SP 2; MYr 1 1/2.

This program of investigation involves radiation recovery and cell metabolism. The measure of radiation damage is the production of chromosomal aberrations in *Tradescantia* microspores after subjection to 400 r of X radiation under different environmental conditions. Potassium gluconate, glutathione and ATP at temperatures of 0°C, 30°C and 40°C exhibit a synergistic effect in reducing the aberration yield. This yield has been reduced from a high of 0.66 aberrations per cell to 0.10 per cell. Many amino acids administered either preirradiatively, postirradiatively or both have reduced the aberration yield. Proline, histidine and citrulline have each reduced the yield by at least 40%. Some amino acids like phenylalanine, isoleucine, threonine and glycine reduce the yield about 20% while leucine, tryptophan, cystine, aspartic acid, glutamic acid, arginine and lysine treated material does not show any variation from the controls. Other amino

acids are being tested. Chloramphenicol treated material shows a 25% reduction in aberrations, while DNP has been found to reduce the yield by at least 50%. This last result is the lowest that has been obtained with any one chemical. Several other experiments involving the chemical are in progress. Anthers irradiated in helium, 5% oxygen, 21% oxygen and 100% oxygen have been fixed, sectioned, stained and the aberrations positioned with respect to outer, middle and inner area of the anther. There is an aberration gradient decreasing in value from the outside of the anther inward in 5% and 21% oxygen. There is no such gradient in material irradiated in helium or 100% oxygen. Experiments using CO as the accompanying gas with 5% and 21% oxygen are being carried out.

Edwardson, J. R. AT(40-1) 2583  
B1A258 A CYTOLOGICAL STUDY OF RADIATION INDUCED ALTERATIONS IN CYTOPLASMIC FACTORS CONTROLLING MALE STERILITY IN CORN.  
Florida. Agricultural Experiment Station, Gainesville. OROO. June 1962 - February 1963.

Gamma radiation is being applied to seed, seedlings, and maturing plants of T-type male sterile corn to induce alterations in cytoplasmic sterility factors. T-type male sterile and maintainer lines exhibit a differential response to radiation damage as measured by seedling heights. T-type material produce taller seedlings than maintainer material; this differential response to radiation damage is probably controlled by differences in the cytoplasm of the lines. Tests are in progress to determine whether possible heterozygosity in male sterile material exerts any control over seedling height in irradiated material. Differences in inclusions in sections of T-type male sterile and maintainer root tip and tapetal cells were found with electron microscopy. Preliminary investigations indicate that the inclusions contain RNA.

Carlson, Gordon J. AT(40-1) 2575  
B1A274 STUDIES OF EARLY EFFECTS OF RADIATION ON CHROMOSOMES AND MITOSIS.  
Tennessee. Univ., Knoxville. OROO. June 1962 - May 1963. SP 3; MYr 1-5/6.

The proposed study will consist of three main projects:

1. Electron microscope studies of the early morphological effects of X rays on the internal structure of the chromosome. Grasshopper neuroblasts will be fixed at different time intervals up to one hour after

X-raying to discover whether changes in the internal structure of the chromosome can be detected.

2. Studies to determine whether recovery from X-ray-induced chromosome damage is accompanied by DNA synthesis. Selected neuroblasts will be irradiated in vitro in any of 15-20 identifiable stages of the mitotic cycle, exposed to radioactive precursors at a desired stage for a given length of time, fixed and made into squash preparations when they are in the desired stage, and autoradiographed.

3. Effects of certain wavelengths of monochromatic ultraviolet radiation on incorporation of tritiated precursors into the grasshopper neuroblast chromosome. The methods used will be similar to those of the preceding project. In addition to DNA synthesis, it is our intention to study also protein synthesis by means of radioactive precursors.

Griffen, Allen B. AT(30-1)2113  
B1A309 THE OCCURRENCE OF CHROMOSOMAL  
ABERRATIONS IN PRE-SPERMATOCYTIC CELLS  
OF IRRADIATED MALE MICE.  
Roscoe B. Jackson Memorial Lab., Bar Harbor, Me.  
NYOO. SP 2; MYr 2.

This research seeks to determine the nature and extent of radiation damage to the chromosome system of pre-spermatocytic cells, including spermatogonia and their precursors. Male mice which have been subjected to X-ray treatment of the testes of 350 r, 700 r, and 1000 r, and suitable untreated controls, were mated to females of standard inbred strains. All offspring sired by each male throughout the remainder of his life are being tested for the presence of chromosomal aberrations capable of producing semi-sterility. All F<sub>1</sub> sterile males and all semi-sterile lines are being analyzed cytologically. The demonstration of gross chromosome aberrations (particularly translocations) in individuals which were sired late in the lives of the treated males clearly indicates that chromosome aberrations are produced in irradiated pre-spermatocytic cells and are transmitted to the offspring. There is no "safe" period after which an irradiated male may sire offspring which will be free from major chromosomal aberrations.

Balley, Paul C. AT(40-1) 2856  
B1A337 THE ROLE OF PROTEIN SYNTHESIS IN  
CHROMOSOME BREAKAGE AND REJOINING WITH  
X-RAYS AND ULTRAVIOLET RADIATION.  
Alabama Coll., Montevallo. OROO. May 15, 1962-  
May 14, 1963. SP 1; MYr 1/2.

This research project will attempt to determine whether the x-ray induced aberrations in Trades-

cantia paludosa pollen tube chromosomes are of the same type as those induced by ultraviolet radiation (2537 A°). Two approaches to the problem are proposed. These are:

(1) Determine whether protein synthesis is involved in the rejoining mechanism of ultraviolet aberrations as is true for x-rays in the same material. Two protein synthesis inhibitors, chloramphenicol and aureomycin, will be used.

(2) Locate the regions where rejoining fails to occur in both x-ray and ultraviolet aberrations. This will involve the identification of the regions and the association of these regions with particular chromosomes. The chromosomes will be identified by a careful analysis of arm-length ratios and total length. The measurements will be made with an ocular micrometer and the aid of a camera lucida.

Warters, Mary AT(40-1)2729  
B1A341 X-AUTOSOMAL TRANSLOCATIONS OF  
DROSOPHILA MELANOGASTER.  
Centenary Coll., Shreveport, La. OROO.

Translocation studies on Drosophila melanogaster have shown that a high degree of sterility can be expected in the male if the X-chromosome is involved in the translocation. The investigation underway was designed to determine the amount of sterility to be expected and, if possible, the factors responsible.

A special procedure had to be designed which would permit the recovery of the induced translocations through the F<sub>1</sub> females of irradiated parents rather than through the F<sub>1</sub> males which is the standard method. The new technique proved very effective in recovering both male sterile and male lethal classes of X-autosomal translocations which otherwise would have been lost through the haploid male. A sample of 180 X-autosomal translocations has been obtained of which 78 are T(X;2)'s; 66 T(X;3)'s and 36 T(X;2;3)'s. Of the first two classes approximately 19% of the males fail to survive and 75% of the viable males are sterile.

Cytological studies are now under way to determine whether a correlation can be found between the break-points on the chromosomes and sterility. Evidence from some studies would lead to the hypothesis that any interruption in the continuity of the X-chromosome would lead to sterility. This has not been confirmed by the analysis of half of the sample of translocations.

Dunavant, B. G. AT(40-1)2892  
B1A383 EVALUATION OF FOUR CHEMICAL  
MUTAGENS FOR EFFECTIVENESS IN PRODUCING

CHROMOSOMAL ABERRATIONS IN MOUSE LIVER, Florida. Univ., Gainesville. J. Hillis Miller Health Center. OROO. SP 1; MYr 1.75.

The livers of mice injected with one of several different radiomimetic agents will be studied for chromosomal abnormalities in mitosis in an attempt to determine if one of these compounds will produce a high number of abnormalities comparable to those produced by X-irradiation. The compounds to be studied are: (1) ethyl methane sulphonate; (2) dimethyl myleran; (3) Nitromin; and (4) a combination of myleran and chlorambucil. All have been selected because of promise as mutagenic agents or producers of chromosome abnormalities. The LD-50 of each compound will first be determined, after which two experimental groups will be injected intraperitoneally either a single time with the LD-50 or twice weekly with one quarter of the LD-50 dose. Five mice of each group and controls will be sacrificed monthly, after injections of carbon tetrachloride to induce mitosis, to determine: (1) any possible decline in abnormalities with time after a large single dose, and (2) any possible accumulation of abnormalities with time after smaller repeated doses.

This evaluation is preliminary to a determination of life shortening capabilities of any compound which should produce a large number of chromosomal abnormalities. Should a compound which produces many abnormalities, as does radiation, shorten the life span in the same way as radiation, it would tend to support the somatic mutation theory of aging.

Mergen, Francois AT(30-1)2755  
BIA395 EFFECTS OF IONIZING RADIATION ON FOREST TREES—ITS GENETIC AND CYTOLOGICAL IMPLICATIONS.  
Yale Univ., New Haven. Greeley Memorial Lab. NYOO. SP 6; MYr 3.7.

In a cooperative study with the Brookhaven National Laboratory, the genetical, cytological, and physiological effects of gamma radiation on the sexual reproduction of forest trees are being evaluated. Work in progress attempts to define the basic radiation sensitivity of two major forest tree genera—Pinus and Quercus—to both chronic and acute exposures. Included are studies on flower initiation, phenology, and morphology; meiotic irregularities; chromosomal aberrations; and on the effects on fertilization and seed set.

Progeny tests are conducted in the greenhouse and nursery from seed collected from a chronically irradiated forest, as well as from trees that had been exposed to acute radiations.

Safe levels of tolerance on reproductive processes are being determined by subjecting trees of flowering size to ionizing radiation.

Sagawa, Yoneo AT(40-1)3088  
BIA406 STUDIES OF THE EFFECT OF IONIZING RADIATIONS ON THE PROCESSES OF CELLULAR PROLIFERATION, MEGASPOROGENESIS, AND EMBRYO-SAC DEVELOPMENT.  
Florida. Univ., Gainesville. SP 2; MYr 1.5.

Although extensive studies have been made on the sensitivity to ionizing radiations of the various phases of growth and reproduction of flowering plants such as embryo, seed, seedling, vegetative and flowering, microsporogenesis, and pollen, very little has been done to study their effects on the processes of megasporogenesis and embryo-sac development. The importance of considerations of the effect of ionizing radiations on megasporogenesis and embryo-sac formation are evident because of the role played by these processes in sexual reproduction. Also, the method of egg formation is different enough from that of sperm formation in plants to warrant considerations of the sensitivity of this process to ionizing radiations.

Studies on the effect of ionizing radiations on the processes of column expansion, placental ridge proliferation, nucellar row formation, megasporogenesis and embryo-sac formation are in progress. Selected orchid clones are being used as an experimental organism because of the unique nature of the above-mentioned processes in orchids. These are brought on by pollinations. Careful observations are being made to compare the radiosensitivity of the various stages. In addition the pattern of recovery is being traced.

Douglas, Lee T. AT(30-1)-3113  
BIA412 GENETIC EFFECTS OF IRRADIATION ON CERTAIN PARASITIC HELMINTHS.  
Johns Hopkins Univ., Baltimore. School of Hygiene and Public Health.

The effects of irradiation on the genetics of Hymenolepis diminuta (cestoda, cyclophyllidea) will be studied at the population as well as at the individual level. By use of tritiated thymidine labelling, percent cross fertilization in different population sizes of normal and irradiated strains of worms will be studied. This experimentation will be made possible by labelling young cestode strobilae in vitro with tritiated thymidine. These worms will then be surgically implanted in hosts with non-labelled ones and the percent labelled embryos determined in the non-labelled worms. With controls to determine the bio-

logical half-life of the thymidine label, the percent cross fertilization should be determinant in infections with various numbers of worms. In case cross fertilization occurs extensively, the thymidine-labelled worm will be marked with an injection of carbon particles. Studies at the individual level will be facilitated by the isolation of pure-breeding mutant strains of worms and investigation of the mechanism of inheritance by use of classical genetic techniques. That is, embryos and later developmental stages of parent worms will be irradiated,  $F_1$ 's reared, and variant worms among the  $F_1$ 's used for backcrosses and for various combinations of test crosses to determine the genetic mechanisms of inheritance responsible for different abnormalities. In preliminary experiments controlled crosses were made possible by micromanipulative techniques of artificial insemination as well as by transferring oocytes to the uterine lumen of a proglottid with the ovary removed. Altered proglottids are marked with carbon particles for identification after they are fully ripe and gravid.

Caspari, Ernst W. AT(30-1)2902  
B1A425 SOMATIC MUTATIONS IN THE MOTH  
EPHESTIA.  
Rochester, N. Y. Univ.

The purpose of the present project consists in investigating the effect of base analogues which may be incorporated into DNA and RNA on developmental processes. The system investigated is the hind wing of the moth *Ephestia kühniella*. The hind wing contains about 7,000 scales each of which represents a differentiated cell. Mutations induced in this system can be found by looking for aberrant single scales or groups of scales. The number of scales in a group will depend on the number of cell divisions from the time of mutation to the development of the scale. The mutagenic agents used up to now are: X-rays, 5-bromodeoxyuridine, 2-aminopurine, 5-fluorouracil, aminopterin, 2-aminopurine and aminopterin are rather toxic, but do not affect mutation rate. 5-bromodeoxyuridine and X-rays affect mutation rate without affecting the development of the organism in any other way. Survival is normal, but the number of aberrant scales is increased, the amount depending on the concentration. The pattern of abnormal scales induced by 5-BDU is strikingly different from that induced by X-rays. 5-fluorouracil inhibits development. Its effects are strikingly dependent on the time of application. One-3 days after pupation it inhibits the outgrowth of scales. If 5-FU is applied on day 4, the scales grow out but are abnormal in shape. Application of 5-FU 5-8 days after pupation does not af-

fect the shape of the scales, but inhibits their pigmentation. Later treatment has no effect. Similar effects have been found with respect to eye pigmentation and oxidative activities of the mitochondria.

It is proposed to follow up these findings more thoroughly. Specifically, it will be attempted to demonstrate that 5-BDU is incorporated into DNA, and 5-FU into RNA. The quantitative relations of different types of mutations will be more thoroughly investigated. Furthermore, it will be attempted to apply the 5-BDU treatment at earlier stages. Further mutagenic agents will be employed in the system; it is hoped that DNA from different strains may be isolated, so that it can be used for transformation studies.

Nilan, R. A. AT(45-1)353  
B1A472 A STUDY OF FACTORS GOVERNING  
PLANT RADIOSENSITIVITY.  
Washington State Univ., Pullman. SP 3; MYr 1.5.

The three main objectives of this research project are to (1) understand basic mechanisms of radiation damage in cells; (2) gain knowledge about the influence of various factors on the response of plant tissues, particularly seeds, to X rays, gamma rays and neutrons; (3) analyze and control the induced mutation process, including the relation between radiation induced chromosome aberrations and genetic mutations.

These objectives are being pursued through the following investigations: A. Studies of the role of oxygen in the induction of radiation damage in cells. This includes investigations of (1) the relation of temperature and water content of the cells, radiation energy, ionization density, and oxygen concentration and mobility to the action of oxygen in irradiated cells; (2) the role of oxygen in the action of growth regulators in irradiated cells; (3) the mutagenic effect of oxygen. B. The combined effects of radiation and partially radiomimetic chemical mutagens, such as diethyl sulfate and ethyl methane sulfonate. C. The influence of calcium deficiency in irradiated and nonirradiated cells.

The barley seed is the chief experimental material because it has a number of advantages for radiation studies. Chief among these advantages are that it will tolerate a wide range of environmental conditions before, during, and after the radiation treatments and the effects of the radiation can be measured quantitatively in many different ways.

Swanson, C. P. AT(30-1)-1695  
B1A508 MODIFICATION BY SUPPLEMENTARY

AGENTS OF THE RATES OF INDUCED CHROMOSOME AND GENE CHANGES.

Johns Hopkins Univ., Baltimore.

Glass, H. Bentley AT(30-1)1472  
B1A543 THE ACTION OF RADIATION AND OTHER MUTAGENIC AGENTS (1) IN INDUCING MUTATION IN *DROSOPHILA* FEMALES, AND (2) IN CONTROLLING THE ACTION OF SPECIFIC SUPPRESSOR GENES.

Johns Hopkins Univ., Baltimore. May 1962~April 1963. SP 3; MYr 1.5.

The study of the mutagenic effect of a 5-roentgen dose of X rays administered to both males and females of *Drosophila melanogaster* has been concluded after the 50th replication of the experiment and examination of 1,360,948 offspring in control and irradiated series. In the latter, the frequency of dominant Minute bristle mutations was 0.008% higher than in the controls. Since this difference is statistically significant at the level  $P = 2.92\%$ , it follows that mutation is linearly proportional to X-ray dose down to 5 r. A significant reduction in the total number of progeny produced by the irradiated parents was also found; it amounted to 1.1%.

Further studies are being conducted on the effects of intermediate doses (100 r; 500 r), to establish the full dosage curve. Studies of the dose rate effect will be carried out over a range from 2 r per minute to 600 r per minute for sex-linked lethals induced at a period in the life cycle when chromosomal breakage is absent or minimal. Since J. Grant Brewen has shown in this laboratory that the dose rate effect upon chromosomal breakage is abolished by Puromycin, known to be an inhibitor of protein synthesis, it is important to find out whether point mutations likewise exhibit a dose rate effect.

## B1B Microbial and Biochemical Genetics, and Gene Action

See also D1C277, D1C291, and D1C379.

Bonner, D. M. AT(11-1)34-70  
B1B20 GENETIC CONTROL OF ENZYME FORMATION.

California, Univ., La Jolla. SFOO. January 1962~December 1962.

Work being carried out in this project is in the field of gene action. The action of the gene controlling the formation of Tryptophan synthetase in Neurospora is being studied in detail. A number of diverse lines of inquiry are underway. Continuing

studies of the genetic fine structure of the locus are being carried on. This work has in general shown that there are regions within the locus in which mutations can occur and result in structural alteration of the formed enzyme. Other regions occur, however, in which no mutations to date have been detected. These are presumably regions in which mutation may occur which in turn does not cause a major structural alteration of the product enzyme. The noisy regions at present appear to be associated with substrate attachment sites while the silent regions may represent the structural backbone of the enzyme.

These questions are being investigated by detailed studies of the enzyme. Attempts are being made to crystallize the parental enzyme. Structural changes occasioned by breaking of the hydrogen bonding and disulfide bridges are being studied chemically and immunochemically. At the same time intensive investigation is under way in an attempt to isolate the protein of those mutant types which fail to form Tryptophan synthetase which can be detected through immunological methods.

Siegel, Albert AT(11-1)873  
B1B175 MUTATION STUDIES WITH TOBACCO MOSAIC VIRUS.

Arizona, Univ., Tucson. COO. Apr. 15, 1962~Apr. 14, 1963. SP 2; MYr  $1\frac{1}{4}$ .

It is proposed to investigate several problems relating to the mutagenesis of tobacco mosaic virus.

- Attempts will be made to deaminate the base residues of tobacco mosaic virus enzymatically. In particular, a study will be carried out to determine whether the specificity of the adenosine deaminase from *takadiastase* extends to adenosine residues in a nucleic acid.
- A search will be made for variants of tobacco mosaic virus which fail to induce the production of viral protein in host cells. Such mutants will be valuable for the study of viral nucleic acid synthesis in the absence of viral protein synthesis.
- A comparative study will be made of the rate of mutation induction of tobacco mosaic virus and turnip yellow mosaic virus using nitrous acid as a mutagen. Because the nucleic acids of these two viruses differ markedly in base composition, this study may provide information about the frequency of mutation induction when different nucleic acid base residues are deaminated.
- Experiments will be carried out to determine whether new proteins, other than viral protein, are synthesized in virus infected host cells. In addition, efforts are being continued to develop a system for plant virus study in pectinase separated tobacco leaf cells.

Sonneborn, T. M. AT(11-1)235  
B1B185 CELLULAR HEREDITY IN PARAME-  
CIUM.

Indiana Univ., Bloomington. COO. SP 21; MYr 19.

Study of cellular heredity, differentiation and development, of intracellular organization and symbiosis, and of general biology using as materials mainly the Ciliate (Protozoan) Paramecium aurelia. Specific projects for the year include one on the genetics and development of the rotifer, Asplanchna, and the following on P. aurelia: (1) The physiological role of micronuclei. (2) The action of sigma particles and their inhibitor in rapid-lysis killers. (3) The action, nature, and genotypic control of lambda, kappa, and mu in other killers. (4) The interaction of temperature, pH, growth rate and various solating and gelating chemicals on the stability and transformation of immobilization serotypes. (5) Cytochemical and electron microscopic localization and organization of DNA and RNA in the macronucleus; (6) The origin, development, reproduction and inheritance of cortical components and their organization. Studies are also being initiated on the Suctorian, Tokophrya infusioformis: its life cycle, aging, metamorphic cellular differentiation, serology, and genetics.

Myers, W. M. AT(11-1)1097  
B1B199 GENETIC CONTROL OF PHYSIOLOGI-  
CAL PROCESSES IN HIGHER PLANTS.

Minnesota. Univ., St. Paul. COO. SP 6; MYr 1.65.

Having found large genetic differences in strontium accumulation in the grain of barley, wheat, and soybeans, detailed studies of the nature of the genetic control of strontium accumulation can now be made.

The project is currently concerned with two main lines of research. One has to do with inheritance of strontium accumulation. In this regard studies will be made of the inheritance pattern in crosses of high x high, low x low, and high x low strontium accumulators. These same crosses will be used as base populations for long-term selection experiments. Substitution lines in wheat and isogenics in barley will be employed to obtain additional information on inheritance of strontium accumulation. The second line of research will be directed toward finding the morphological or physiological basis for observed differences. Differential absorption will be investigated in both intact and excised roots. Translocation patterns will be studied using autoradiographs and component part analyses of the plant. The relationship between strontium and calcium entry and movement in the plant as well as sites of deposition, such as the pectates of the cell wall, will be investigated.

DeBusk, A. Gib AT(40-1)2788  
B1B254 THE MOLECULAR BASIS OF FORWARD  
AND BACK MUTATION.

Florida State Univ., Tallahassee. OROO. SP 6;  
MYr 2 $\frac{1}{2}$ .

Back mutation was first demonstrated with nitrous acid in Neurospora crassa at the ad-3 locus (38701). A detailed analysis of the kinetics of HONO reversion of this U.V.-induced mutant indicates that two independent oxidative deaminations are required to restore the wild phenotype. This further suggests that two nucleotide bases must be submitted in the region of the ad-3 locus to restore prototrophy. If reversion is attributable to suppressor action, it must be intragenic in nature and be within 0.0005 crossover units of the mutation under analysis.

Studies with a series of lysineless mutants induced with nitrous acid reveal examples of both one and two hit reversion kinetics with HONO as the reverse mutagenic agent. Others with intermediate values are being investigated more extensively. Such studies are being extended with other mutagens such as ethyl methyl sulfonate and 2-amino purine both in terms of reversion pattern and reversion kinetics.

New techniques are being developed to better resolve possible intraallelic suppressors in revertants of Neurospora.

A new technique has been developed for the isolation of high molecular weight DNA from Neurospora which employs liquid nitrogen and aerosol OT in key steps. Molecular weights, base ratios, and other physical properties are under investigation.

An attempt is being made to demonstrate the existence of subchromosome units, only some of which are altered in the production of a "base pairing" mutant resulting in subsequent meiotic or mitotic segregation of parental genotypes from non-suppressor revertant clones.

Wells, Carolyn AT(40-1)2793  
B1B266 CYTOLOGICAL, PHYSIOLOGICAL AND  
GENETIC STUDIES OF CERTAIN STRAINS OF  
TETRAHYMENA PYRIFORMIS.

Longwood Coll., Farmville, Va. OROO. SP 2;  
MYr about  $\frac{3}{4}$ .

An attempt is being made to establish a breeding method using the ciliate, Tetrahymena pyriformis, that will be useful for a study of physiological aspects of radiation-induced mutation. This is the long-range purpose of the project. Cytological studies of conjugating organisms have failed thus far to reveal a system in which true nuclear reorganization is completed. Many anomalies have been seen in conjugating pairs. A monosomic strain (1/II) has been examined

in detail. Meiosis in this strain usually leads to the degeneration of all meiotic products, primarily as a result of massive loss of laggard chromosomes during the anaphases. Some evidence indicates that this behavior may be associated with aging of the strain. Present research efforts are centered around this possibility.

Glassman, Edward AT(40-1)3013  
B1B271 BIOCHEMICAL AND GENETICAL  
STUDIES ON CHRONIC ANEMICS.  
North Carolina. Univ., Chapel Hill. OROO. SP 1;  
MYr 1.

This study is a result of a screening program which used paper chromatography of human urine in order to detect human individuals with metabolic defects in compounds (such as nucleic acid derivatives) which absorb ultra violet light. We were successful in detecting very high amounts of normally occurring metabolites in the urine of chronic idiopathic anemias. Isolation and identification of these compounds are underway. High incidence of accumulation of these compounds has also been detected in relatives of the propositus, and a genetic basis is suspected.

Borek, Ernest AT(30-1)2358  
B1B294 A STUDY OF THE MECHANISM OF  
INDUCTION BY IRRADIATION IN A LYSOGENIC  
ORGANISM WHICH CONVERTS THE LATENT  
BACTERIAL VIRUS TO VIRULENCE.  
Columbia Univ., New York. Coll. of Physicians  
and Surgeons. NYOO.

There are two separate areas of investigations in our laboratory: A study of the translation of radiant energy into biological sequelae and the synthesis and structure of transfer RNA.

In the first area we have chosen the lysogenic system of *E. coli* K<sub>12</sub> as the model for study. Our main effort has been directed towards the elucidation of the biochemical mechanism of induction, i.e. the mechanism which upon receipt of radiant energy triggers the aberrant metabolism which results in bacteriophage formation in the otherwise stable system. We have found that in the case of u. v. irradiation induction is achieved by a stable intermediate irradiation product. The existence of such a product has been demonstrated by the passage of it during conjugation from an irradiated F<sup>+</sup> non-lysogenic organism to an unirradiated F<sup>-</sup> lysogenic organism. It was found that the latent phage of the recipient organism is induced just as if the organism had been exposed to the irradiation directly.

Our main effort in this area is an attempt to characterize and possibly to identify this irradiation product.

Soluble or transfer RNA is characterized by the presence of methylated purines and pyrimidines. The origin of these methylated bases has been obscure until recently.

During the past year we demonstrated that the synthesis of the methylated bases in S-RNA occurs not at the level of the monomers but by the methylation of the S-RNA poly-nucleotide. We showed the existence of an enzyme system—RNA Methylase—which achieves such methylations. This enzyme is the first one known which is ubiquitously distributed and whose function is the alteration of the tertiary structure of a nucleic acid.

Taylor, J. Herbert AT(30-1)1304  
B1B298 NUCLEIC ACID AND PROTEIN SYN-  
THESIS IN INDIVIDUAL CELLS AND CHROMOSOMES  
STUDIED BY RADIOACTIVE TRACERS AND AUTO-  
RADIOGRAPHS.  
Columbia Univ., New York. NYOO. SP 1; MYr 1/2.

The mechanism of chromosome reproduction and the molecular composition and organization in relation to function are being studied in three ways.

1. Autoradiography with thymidine-H<sup>3</sup> is used to follow DNA replication over the cell cycle. Changes in number of subunits, which can independently break and exchange under the influence of radiation, are determined at various stages in the cycle. Chromosomes were found to break if DNA synthesis is prevented by fluorodeoxyuridine or aminopterin at certain stages of the cell cycle. Stable reunion of breaks induced by radiation or chemicals also require thymidylate and presumably DNA replication.

2. The pattern of DNA replication along chromosomes is being studied over the cell cycle with the idea that it may reveal genetic control mechanism in chromosome reproduction. Studies on the sex chromosomes of mammals reveal that a part or the whole of one X-chromosome of females is normally late in replication. The condition is induced in somatic cells at early embryonic development and evidence suggests the differentiation involves a genetic inactivation of the late replicating region.

3. Tritiated nucleosides have been prepared and these are being used to study the intracellular sites of soluble RNA synthesis.

Zamenhof, Stephen AT(30-1)3103  
B1B299 STUDY OF MUTATION TO RADIATION  
RESISTANCE IN SPORES.

Columbia Univ., New York. Coll. of Physicians and Surgeons. NYOO.

The organism which will be used in this study is Bacillus subtilis which the applicant has used in his transformation studies. If a mutant to higher radiation resistance of spores can be induced, an attempt will be made to transfer such resistance by transformation. Thus, the study will include an attempt to demonstrate that the acquired information concerning improved radiation resistance is carried by deoxyribonucleic acid. The studies in subsequent years may include localization (mapping) of the site carrying this information, using transforming phenomenon, as it has been done for other genes. The technique used will include sublethal x-ray irradiation of large quantities ( $>10^{10}$ ) of spores, in dry state in vacuum. The surviving spores (at a very low level of survival) may include spores that were more resistant to radiation due to previous spontaneous mutation, and those which became potentially more resistant due to mutations induced by radiation. Both mutations will be detected by cultivating the survivors, inducing sporulation and assaying such spores for improved radiation resistance.

Thomas, W. I. AT(30-1)2744  
B1B305 THE INHERITANCE AND CHARACTERISTICS OF DIFFERENTIAL ELEMENT ACCUMULATION BY MAIZE WITH PARTICULAR EMPHASIS ON STRONTIUM AND CALCIUM.

Pennsylvania State Univ., University Park. NYOO.

Ear leaf blades from 3 diallel sets of single-cross corn hybrids were analyzed spectrochemically for 11 elements (Sr, Ca, Mg, K, P, B, Al, Cu, Mn, Zn, Fe). Previous research had indicated significant differences among hybrids to accumulate different levels of Ca, Mg, K and P.  $F_1$ ,  $F_2$  and reciprocal back-cross populations as well as  $F_3$  lines from high x high, high x low and low x low single cross hybrids with respect to calcium accumulation have been made and will be analyzed to determine the mode and degree of inheritance of calcium accumulation. Correlations also will be made between the levels of different elements, especially between calcium and strontium accumulation.

Relationships of different levels of corn plant accumulation of elements to agronomic characteristics such as dry matter accumulation, resistance to plant pathogens and level of chemical elements in the soil will be studied.

Technique studies will be carried out to determine whether washing of plant surfaces is necessary to prevent contamination and to determine at what stage of growth genetic differences in element accumula-

tion may be detected. In addition growth chamber facilities will be used with such radioactive elements as calcium and phosphorus to determine whether these techniques will permit differentiation of genetic entities at the seedling stage.

Forest, Herman S. AT(30-1)3046  
B1B308 GENETICS OF BLUE-GREEN ALGAE-II.  
Rochester, N. Y. Univ. NYOO.

The principal direction is toward a partial test of Gabriel's (1960) theory on primitive genetic mechanisms, inasmuch as the blue-green algae give increasing evidence of possessing a structurally non-chromosomal mechanism, which is highly polyploid. The approaches are: (1) Continued analysis of variability in the genus Anabaena employing both herbarium and experimental taxonomy (a. colony type in culture. b. response to salts of  $Na^+$ ,  $Li^+$ , and  $Cu^+$ . c. relationship with certain bacteria. d. resistance to UV and X-radiation, and e. transformation attempts with extracted DNA) . . . (2) Cooperative program in interpretation of electron photomicrographs of a series of developmental stages of species of Anabaena and other genera . . . (3) Cooperative program in interpretation of results of the broadest possible biochemical analysis of DNA and RNA content of cells . . . (4) Continued morphological investigation of developmental cycles to determine their biological meaning and control . . . (5) Use of "killing curves" and germination capacity tests to obtain information about the organization of genetic mechanisms.

Mittler, Sidney AT(11-1)1081  
B1B330 STUDIES OF CHEMICAL PROTECTION AGAINST RADIATION INDUCED MUTATIONS.  
Northern Illinois Univ., DeKalb. COO.

Sulfhydryl compounds, which are effective in protecting mammals from death by irradiation will be studied with respect to chemical protection against induced mutations, and chromosome translocations, and deletions in Drosophila melanogaster, MEA, 2 mercaptoethylamine, and AET, 2 aminoethylisothiouonium bromide, will be injected near the testes of the fly which will then be irradiated with 2000r from an x-ray source. Recessive sex linked lethal mutations will be determined by the M-5 method and translocations between II and III chromosome by bw; st method. The protection if any, against deletions of the x chromosome will be determined by the attached x method. Preliminary experiments indicate that the sulfhydryl compounds are not protecting against genetic damage, but are enhancing it. This may be due to some inhibition of a recovery process.



Marcovich, H. AT(30-1)2803

B1B346 (1) STUDY OF THE MECHANISM OF ACTION OF IONIZING RADIATIONS ON THE GENETIC MATERIAL OF *E. COLI* K 12. (2) A MUTATION OF YEAST RESISTANT TO IONIZING RADIATIONS.

Institut Pasteur, Paris. Mar. 15, 1963–Mar. 14, 1964.

(1a) Study of the effects of X-,  $\alpha$ -, and UV-rays on recombination in *E. Coli* K12. The irradiation of the male strain produces lesions which inactivate the transmission of the genetic markers, probably by weakening the chromosome chain. This inactivation is proportional to the distance of the selected marker from the origin of transfer. But a region of the chromosome located between the Histidine and Tryptophane determinants is abnormally resistant to  $\alpha$ - and UV-rays.  $P^{32}$  labelling of the male has shown that this difference is not due to a lower phosphorus content per unit length. Other hypotheses are being tested. When the female are irradiated, the mating results in a "restoration" of these cells, proportional to the length of male material transferred. These experiments are in favor of a polarized copy-choice mechanism for the formation of the recombinant chromosome in the irradiated females.

(1b) Study of the induction of mutation by radiations: X-ray induced mutations in a male cell are immediately transferable to the female by mating, whereas UV-induced ones are not. Furthermore, UV but not X-ray irradiation of the female can mutate the male genetic material transferred by mating; these results suggest that X-rays act directly on the chromosome, and that UVs have a cytoplasmic stage.

(II)  $P^{32}$  decay induces in yeast with a high efficiency a mutation to radiation-resistance. This genetic character is stable and specific of ionizing radiations. The DNA dosage and the genetic analysis demonstrate that the radioresistant strains are still haploid, as are the parental ones, but their RNA content is higher. The character of normal radiosensitivity ( $S^+$ ) is dominant over radioresistance ( $S^-$ ); the two alleles segregate in the ratio 2:2 by sporulation of the diploid  $S^+S^-$  cells. This mutation can be induced by UV-,  $\alpha$ -rays and mustard gas. The mechanism of this radioresistance is under study.

Grosch, D. S. AT(40-1)2836

B1B376 THE LOCALIZATION, PERSISTENCE AND RESULTANT GENETIC EFFECTS IN INVERTEBRATES OF INGESTED FOURTH PERIOD METALS IN STABLE AND RADIOACTIVE FORMS.

North Carolina State Coll., Raleigh. OROO. June 1962–October 1963. SP 3; MYR  $1\frac{2}{5}$ .

For the 1962–63 period we propose to continue research concerned with the tissues, cells and cell components with which fourth period cations become associated in the female insect. Along with these determinations, quantitative data on the sensitivity of ovarian cell types will be obtained from scoring egg production and embryonic survival. The special advantage of parthenogenetic production of male *Habrobracon* will be utilized in comparisons of impaternal offspring with survival of biparental offspring to determine induced dominant lethals. In addition to the stable isotopes employed, radiozinc, radiocobalt and radionickel will be fed. Radioactivity will be assessed for body parts and tissues and of the eggs deposited. Results will be correlated with hatchability records where possible and attempts will be made to distinguish between chemical damage and that for which radiation is responsible. Electrophoretic and chromatographic procedures will be applied in an attempt to determine the particular cell components which bind fourth period cations.

Ingestion experiments with insects are of practical value not only because of the search for effective control measures but also because they yield fundamental information about the biological behavior of potentially hazardous nuclides of the environment. Unique features of a braconid wasp enables the investigator to distinguish between chromosomal and genic damage in the germ line, and interrelations with somatic tissue metabolism.

Plough, Harold H. AT(30-1)2452

B1B388 RADIOBIOLOGICAL STUDY OF TRANSDUCTION IN *SALMONELLA*.

Amherst Coll., Mass. NYOO.

This research is concerned with bacterial genes, their size, arrangement and mutation. The mechanisms of action and replication of bacterial genes are similar to those in higher organisms. Thus the purpose of these studies is to secure additional information concerning the relation of genes to the architecture of the DNA molecule in chromosomes generally.

We are studying the transfer of bacterial DNA from one bacterial cell to another by the agency of bacterial virus particles, a process called transduction. These transducing fragments are formed in the cell soon after the bacteriophage enters and begins to replicate, eventually causing a burst. Some of the fragments become incorporated in the phage particles, and are carried into other cells along with the

phage DNA. The frequency of transduction differs for different gene markers, and for different strains of cells and different phages. In addition it is increased by radiation of the cells in which the fragments are formed.

We are currently studying these processes using Density Gradient Centrifugation in order to determine if transducing fragments have different weights, and if these are associated with different genetic markers in the bacterial cell. Current results suggest certain constant differences which we hope to associate with the linear order of genes and the location of the prophage sites.

Robinson, Trevor AT(30-1)2736  
B1B392 BIOCHEMICAL MUTANTS OF HIGHER PLANTS.  
Massachusetts. Univ., Amherst. NYOO. SP 1;  
MYr  $\frac{1}{4}$ .

An investigation is being made of biochemical mutants produced by gamma irradiation of Lemna plants. After exposure of parent plants to a sublethal dose of radiation the vegetatively-produced progeny are subcultured on media enriched with yeast extract. Wild plants are benefitted by yeast extract, but it is not required for growth. Subcultures from plants growing on enriched media are made to media lacking yeast extract to see whether irradiation has produced mutants which require constituents of yeast extract for their growth.

Biochemical mutations which do not show up as nutritional requirements are being sought by analyzing the various clones to see whether different patterns of constituents appear in them. Analyses are carried out using chromatographic techniques and absorption spectra of the separated constituents. The chief categories currently under investigation are chloroplast pigments, amino acids, sugars, and phenolic compounds.

The literature contains innumerable studies of biochemical mutations produced in fungi by ionizing radiation but almost no reports of such effects on the higher plants. Lemna is an especially convenient higher plant to investigate because of its small size and rapid multiplication. Production of biochemical mutants of it may open the way to studying biosynthetic pathways of types of compounds peculiar to higher plants in the same way that many pathways have been elucidated in fungi.

Lundgren, Donald AT(30-1)2038  
B1B394 PRODUCTION AND STUDY OF ASPOROGENIC MUTANTS OF BACILLUS CEREUS.  
Syracuse Univ., N. Y. NYOO. MYr 6.

Induced asporogenic mutants of Bacillus cereus have been isolated and are being compared to the parent. Normal growth and sporulation patterns of the parent have been determined when grown in a glucose-glutamic acid-glycine-salts medium. Enzymatic deficiencies in the mutants are being sought which are related to the sporulation process. An auxotrophic mutant of B. cereus has been isolated which requires either cystine, cysteine or methionine added to the mineral medium for growth. No spores were formed when the auxotroph was grown on methionine and approx. 5% sporulation occurred on cyst(e)ine. Radiation resistance of spores and vegetative cells grown on different levels of cyst(e)ine were compared and correlated to the level of cyst(e)ine in the cells. Radiation resistance increased as the S-S/S-H ratio increased. Cystine (S-S) and cysteine (S-H) were determined polarographically. The auxotroph accumulated large amounts of the polymer, poly-beta-hydroxybutyrate. Extracted polymer was studied as regards its physical characteristics. X-ray diffractograms indicated the polymer to be crystalline and electron micrographs revealed "lath" shaped crystals with a distinct lamella morphology. The lamella were arranged in pyramiding layers. The mol. wt. was approx. 7000. The role of polymer in sporulating cells is under investigation.

Pittman, David AT(11-1)1249  
B1B403 RADIATION GENETICS OF SACCHAROMYCES.  
Southern Illinois Univ., Carbondale. SP 3; MYr 1.

This project will center on the genetics and radiation sensitivity of yeast protoplasts. Protoplasts prepared by snail enzyme treatment generate plasmic entities on appropriate hypertonic nutrient agar. On sustained incubation, the entities converge to produce a protoplasmic monolayer which is highly vacuolar and particulate. Electron microscopy of the protoplast reveals that it contains a nucleus, vacuole, mitochondria, cell membrane, but no detectable cell wall. The ability (inability) of such protoplasts to produce plasmic entities and monolayers on synthetic hypertonic nutrient agar appears to be governed directly by the biochemical (genetic) markers of the intact cell from which the protoplasts are derived. The ability of protoplasts to form plasmic entities following X rays and UV will be determined and compared to that of the intact cell to produce a micro- and macrocolony. This is being followed quantitatively by plating irradiated cells and protoplasts separately on the gridded surface of hypertonic nutrient agar.

Jones, Raymond F. AT(30-1)-3105  
B1B423 BIOCHEMISTRY OF GAMETOGENESIS  
AND FERTILIZATION IN ALGAE.  
Princeton Univ., N. J.

The proposed work concerns a biochemical investigation of the metabolic changes which occur during the onset of gametogenesis in the heterothallic green alga *Chlamydomonas moewusii*.

Using radioactive  $\text{HC}^{14}\text{O}_3$  and  $\text{S}^{35}\text{O}_4$  vegetative cells and gametes of both mating types will be labelled and the various cellular and flagella constituents analyzed after various periods of incorporation by chromatography and radioautography.

Vegetative cells labelled with appropriate radioactive compounds will be induced to form gametes and the gametes analysed to see what metabolic changes occur during the process.

A study of the stable (non-radioactive) metabolic pools within the cells and changes that occur during the onset of gametogenesis will be made.

These studies will be extended to the events involved in the actual fertilization process.

Giles, N. H. AT(30-1)-3098  
B1B512 STUDIES ON MECHANISM OF MUTATION,  
RECOMBINATION, AND GENE ACTION IN NEURO-  
SPORA.  
Yale Univ., New Haven.

Rossi, Harald H. AT(30-1)2740, BP-3  
B1B588 THE GENETIC BASIS FOR DIFFER-  
ENCES IN RADIOSENSITIVITY WITHIN A SINGLE  
STRAIN OF BACTERIA (*E. COLI* STRAIN B).  
Columbia Univ., New York. Coll. of Physicians and  
Surgeons.

Since it has been shown that differences in radiosensitivity among variants of the bacterium *E. coli* strain B are not due to gross genetic changes, it is proposed to investigate the possibility of changes at the gene level. The variants to be used include non-identical forms of B/r (more resistant) and B<sub>S</sub> (more sensitive). It is planned to use the standard methods of bacterial recombination. Since these require the introduction of suitable genetic markers, including that governing the mating type, the success of the proposed investigation will depend upon the constancy of radiosensitivity after these other genetic changes. Nevertheless, changes in radiosensitivity conferred by other markers are themselves of importance since, if observed, they would constitute evidence for a non-specific genetic origin of radiosensitivity.

Rossi, Harald H. AT(30-1)2740, BP-4  
B1B589 THE PROBLEM OF THE SPONTANEOUS

"BACKGROUND" IN THE STUDY OF RADIATION-  
INDUCED MUTATION.

Columbia Univ., New York. Coll. of Physicians and  
Surgeons.

It is proposed to study the appearance of mutations from tryptophane dependence to independence (reversions) in *E. coli* strain B/r. This system has been chosen since it has been shown, on one hand, that the numbers of such mutations appear to increase as the result of irradiation but on the other hand, the existing literature and our own preliminary findings indicate that the "background" correction may be much too low. This particular system is only one example in which the role of radiation may not be directly mutagenic in the sense of causing a true genetic change but may be selective. Apart from the obvious example of the selection of radiation-resistant forms by radiation, the possibility of selection of other types of mutations has not been investigated to date, even though this is important for a complete understanding of the action of radiation and of the mechanisms of genetic change.

It is planned to extend the investigation to other bacterial mutations reported to be radiation-inducible such as mutations to nutritional deficiency, to virus-resistance, and to antibiotic-resistance.

B1C Human and Mammalian Genetics  
*See also A1B46.*

Gowen, John W. AT(11-1)1225  
B1C186 A QUANTITATIVE STUDY OF LIFETIME  
SICKNESS AND MORTALITY AND PROGENY EF-  
FECTS RESULTING FROM EXPOSURE OF ANIMALS  
TO PENETRATING IRRADIATION.  
Iowa State Univ. of Science and Tech., Ames. COO.

Our experience has shown that lifetime reproductive-  
ivities or lifespans of animals exposed to irradiation  
or their progenies are best indexes of radiation ef-  
fects. We now have mice which have an ancestral  
record of 18 generations of continuous irradiation  
with Cobalt 60 gamma irradiation. Similar groups of  
mice have received acute irradiations from both  
X-rays and Cobalt 60 gamma rays in utero and fol-  
lowing birth. These mice give comparable information  
to those receiving continuous irradiation during  
these two life periods. The contrasting results of  
these sets of data show that the accumulative effects  
of continuous low dose rate irradiations can be  
tolerated to a much greater degree than when the  
same or even  $\frac{1}{10}$  the same cumulated dose is given  
acutely. Average young for males actually increased  
but not appreciably as whole body 250 pkv X-ray acute  
dosages advanced from 0 to 20, to 80, to 160 r. Fe-

males irradiated with 20 r on the other hand showed a 33 per cent decrease in progeny while at 80 r the decrease was 87 per cent. In pair matings of jointly exposed sexes it is the effect of the irradiation on female germ cells which is the all important factor in litter productivity. Cumulative effects of 0.6 to 2.0 r per day even over 18 ancestral generations of continuous irradiation still allowed adequate reproduction to maintain the germ line. This cumulated ancestral irradiation is not less than 10 times that required to produce sterility when given acutely.

Effects of high energy irradiations on these strains of mice in the ranges of acute or continuous irradiation dosage indicated, measured in terms of lifespan, lifetime reproductivity and mutation, over a five generation period will soon be available.

These results are taken from much more extensive investigations, designed to model the conditions which may prevail should man be exposed to more than spontaneous irradiation. Objectives are to measure quantitatively effects of radiant energies of various qualities and intensities on the general well-being, morbidity and inheritance of those exposed. Several species are studied for only by such comparative studies can information be obtained for predictions on what may happen to man under comparable exposures.

Gershowitz, Henry AT(11-1)-405  
B1C194 STUDIES ON HUMAN POPULATION  
GENETICS.

Michigan. Univ., Ann Arbor. COO. SP 7; MYr  $4\frac{2}{3}$ .

This study is part of a continuing effort to characterize the genetics of human populations. It is believed that a more complete comprehension of the genetics of man will lead to a better evaluation of the possible genetic risks of ionizing radiation.

The various phases of the investigation can be summarized as: 1) Studies on selection—a search for possible correlations between blood types and certain fatal or potentially fatal pediatric diseases is to be undertaken by a comparison of frequencies of the blood groups and an analysis of segregating families. An attempt is also being made to characterize a possible mechanism for pre-conceptual or pre-zygotic selection in relation to the presence of hemagglutinins in the secretion of the uterine cervix. 2) The study of polymorphic systems—(a) the Gm system ( a series of inherited serum globulin differences), and (b) quantitative variation within the subtypes of the A blood group are currently under investigation. In addition, the protein and non-protein components of saliva are being studied with the particular orientation toward detection of any poly-

morphic systems. 3) Gene frequencies—the bloods of various populations will be surveyed by a variety of methods involving 12 genetic markers.

Stone, William H. AT(11-1)1210  
B1C234 THE EFFECTS OF IRRADIATION ON  
ERYTHROCYTE CHIMERISM AND IMMUNOLOGIC  
TOLERANCE IN CATTLE TWINS.

Wisconsin. Univ., Madison. COO. June 15, 1962–  
June 14, 1963.

About 90 per cent of dizygotic cattle twins contain a mixture of two antigenically distinct kinds of blood cells derived from genetically different tissues. This condition is known as erythrocyte chimerism or mosaicism and results from an anastomosis of embryonic membranes in utero followed by a reciprocal exchange of primordial blood-forming tissues. Chimeric twins are tolerant to transplantation antigens as well as erythrocyte antigens since they readily accept reciprocal skin grafts.—Recent observations indicate that the proportion of the two kinds of blood cells in chimeric twins is not constant, suggesting that each twin may lose tolerance for the tissues of the co-twin. In addition, there appears to be a major shift toward a "recombinant" cell type containing blood group antigens that were previously unique to each of the two original types. Other studies indicate that sub-lethal irradiation may abrogate tolerance. Thus, we propose to irradiate one member of a pair of chimeric twins (the other serving as a control) and to determine if there are changes in the proportion of the two cell types and if "recombinant" types appear. Prior to irradiation, reciprocal skin grafts will be made as another means of assaying the state of tolerance.

Dunn, L. C. AT(30-1)1804  
B1C295 GENETICAL AND DEVELOPMENTAL  
STUDY OF VARIANT ALLELES NEAR A COMPLEX  
LOCUS IN THE HOUSE MOUSE.

Columbia Univ., New York. NYOO. SP 6; MYr  $2\frac{1}{2}$ .

The object is to try to understand how hereditary factors with deleterious effects maintain themselves in high frequency in natural (feral) populations. This involves methods of breeding analysis and of both developmental and population genetics. For each allele at one complex locus detected in a wild population the following information must be obtained: the ratio in which it is transmitted through egg and sperm; its effect on embryonic development; if lethal, whether it differs from (i.e. is complementary to) lethal alleles previously collected; its effect of recombination in the vicinity of the locus; if viable, its effect on male fertility when combined with other

lethal or viable alleles. From studies of some 70 spontaneous occurrences of variant alleles it appears that those maintained in wild populations are all transmitted in extremely high ratios (90% and over) through sperm, and all suppress recombination near the locus. The cause of the abnormal sperm ratio appears in some cases to be due to effects of genes on the behavior of sperm and this may be the channel through which polymorphism of lethals is maintained. New alleles arise by exceptional recombination near the locus and this results in repeated occurrences of the same alleles in different populations.

Russell, E. S. AT(30-1)1800  
B1C310 ATTEMPTS TO DELINEATE INBORN  
ANEMIAS IN MICE.  
Roscoe B. Jackson Memorial Lab., Bar Harbor, Me.  
NYOO.

This contract supports extensive investigations of the etiology of three different types of hereditary anemia in the house mouse. Completed studies of W-series macrocytic anemia include tests of limitations of therapy through implantation of normal bloodforming tissue and detailed studies of contrasting reaction of normal and anemic mice to radiation damage. Studies of reaction to different hematopoietic stimuli and plethorization, and search for metabolic error in hematopoiesis through isotopic labelling studies of the kinetics of heme synthesis continue. Studies of S1-series macrocytic anemia include characterization of effects of a new viable allele (S1d); attempts at therapy through implantation; and studies of reactions of viable anemic mice to erythropoietic stimuli and X-irradiation. Similarities and differences between results with the two genetically distinct macrocytic anemias may provide clues as to the gene actions involved. Studies of the transitory siderocytic anemia of ff mice, based on a new homozygous inbred stock (FL/Re), include detailed characterization of the anemia and its effects on growth in fetuses and newborn mice; tests of effects of single-gene substitutions (Ww, Ff, and FF) on growth, blood formation, and pigmentation; and search for evidence of metabolic error in FL/Re mice. The previous finding of effects of single-gene substitutions on acute radiosensitivity is being followed up by a more extensive study of the effects of single doses of a wide range of deleterious genes affecting hematopoietic tissues.

Lush, J. L. AT(11-1)707  
B1C329 GENETIC EFFECTS OF IRRADIATING  
SWINE.

Iowa State Univ. of Science and Tech., Ames. COO.  
SP 20; MYr 20.

The purpose is to measure the genetic effects of paternal X-irradiation (300 r given 6 months prior to breeding) on quantitative characters of the offspring and to detect mutations at blood-group loci.

The results from 712 litters show a 4 percent increase in mortality among offspring sired by exposed males when compared with controls. The effect on growth rate is inconsistent, favoring offspring by control males in the first 362 litters and the reverse in the later litters. The measure of learning ability used shows important genetic differences, but only small genetic effects of paternal exposure. Problems in the production and isolation of reliable blood-typing reagents are being studied. No exceptional blood type has been observed in the first 350 litters examined.

Woolf, Charles M. AT(11-1)1084  
B1C356 GENETICS OF CONGENITAL MALFOR-  
MATIONS AND OTHER DISORDERS IN MAN.  
Arizona State Univ., Tempe. COO. September 1962-  
August 1963. SP 5; MYr 2½.

The objectives of the proposed project are (1) to complete a genetics and epidemiological study of harelip and cleft palate in man; (2) to initiate similar studies on other types of congenital malformations in man such as syndactyly, polydactyly, and brachydactyly; (3) to determine the distribution of the gene for albinism among the Indians of the southwestern part of the United States; and (4) to determine the reason(s) for the high frequency of the gene among some of these Indian populations.

Cepellini, Ruggero AT(30-1)-2959  
B1C511 PHENOTYPIC EXPRESSION OF HISTO-  
COMPATIBILITY OF GENES AS A FUNCTION OF  
CELLULAR DIFFERENTIATION AND MATURATION  
IN MAN.  
Turin. Universita.

Green, Earl L. AT(30-1)1979  
B1C541 QUANTITATIVE POPULATION GENET-  
ICS OF MICE UNDER IRRADIATION.  
Roscoe B. Jackson Memorial Lab., Bar Harbor, Me.

Two groups of populations of mice are being propagated generation after generation, under selected levels of gonadal irradiation and of inbreeding. The objective is to assess the effects, if any, of irradiation and inbreeding on several characteristics which measure biological fitness. One group of populations, called "genetically homogeneous," is descended from a single pair of an inbred strain of mice. The other group, called "genetically heterogeneous," is de-

scended from 4 pairs, one from each of 4 inbred strains, which were crossed to produce double-cross hybrids. In each group there are 12 populations with 16 mated pairs per generation. The 12 populations represent all combinations of 3 levels of radiation (0, 50, 100 r) and 4 levels of inbreeding. Samples of these populations are studied at certain generation intervals for reproductive performance, longevity, and radiation resistance.

In addition, two associated experiments are in progress, one on the question of genetic extinction due to gonadal irradiation, and the other on the genetics of resistance to chronic whole-body irradiation. In the latter experiment 27 different inbred strains have been studied, and two-way selection has been effected from a genetically heterogeneous population for resistance to 100 r/day and 400 r/day.

This same project is supported in part by PHS research grant GM 07249-03 from the Division of General Medical Sciences, Public Health Service.

Glass, H. Bentley AT(30-1)-1939  
B1C544 THE EFFECTS OF IONIZING RADIATIONS ON GENE AND CHROMOSOME MUTATION RATES IN NORMAL HUMAN CELLS IN TISSUE CULTURE.

Johns Hopkins Univ., Baltimore. June 15, 1963-March 14, 1964.

Using the corneal epithelium of the Chinese hamster as especially suitable material, J. Grant Brewen has studied the effect on chromosomal breakage of doses of X rays over a range from 10 roentgens to 150 roentgens, and of different dose rates from 2 r per minute to 600 r per minute. He has found that the frequency of chromosomal breakage is directly proportional to the dose, and is approximately 3-fold higher at the high dose rate than the lowest dose rate used, when dose is constant. There is no sign of a threshold for the effect of radiation on chromosomal breakage. The dose rate effect is abolished by Puro-mycin, a known inhibitor of protein synthesis, so that the effect of dose rate is probably related to chromosome repair and rejoining rather than to the initial breakage.

Comparisons of chromosomal breakage in the same tissue, the corneal epithelium, are being made also in the spider monkey *Ateles*. Comparisons of frequency of breakage in the corneal cells irradiated *in situ* and irradiated in cell culture are being made to determine the effect of maintenance of cells in culture upon susceptibility to radiation.

Buzzati-Traverso, A. AT(30-1)2280  
B1C561 MUTABILITY AND MUTATIONAL LOADS IN MAN.

Pavia, Italy. Universita. Istituto di Genetica.  
December 1961-November 1962.

A statistical analysis has been carried out of data on consanguinity of marriages obtained by direct survey—the results indicate a qualitative agreement with other sources, but discrepancies are evident. It is believed that the best sources of data for Catholic populations are consanguinity dispensations and the collection of such data is being extended to all Italy. A detailed analysis of 168 types of consanguineous matings shows that it is thus possible to demonstrate the relative importance of several factors, e.g., age and migration effects, on the incidence of consanguinity. The analysis of parish books is being continued and the present problem is the best way to establish family linkages from such data.

An analysis of the effect of the age of the maternal grandparents at the conception of their daughter, on the sex ratio of her progeny is consistent with the hypothesis that this effect is due to the accumulation, with age, of sex linked recessive lethal mutation in the gametes. It is hoped to extend this type of data for an estimation of human mutation rates.

## B1D Population Genetics

See also K1B268.

Lewis, E. B. AT(04-3)41  
B1D18 THE GENETIC AND CYTOLOGICAL EFFECTS OF HIGH ENERGY RADIATION.  
California Inst. of Tech., Pasadena. SFOO.

The way in which genes control developmental processes in living organisms is being studied in *Drosophila* with the aid of a group of mutations which affect the body segmentation pattern. These mutants produce extra wings and extra legs and collectively are called the bithorax genes. By making use of special ring chromosomes which under certain conditions are unstable it is possible to construct three-winged flies and other types of mosaics. The results indicate that the effects of the bithorax genes are mediated by substances which do not readily diffuse from one portion of the body to the other.

The rate of dissociation of  $I^{131}$  labeled antigen from antigen-antibody complexes formed in antigen excess and related techniques show clear differences between antibody formed early and late in the course of immune responses. Utilizing this fact, first shown by Farr for rabbit antibody and in this laboratory for chicken antibody, such problems as the response to successive injections of related antigens and the effect of the base analog, 6-mercaptopurine, on the quality of antibody in both primary and secondary

responses have been investigated, with a view toward deeper understanding of the nature and specificity of the antibody response. We are currently studying whether the change in antibody quality is the property of all antibody molecules or simply a change in the proportion of antibodies of different qualities. Techniques used in this work include chromatographic separation on DEAE-cellulose and Sephadex G-200, and sensitivity to treatment of 2-mercaptoethanol. An interesting finding has been the detection of significant amounts of  $I^{131}$  antigen binding activity as late as 240 days after a second injection. This prompts us to investigate in more detail the time of synthesis of this antibody with the use of either  $C^{14}$  or  $S^{35}$  amino acids.

Neel, James V. AT(11-1)942  
B1D193 STUDIES ON CONSANGUINITY EFFECTS.  
Michigan. Univ., Ann Arbor. COO. SP 5; MYr  $3\frac{5}{12}$ .

In 1957, with the financial support of the AEC, the Department of Human Genetics initiated a study of the effect of inbreeding with a view toward determining the burden of deleterious genes borne by two "typical" human populations. The populations were the children of Hiroshima and Nagasaki, Japan, born in the years 1948-1953 to parents registered with the Atomic Bomb Casualty Commission and who were either unexposed to or received inappreciable doses of radiation from the atomic bombings of these cities. The program as originally projected involved three distinct phases, namely, a year of planning (1957-1958), two years of data collection in Japan (1958-1960), and two years of analysis (1960-1962). However, the analytical problems posed by the data have proven even more complex than anticipated—and it was anticipated they would be complex—and we are now requesting support for a third year of analysis, during which we confidently expect to bring to a conclusion the work-up of the data collected during 1958-1960.

Bell, A. E. AT(11-1)965  
B1D204 THE EFFECTS OF X-RADIATION ON  
PLATEAUED POPULATIONS OF TRIBOLIUM  
CASTANEUM IN REGARDS TO REPRODUCTIVE  
FITNESS AND RESPONSE TO SELECTION.  
Purdue Univ., Lafayette, Ind. COO. February 1962-  
January 1963.

Except for the intensive studies on Drosophila by Scossiroli in Italy, no reports can be found in the literature relating the effects of irradiation on response to selection in plateaued populations. Two selection experiments for increased body size in Tribolium castaneum resulted in linear responses

for 15 and 22 generations, respectively, followed by typical plateaus in response (Bell and Moore, X International Congress of Genetics).

In this project we proposed to study the effects of three levels of irradiation (none, 100 r and 1000 r each generation) on two types of populations of Tribolium castaneum (plateaued and unselected) under two kinds of selection (no selection and family selection). The selected trait will be body weight at the pupa stage. Reproductive fitness, as determined by number of progeny, will be measured as a correlated trait. The following analyses will be made on the data obtained from each of the twelve lines: (1) Regression of response on generations of selection, (2) Amount of phenotypic variance, (3) Additive genetic variance as estimated by parent-offspring regression, (4) Realized selection differentials and heritabilities, and (5) Correlation of reproductive fitness with response in the selected trait and with level of irradiation.

Chapman, Arthur B. AT(11-1)697  
B1D231 GENETIC EFFECTS OF CUMULATIVE  
IRRADIATION IN RATS.

Wisconsin. Univ., Madison. COO. SP 8; MYr 3.

The objective of this research is to estimate the induced mutation rate in a mammal (albino rat) by sampling the genome broadly. The traits used to reflect the effects on the genome are: sex ratio, size of litter, regularity of litter production, mortality rate of individuals at different stages of development, growth, and age at sexual maturity. The lethal equivalent theory and a modification of the techniques based on this theory are being used as the means for estimating the genetic effects of irradiation. The x-ray dosage being used is as large an amount as can be administered practically and as the body can tolerate without major effects on general health and fertility (450 r.). An inbred colony of rats is being used for the two main experimental groups and their controls. In one group, males only are irradiated each generation, in the other, females only. An "inbreeding" test (full sib mating) is made each generation but each experimental group is continued by mating animals not closely "related" within the inbred line. Progeny of five generations of irradiated sires in the male-irradiated group, of irradiated dams in the female-irradiated group and of their respective controls have resulted in records on more than 17,000 animals, about 60% of which are controls. The genetic theories basic to analyzing the data, the biometrical procedures for estimating effects in terms of these theories, and the electronic computer programs have been developed. The records are now punched on IBM cards and part of the

analyses have been made. It is hoped that as a result of this work it would be possible to get an estimate of over-all mutational damage resulting from irradiation in the rat, and that, in conjunction with other data, a more realistic picture of the genetic effects of radiation in man might result.

Edington, Charles AT(40-1)2417  
B1D255 A STUDY OF GENE AND CHROMOSOME  
CHANGES INDUCED BY IONIZING RADIATIONS IN  
DROSOPHILA MELANOGASTER.  
Florida State Univ., Tallahassee. OROO. SP 3;  
MYr 1.

A study of the frequency of radiation- and chemical-induced fractional mutations in *Drosophila* is in progress. The utilization of special screening techniques allows the detection of F-1 females that are mosaic for sex-linked recessive lethal mutations. The mosaic females give rise to cultures in the F-2 generation that are scored as non-lethal cultures; however, an additional mating of the daughters present in these non-lethal cultures shows that some of the daughters are heterozygous for an induced lethal while their sisters are homozygous for the normal allele of the lethal. The average proportion of females that are heterozygous for a lethal from a mosaic F-1 mother can be used to estimate the probable number of basic strands in the chromosomes of *Drosophila*.

In addition, studies are continuing on the investigation of the effect of the amount and distribution of heterochromatin in the X chromosome of *Drosophila* on the frequency of X-ray induced X-autosome translocations.

Emery, Donald A. AT(40-1)1747  
B1D267 RADIATION GENETICS AND RADIATION  
RESISTANCE IN PEANUTS.  
North Carolina State Coll., Raleigh. OROO. SP 6;  
MYr 3<sup>41</sup>/<sub>60</sub>.

The proposed work for 1962-63 is abstracted under four major areas of research.

1. The timing of irradiation in the breeding cycle—To increase and classify for mutation approximately eight randomly chosen XO or X<sub>2</sub> families (in X<sub>3</sub> or F<sub>3</sub> generation) from each of 300 P1X, 300 P2X<sub>1</sub>, 200 P1, and 200 P2 families. These four parental groups are to serve as standards for future research to be conducted on the genetic analyses of F<sub>1</sub>, F<sub>1</sub>X<sub>1</sub>, F<sub>2</sub>X<sub>1</sub> and X<sub>2</sub>F<sub>1</sub> progenies involving the same parentage.

2. The selection for radioresistance—To evaluate the primary radiation responses of 144 radioresistant, 43 hybrid, and 30 radiosensitive X<sub>1</sub> families from a cross among two highly uniform parents as they occur

in the X<sub>3</sub>X<sub>1</sub>, X<sub>5</sub>X<sub>1</sub>, X<sub>7</sub>X<sub>1</sub>, X<sub>5</sub>X<sub>3</sub>X<sub>1</sub>, and X<sub>7</sub>X<sub>5</sub>X<sub>3</sub>X<sub>1</sub> generations.

3. The estimation of primary and late generation responses to preirradiation seed moisture treatments—To determine the mutation frequency of named mutants occurring in the X<sub>2</sub> generations of five preirradiation seed-moisture-treatment populations in a single autogamous and non hybrid line of peanuts.

4. The breeding value of the deleterious mutant—To cross deleterious mutant plants A<sub>1</sub> . . . A<sub>n</sub> and B<sub>1</sub> . . . B<sub>n</sub> with control plants C<sub>1</sub> . . . C<sub>n</sub>. Ultimately the quality and quantity of background mutations occurring within and between different classes of mutants arising within an inbred line of peanuts will be assessed.

Kojima, Ken-ichi AT(40-1)2798  
B1D269 POPULATION DYNAMICS IN THE  
EVOLUTION OF MUTANT GENES.  
North Carolina State Coll., Raleigh. OROO.

In a large population, newly induced mutant alleles are usually kept as heterozygotes until either they are eliminated from the population or until they increase to a certain substantial level in frequencies. The process of evolution of mutants up to this stage must be stochastically treated. If a mutant becomes established in the population with a nontrivial frequency, then future evolutionary prospect of the mutant can be studied in terms of deterministic processes.

The proposed research has three major objectives:

(1) To formulate stochastic processes of spread and extinction of mutant alleles for various biological populations.

(2) To study the joint evolution of genetic systems with multiple loci. Epistasis and linkage among loci are recognized as important elements of evolutionary changes in such systems.

(3) Experimental evaluations of population genetic theories concerning mutation and selection. The organisms to be used are *Drosophila* and *Habrobracon* species.

Murphy, Charles F. AT(40-1)3028  
B1D270 COMBINING ABILITY AND THE EFFECT  
OF IRRADIATION UPON HETEROSIS AMONG DIVERSE  
POLYGENIC SYSTEMS IN OATS.  
North Carolina State Coll., Raleigh. OROO.

The proposed research will be directed toward the identification and understanding of the genetic systems controlling certain quantitative characters. The presence of diverse polygenic systems affecting similar phenotypic expressions is postulated. The primary objectives of the proposed study may be out-



lined as follows: (1) To study 15 specially chosen lines of diverse origin and to attempt to identify the action of specific polygenic systems as they affect the quantitative characters to be studied (components and sub-components of yield). (2) To compare the ability of two lines of differing combining ability to transmit heterosis when crossed with a common parent; and to study the effects of mutation pressure on the expression of these heterotic effects. (3) To determine whether the components of yield or yield itself manifests, most closely, the primary effects of genes.

Several secondary objectives will also be kept in mind in designing the experiments. These include: (1) Utilizing both genotypic and phenotypic correlations to determine the relationship between the components of yield. (2) A complete analysis of the data obtained to provide reliable estimates of the components of genetic variance. (3) To utilize the large populations which will be available to estimate the heritability of the quantitative characters being studied.

Stone, Wilson S. AT(40-1)2952  
B1D280 RESEARCH IN GENETICS.  
Texas. Univ., Austin. OROO. MYr 3.3 (+3).

This research includes: 1) Population and evolutionary studies of *Drosophila* and 2) Direct and indirect effects of radiation and their modifications using dominant lethals, recessive lethals and translocations as a measure of genetic damage. The first part is concerned with the analysis of genetic population structure including concealed variability in the form of detrimental, sterile and lethal factors. This is investigated in small populations, large thin populations and in large dense populations. Further extensive tests of viability, fertility and fecundity utilizing other island populations where migration is minimum will provide a better understanding of the genetic structure of populations in relation to their size, distribution and isolation. Studies are being made with *Drosophila pseudoobscura*, *Drosophila ananassae*, *Drosophila melanogaster* and others.

Direct and indirect radiation effects are being studied with *Drosophila* and microorganisms. Experiments measure the relation between radiation damage and environmental variables such as temperature, gaseous environment of the organisms (argon, air, oxygen, helium, methane, carbon monoxide, nitric oxide, propane, etc.) under normal or increased gas pressure. We are studying these effects on both male and female *Drosophila melanogaster* (recessive lethals) and in *Drosophila virilis* (dominant lethals and translocations) over the full cycle of spermatogenesis

and some stages of oogenesis. The amount of damage from the same dose of radiation may be modified by a factor of four, therefore they provide understanding of the relationships between radiation and organism.

Lee, William R. AT(30-1)2315  
B1D302 RADIATION INDUCED VIABILITY MUTATIONS IN THE HONEY BEE.  
New Hampshire. Univ., Durham. NYOO.

Research has comprised three areas of work: partial body irradiations of queen honey bees; the dominant lethal response curve at low dosages; and recessive lethals. Work on partial body irradiations with 50KV x-ray has shown the sensitive region, as measured by mortality of queen bees, to be segments III through V of the abdomen. This abdominal region contains the ventriculus which, according to Snodgrass (1956), is the only region other than the gonads where cell division occurs in adults. Apparently death of queen bees due to radiation is because of inhibition of cell division which is necessary to replace the lining of the digestive tract. Death characteristically occurs 10 to 14 days after irradiation. Because of high mortality, it is not practicable to give whole body radiations in excess of 2,000r; however, by shielding segments III through V the spermatheca or the oögonia may be given an acute dose of 10,000r without excessive mortality. A dose of 10,000r to the oögonia causes sterility; however, work is continuing on fractionated doses to the oögonial cells in an effort to give high doses without sterilizing the queen.

By giving successive low doses of x-rays to the spermatheca, it was possible to study the dose response curve of dominant lethals where comparisons were intra-queen. For doses of 260r, 520r, and 780r there was a significant non-linear component to the dosage response curve.

Recessive lethals were studied by producing F-1 queens from irradiated semen and determining the viability of the haploid male progeny of these F-1 queens. This viability would be within statistical range of 50% if the F-1 queen was heterozygous for a recessive lethal. By using this method—after the semen of a single haploid male had been irradiated with 2,500r—the average proportion of post-embryonic, recessive lethals per gamete for all chromosomes was determined to be 0.5.

Ives, Philip T. AT(30-1)2467  
B1D387 GENETIC AND DIRECT EFFECTS OF GAMMA RADIATION ON DROSOPHILA.  
Amherst Coll., Mass. NYOO.

During the year we completed work on the X-mutation rate- $\gamma$  dose relationship after 1/4, 1/2 and 1 kr, testing daily sperm samples, days 1-12, at 25°C. The relationship is linear except that 1/4 kr gives the same rate as 1 kr and higher than 1/2 kr in days 9-10 sperm dropping to the linear level in days 11-12. Possibly germinal selection is delayed until day 11 at 1/4 kr. The control rate is constant for all days. — $\sigma\sigma$  raised and kept at 20° or 15° show peak mutation rates, after 1 kr, in sperm deposited as much later after irradiation as development was longer at those temperatures, proving that the level of mutation response is "stage specific" in spermatogenesis, not "time specific" after irradiation. There was variation by a factor of 2 between series of tests at 15°C. —Studies on induced chromosomal changes showed 35% lethality, probably position effect, associated with each translocation break, but none associated with crossovers, in  $\sigma\sigma$ . —Current studies are on (1) Variation in mutagenic response to radiation in 15°C tests, (2) Lethality associated with induced autosomal inversions, and (3) Possible synchronized responses to radiation (simultaneous crossovers in chromosomes 2 and 3) in premeiotic spermatogenic stages.

Lewontin, R. C. AT(30-1)2620  
B1D393 A STUDY OF MATHEMATICAL MODELS OF MUTATION AND SELECTION IN MULTI-LOCUS SYSTEMS.  
Rochester, N. Y. Univ. NYOO. September 1962–August 1963. SP 2; MYr 1 1/2.

The study of genetic models, in which environment is allowed to fluctuate, will be continued. In addition the effects of linkage on the course of natural selection have already been studied in a model with five loci segregating. This program was constructed so that it is possible to use it further to investigate the effects of variation of heritability dependant upon genotypic and phenotypic changes.

A program has been written, involving four loci, in which different loci govern different correlated phenotypic characters influencing fitness. One or more loci will be treated as modified loci, influencing mutation role, etc., at the main locus.

A program will be constructed simulating a complex situation, with up to 100 loci and several simultaneous modifying functions. This program will be designed so as to be applicable to very large populations only, since the results of small population simulations can be understood only in the light of large population theory, and also the problems of human genetics, which are especially relevant to this project, are those of very large breeding groups.

Mode, Charles J. AT(45-1)1753  
B1D480 THEORETICAL AND EXPERIMENTAL WORK ON THE DYNAMICS OF HOST-PATHOGEN SYSTEMS.

Montana State Coll., Bozeman. RLOO. SP 1; MYr .5.

Our research program is composed of two facets, namely, theoretical and experimental, and was initially motivated by the following biological problem.

One of the most important problems facing the breeder of economic crop plants is the control of diseases caused by pathogenic fungi. At the present time the principal method of controlling these diseases is that of breeding resistant varieties. Unfortunately, newly bred varieties resistant to disease seldom remain resistant for long periods of time due to the origin of new races in the pathogen population or to changes in the racial composition of the pathogen population. This situation has numerous analogues in other biological systems in which one is attempting to control disease organisms. The main purpose of our research program is to study the role mutation in the pathogen plays in the dynamics of the process outlined above, using mathematical and genetic techniques and the host-pathogen system consisting of barley and barley mildew as an experimental tool.

The results of this research should be of general interest and will be applicable to any host-pathogen system similar to that of the barley and barley mildew system.

The theoretical work is concerned with the construction and analysis of mathematical models of host-pathogen systems. These models are stochastic in nature and take mutation in both the host and the pathogen into account. It is hoped that eventually they may be used as predictive tools.

At the present time the experimental work is concerned with the estimation of the probabilities of mutation from avirulence to virulence at several loci in the pathogen. The probabilities of spontaneous mutation as well as the probabilities of mutation under various dosages of gamma irradiation are being studied.

Wallace, Bruce AT(30-1) 2139  
B1D491 THE INVESTIGATION OF THE GENETIC STRUCTURE OF POPULATIONS.  
Cornell Univ., Ithaca, N. Y. April 1962–March 1963.  
SP 4; MYr 4.

This work is a continuation of our studies on the genetic structure of populations. The specific problem is the evaluation of the roles of mutation and selection in maintaining genetic variability.

We propose to continue the investigation of viability effects of induced mutations in heterozygous condition and in a variety of genetic backgrounds for most of this coming year. Before the year ends, however, we expect to have sufficient data for our purposes and will then investigate spontaneous mutations in much the same manner.

Dobzhansky, T. AT(30-1)3096  
B1D495 GENETIC STRUCTURE OF NATURAL POPULATIONS.

Rockefeller Inst. for Medical Research, New York.

The aim of this research program is to fill some of the gaps in the basic knowledge on which the judgment of the magnitude of the genetic radiation hazards must rest. Among the crucial questions which are still awaiting solution are: (1) how widespread in natural populations are genetic variants which are detrimental in double dose while favorable (heterotic) in single dose; (2) are such genetic variants merely temporary adaptive expedients, soon to be replaced, as claimed by some authors, by highly fit homozygotes, or do they endure for a long time; (3) are the effects on fitness of the genetic variants found in natural populations more or less constant or dependent on interaction with other variants in the same populations; and (4) are many gene loci represented in natural populations by numerous alleles or only by a single or by two alleles.

Scossiroli, R. E. AT(30-1)-2466  
B1D509 INVESTIGATIONS ON MUTABILITY OF POLYGENES AND ON UTILIZATION OF INDUCED GENETIC VARIABILITY.  
International Atomic Energy Agency, Pavia, Italy.

Mode, C. J. AT(45-1)-1729  
B1D510 THEORETICAL AND EXPERIMENTAL WORK ON THE DYNAMICS OF HOST-PATHOGEN SYSTEMS.  
Montana State Coll., Bozeman.

Spiess, Eliot B. AT(30-1)1775  
B1D555 GENETIC POTENTIAL OF CERTAIN POPULATIONS OF DROSOPHILA PERSIMILIS FROM THE SIERRA NEVADA OF CALIFORNIA.  
Pittsburgh. Univ. February 1962-January 1963.

Experimental populations of flies are being sampled to ascertain effects of rate of change in food medium on adaptive values of chromosomal combinations which differ in rate of development. Other populations from timberline contrast markedly with populations from lower elevation by apparent lack of heterosis in heterokaryotypes. Heterotic combinations may be evolving in certain populations. This hypothesis of laboratory evolution is being tested by reextracting

chromosomes from each population and initiating new populations for comparison with original frequency change curves.

Tests on quantitative properties of chromosomal combinations (survival, rate of development, fecundity, and behavior) are being carried out to ascertain the mechanism of chromosomal adaptive polymorphism. An interesting difference in sexual behavior of males (the commonest chromosomal type mates three times as frequently as the rarer chromosomal type) is being extensively investigated.

Recombinant lethals and other viability classes produced by crossing over on chromosome II in D. persimilis have raised theoretical points which are being investigated in D. melanogaster. We are trying to elucidate the criteria for synthetic lethals and the abilities of chromosomes to produce them.

Scossiroli, R. E. AT(30-1)2686  
B1D578 INVESTIGATIONS ON MUTABILITY OF POLYGENES.  
Pavia, Italy. Universita. Istituto di Genetica.  
January 1962-December 1962.

The aim of the work is to obtain estimates of spontaneous mutability for polygenes; to collect data on the relation between dose of radiation, applied to seeds in plants or to gametes in the wasp Habrobracon, and increase of genetic variance; to estimate the dose necessary to double the genetic variance for quantitative traits and finally to evaluate the degree of utilization of the induced genetic variability.

Tomato. Seeds of an autodiploid strain will be treated with different X-rays doses (0 r, 2000 r, 4000 r). Observations will be made on different quantitative traits on  $R_1$  and  $R_2$  and subsequent progenies. Analysis will be made following a hierarchic scheme to identify portion of variability due to spontaneous (in control group) as well as X-ray-induced mutations (in treated group).

Alfalfa. Analysis of data collected on clones obtained by root subdivisions of different plants derived from untreated and treated seeds will give information and estimates on new genetic variability induced by the treatments. A second level of clones will be obtained by inducing rooting in stem cuttings to give information about the role of diplontic selection in this plant.

Habrobracon. A highly inbred strain was used in previous work. The results of a selection experiment showed that such a strain, supposed to be almost completely homozygous, presented high amounts of genetic variability. An inbreeding cycle will be repeated and estimates of genetic variability present in the strain will be obtained at different inbreeding levels.

Pavan, C. AT(30-1) 2733  
B1D583 A COMPARATIVE STUDY BETWEEN  
NATURAL LETHALS AND LETHALS INDUCED BY  
RADIATION IN POPULATIONS OF DROSOPHILA  
WILLISTONI.

Sao Paulo, Brazil. Universidade. Departamento de  
Biologia Geral. April 1962-March 1963.

To compare the behavior of radiation induced lethals and of lethals present spontaneously in the natural population we are doing two types of experiments.

In one experiment we released flies heterozygous for two lethals, one natural and one induced by radiation, in the populations of two islands in the bay of Angra dos Reis in Brazil.

In the other project which is in connection with the present contract, we are doing in the laboratory experiments parallel to that being made in nature in the islands. Starting April 1st of 1961 we prepared the mutants which we are using in the island, and on July 26 we started 6 populations cages being 3 with the constitution N1R1, N1R2, N2R1 and N2R2 and 3 with the composition N3R3, N3R4, N4R3 and N4R4. About 3000 crosses were made with the marked strains, being 500 with flies from each cage.

Other samples were taken, the results of which we do not have yet. The results which we are getting from the natural population as well as from the experimental populations are very exciting and we hope to make a report about them in the near future.

## B1E Molecular Radiation Genetics

*See also D1C203 and D1C367.*

Oster, Irwin I. AT(30-1)2618  
B1E301 MODIFICATION OF GENETIC DAMAGE  
PRODUCED BY IONIZING RADIATION.  
Institute for Cancer Research, Philadelphia. NYOO.

Experiments aimed at modifying the genetic damage produced by ionizing radiation will be continued using the reproductive cells of the fruit fly, Drosophila melanogaster.

Our studies on induced crossing-over and non-disjunction will be extended. Several new stocks will be utilized in order to pinpoint more exactly the regions of the chromosomes which are differentially affected as regards crossing over by different conditions existing during irradiation. In addition, experiments to determine the extent to which chronically-delivered radiation affects crossing over and non-disjunction will be undertaken.

It is planned to extend our analyses of the effects produced by types of ionizing radiation character-

ized by different linear energy transfer properties (i.e., gamma rays, X-rays, and neutrons) in the genetic material when delivered at different doses and under different conditions. Special emphasis will be placed on determining the relative incidences of induced mosaic and whole-body mutations. The frequencies of such changes will also be studied following the exposure of germ cells to chronically-delivered radiation with a view to detecting the presence of repair mechanisms.

In addition, with the aid of a newly developed cytological technique for studying somatic chromosomes we hope to be able to investigate the effects of relatively low doses of radiation, differences between acutely- and chronically-delivered radiation, and the effects of chemical mutagens.

## B1F Mutation Rate Analysis

*See also K1B391.*

Yanders, Armon F. AT(11-1)1033  
B1F189 BASIC FERTILIZATION PHENOMENA  
AND GAMETIC LETHALITY IN DROSOPHILA.  
Michigan State Univ., East Lansing. COO. SP 3;  
MYR 2.

Studies of the behavior and survival of mature sperm of Drosophila melanogaster in various types of crosses, as well as after irradiation, have given results which suggest that some type of gametic lethality may exist. This interpretation conflicts with the belief that spermatozoa simply serve as vehicles of transmission unaffected by their gene content. Furthermore, it implies that certain distortions of genetic ratios may reflect, at least in part, a non-random success of sperm in insemination and/or fertilization.

Direct estimates of the number of sperm potentially capable of fertilization after different periods of storage, as determined by observations of excised ventral receptacles of inseminated females dissected at various times after copulation, are being compared with the results of parallel genetic tests designed to detect the selective survival of sperm with certain genotypes, e.g., shifts in sex ratio and sex-linked lethal rate in irradiated sperm, ratio distortion in the progeny of males heterozygous for abnormal chromosomes or genes, etc. Concurrent microscopical studies of the events taking place in normal inter- and intra-strain insemination and fertilization are being made in order to interpret these results more adequately.

Herskowitz, I. H. AT(11-1) 633  
B1F206 SPONTANEOUS AND RADIATION MUTA-  
GENESIS AND MUTABILITY IN DROSOPHILA.  
Saint Louis Univ. COO. June 1962-May 1963.  
SP 4; MYr 2.8.

The broad purpose of the proposed program is to learn more about the phenotypic effects of mutations and the factors involved in the production of chromosomal breakage, chromosomal rearrangement, and point mutation occurring spontaneously and induced by radiations in a given cell type, including different stages in its differentiation, and in several cell types.

Attempts will be made to construct stocks containing balanced lethals which when mated together result in the death of all progeny during the egg stage, unless nondisjunction or reverse mutation occurs. If such stocks can be constructed, they will be used to study spontaneous and X ray-induced nondisjunction and reverse mutation of recessive lethals.

Various mutational events will be studied, following X ray or no X ray treatment of developing eggs, when the adenine available is or is not restricted in the diet of larvae auxotrophic for adenine. Using a diet restricted in adenine, the effects of adding other purines or adenosine to the diet will be studied upon the spontaneous and/or X ray-induced mutation rate.

Several experiments are planned to study the effect of penicillin on X ray-induced mutations of various kinds.

Wallace, A. T. AT(40-1)2562  
B1F260 MUTATION RESEARCH WITH GAMMA  
RADIATION AT A SPECIFIC LOCUS IN A HIGHER  
PLANT.  
Florida. Agricultural Experiment Station, Gainesville. OROO.

Research to date under this project has shown that the induced mutation rate at the Vb locus (controlling reaction to *Helminthosporium victoriae*) in oats ranges from  $2-8 \times 10^{-8}/r$  when the seeds are irradiated with cobalt-60 gamma radiation under standard conditions. This rate was increased to  $314 \times 10^{-8}/r$  (1.5% per panicle) by pre-irradiation seed treatment. The highest rate obtained with ethylenimine was 1% of the panicles. The plan is to continue the program testing 4 chemical mutagens with and without ionizing irradiation.

Data on seed germination, seedling heights, and plant survival in the field for oats and the frequency of chlorophyll deficiencies in barley are being collected from similar treatments with the hopes of using such easily collected information to predict the mutation frequency of this vital locus (Vb) in oats.

Cytogenetic and genetic studies of some of the mutants will be initiated to determine the genetic nature

of the induced mutations. The genetic studies will include allelic complementation and suppressor mutation tests.

Burton, G. W. AT(40-1)2976  
B1F262 GENETIC AND CYTOGENETIC ANALYSIS  
OF THE EFFECTS OF RECURRENT IRRADIATION  
AND CHEMICAL MUTAGENS ON SPECIFIC AND  
GENERAL COMBINING IN PEARL MILLET (*PEN-  
NISETUM GLAUCUM*).  
Georgia. Univ., Tifton. OROO.

The effect of recurrent TN (thermal-neutron) and EMS (ethyl methane sulfonate) seed treatments on specific and general combining ability in the highly cross-pollinated annual grass, pearl millet, is being studied. The first year's results suggest that 60- and 90-minute thermal neutron treatments and a 4-hour soak in 0.2 and 0.4% EMS will allow for reasonably normal plant development and will give the largest number of mutants based on the number of chlorophyll deficient plants created. EMS treatments delayed emergence, reduced seedling growth, delayed heading, and reduced stands in the field more than TN treatments. Plants from TN treated seed produced only about half as much sibbed seed per head as plants from EMS treated seed.

Data on height, number of leaves per culm, number of culms per plant, green weight, self-fertility, and head length were collected from over 4,000 plants, were recorded on mark sense cards, and will be analyzed to note treatment effects on means and variances. Shoot tips and spikes were collected and fixed for cytological analysis. Sibbed seed will receive the same treatments in 1963 for another cycle of similar study.

After one more recurrent treatment, yields of hybrids from selected matings will be obtained to ascertain the effect of these treatments on specific and general combining ability.

Singleton, W. Ralph AT(40-1)2071  
B1F340 RADIATION EFFECTS ON GROWING  
PLANTS.  
Virginia. Univ., Boyce. Blandy Experimental Farm. OROO. June 1962-March 14, 1964. SP 8; MYr 3.5.

Extreme differences in sensitivity have been found in developing corn pollen. Induced chromosomal losses are greatest five days before mature pollen, more than twice the rate for either four or six days. All pollen was killed when radiated 21 days before pollen shedding, a premeiotic stage. In sensitive stage experiments gene type mutants were induced only in premeiotic stages. The rate for 49 gene type changes varied from  $14$  to  $167 \times 10^{-6}$ , the rate for

24 spontaneous mutants in controls was  $2 \times 10^{-6}$ . Two induced waxy (wx) mutants back mutated to Wx with about the same frequency as spontaneous waxy mutants. An inhibitor stock (CI) when radiated premeiotically produced two colorless mutants that had apparently lost the whole CI allele, with no deleterious effect on the viability of either the egg or pollen. Good 3:1 selfed ratios were obtained. In future experiments induced premeiotic mutations at this locus will be studied intensively. Dose response investigations for this period are continuing. Preliminary results indicate a curvilinear effect. Pro-embryo radiation investigations are continuing. Mutations for seedling characters are being studied intensively. Somatic mutations from dwarf to tall types have been induced in Forsythia and Boxwood. Dwarf Vinca is being radiated with the hope of finding a genetic explanation of this phenomenon.

Muller, Hermann J. AT(11-1)195  
B1F359 THE INFLUENCE OF RADIATION IN ALTERING THE INCIDENCE OF MUTATIONS IN DROSOPHILA.

Indiana Univ., Foundation. Bloomington. COO. September 1962-September 14, 1963.

1. In order to throw light on the relative mutagenicity of chronic versus acute gamma irradiation, the mutation frequency among offspring derived from eggs laid different lengths of time after irradiation of the female will be further investigated.

2. Pre-imaginal and imaginal stages will be irradiated chronically and acutely, in a study of mutagenicity at these stages. Solutions of radio-nuclides will be used for delivering radiation at controlled rates.

3. The effect of the pre-imaginal irradiations on survival and the life span of the exposed flies will also be studied, in order (among other things) to throw light on the influence of dose fractionation on the effectiveness of the radiation in producing damage of this kind.

4. A series of other experiments designed to investigate the kinds of genetic basis underlying the damaging effects of X or gamma radiation on survival and the life span will be carried out. These will involve the use of diverse specially constructed genetic stocks.

5. The investigation of the question whether spermatozoa held in the male after irradiation undergo a natural pre-mutational repair, protracted over some 24 hours, will be carried further.

6. The study of the effect of anoxia (nitrogen) pre- and post-treatments on radiation mutagenesis will be carried further.

7. Work will be continued on peculiarities of heterochromatin in undergoing radiation-induced structural changes.

Alexander, Mary L. AT(40-1) 3014  
B1F380 THE EFFECTS OF RADIATIONS ON GENETIC SYSTEMS OF ORGANISMS IN RELATION TO THEIR PHYSIOLOGICAL AND BIOCHEMICAL SYSTEMS.

Texas. Univ., Austin. Genetics Foundation. OROO. May 1962-April 1963.

The study of radiation damage on genetic systems includes the effects of ionizing radiations on genetic damage in various stages of germ cell development in *Drosophila*. The specific problems include (1) dose rate studies with X-rays and gamma rays in relation to the oxygen concentration at the time of irradiation. The dependence or independence of oxygen with dose rate or fractionation effects of radiations will be tested on the developing germ cells of *Drosophila*. The second study (2) will test the possible sites for intracellular oxygen activity. The enhancement of genetic damage by oxygen with the protective action of different inert gases under various pressures and biological damage in cells of different physiological characteristics will be utilized for testing specific sites of oxygen activity in the cell.

The other studies include (3) the post-irradiation control of genetic damage by use of inert gases and chemicals and (4) genetic damage induced in spermatogonial cells with chemicals. Genetic damage resulting from chemical treatment will allow comparisons of chemical damage with previous X-radiation studies. Studies with combined radiation and chemical treatment of spermatogonial cells for control of genetic damage are also planned.

Brock, R. D. AT(30-1)2820  
B1F389 MUTATION-RATE, RADIATION INTENSITY STUDIES IN PLANTS.

Australia. Commonwealth Scientific and Industrial Research Organization, Canberra. NYOO. SP 1; MYr  $\frac{1}{4}$ .

The objective of this work is to measure mutation rates, at specific loci, induced by gamma rays of widely differing intensities. Acute (360 and 172 rads per min) and chronic (0.4 rads per min) gamma radiation is applied to wild-type *L. pimpinellifolium* pollen, which is then tested for mutation at three loci (a, aw and hl) by crossing to *L. esculentum* stocks homozygous for these marker genes.

From pollen subjected to 6000 rads at dose rate of 172 rads per min, 77 mutants have been detected from 24400 treated pollen grains. Each mutant is

being crossed to single gene stocks to identify the mutant locus.

If the mutation rates at the three loci are assumed equal this mutation frequency corresponds to a mutation rate of  $19.8 \pm 2.1 \times 10^{-8}$  per rad per locus.

Data are not yet available for gamma radiation delivered at 360 rads per min or at 0.4 rads per min.

Moseman, John G. AT(49-7)2087  
B1F485 UTILIZATION OF MUTAGENS TO INVESTIGATE THE GENETICS OF BARLEY, HORDEUM VULGARE, THE FUNGUS ERYSIPHE GRAMINIS F. SP. HORDEI, AND THEIR INTERRELATIONSHIPS. Department of Agriculture. Agricultural Research Service, Beltsville, Md. WASH. SP 1.25; MYr 2.

The primary objective of using mutagens is to obtain mutants for pathogenicity of the fungus Erysiphe graminis f. sp. hordei that permit a detailed analysis of the pathogen and host genetic systems and the interrelationships of those two systems. Some of the phenomena being studied are effect of radiation of fungus on germination, infectivity, and disease development; mutation rate of specific genes conditioning pathogenicity; relative mutation frequency of genes for virulence and avirulence; and comparison of mutation rates of genes conditioning pathogenicity with mutation rates of corresponding genes conditioning reaction of the host.

The following information has been obtained on the effect of ultraviolet radiation on the fungus and disease development: Less radiation is required to reduce infectivity than to reduce germination. Effectiveness of radiation varies with time after infection. When radiated within forty-eight hours after inoculation, the mycelium of the fungus is distorted, no viable conidia are produced, and disease development stops. The general vigor of the fungus is reduced by radiation three to four days after inoculation, when infection is well established and the fungus is rapidly producing conidia. At this time the fungus is killed by only an extremely high dosage of radiation. The competitive ability and degree of virulence of the fungus are reduced by radiation.

North, David T. AT(11-1) 332  
B1F487 THE GENETIC BASIS AND PRACTICAL SIGNIFICANCE OF MUTATIONS INDUCED IN OATS AND BARLEY WITH IONIZING RADIATIONS. Minnesota. Univ., St. Paul. April 1962-March 1963. SP 3; MYr 2.

The research being conducted under this contract can be outlined into the following areas,

1). Studies determining the relation of pre- and post-irradiation heat treatment, storage, and oxygen

sensitivity to the induction of genetic injury, as measured by mutations and chromosomal aberrations.

2). Studies attempting to determine the genetic and cytogenetic basis of x-ray induced phenotypic reversion in barley. To date the findings parallel the reverse mutation work in microorganisms.

3). Recurrent irradiation studies in barley concerned with either 1). the induction of a large number of chromosome structural changes in the genotype so that synapsis will be reduced in crosses to the normal progenitor, and 2). the induction of mutations of a quantitative nature with possible economic importance.

4). Continuation of programs in both oats and wheat to determine the rate at which mutations for qualitative characters (chlorophyll mutations) are induced by recurrent irradiation.

5). A study paralleling the one described above for barley (item 3) is in progress in which an effort is being made to structurally differentiate the chromosomes.

Whiting, P. W. AT(30-1)1471  
B1F496 MUTATION RATES IN MORMONIELLA. Pennsylvania. Univ., Philadelphia. June 1962-December 1962.

These investigations are concerned chiefly with the nature of the "R" region in which mutant allelic genes are formed by mutation—both irradiation-induced and spontaneous. Each mutant gene differs from wild type in one or more of many "factors". The three previously known eye-color factors, O, S and M, have recently been increased to five by the production of two new genes, dahlia-442 and mahogany-857, mutant in factors P and Q respectively. These five factors are probably cistrons in Benzer's sense. Spontaneous mutations (instability) in factor O may be intracistronic recombination. The numerous lethals and other deleterious changes which are being homologized by use of diploid males are probably injuries of many diverse types (and therefore for the most part non-homologous) to the complex mechanism constituting the germ plasm.

A second and minor project recently initiated is to locate the sex-determining factor and a third is to classify the "black" eye colors. These are due apparently to decrease of bright pigments by mutation, a condition reverse to that causing bright colors by decrease of dark pigment.

Atwood, K. C. AT(11-1)1035  
B1F540 ERYTHROCYTE AUTOMOSAICISM. Illinois. Univ., Urbana. May 1962-April 1963.

It has been established that persons of a given blood group regularly possess small proportions of

erythrocytes with different blood group phenotypes. The primary purpose of the project is to find out how these exceptional cells originate. With respect to exceptional cells representing losses of ABO antigens, present data indicate that the proportions are mostly independent of age, but are greatly increased by radiation. The proportions in blood group heterozygotes are about ten times higher than in homozygotes.

The project will be concerned with the stability of these proportions under various conditions, further studies on the radiation effect, the degree of concordance in twins, and the occurrence of automosaicism at loci other than the ABO.

A leading hypothesis is that the exceptional cells originate through genetic mutations in the erythropoietic system. If this is true, the frequencies of these cells will be useful in assessing human mutation rates under various conditions. The project will supply data sufficient to evaluate the mutational hypothesis of automosaicism.

Bianchi, Angelo AT(30-1) 2613  
B1F573 THE INDUCTION OF GENETIC MUTATIONS BY IRRADIATION IN PLANT SPECIES OF ECONOMIC IMPORTANCE.  
Universita Cattolica del Sacro Cuore di Milano, Piacenza. Istituto di Genetica. November 1961–October 1962.

The radiogenetics programme deals with basic investigations presenting future possibility of application in agriculture, utilizing species of economic importance like maize, tomato and wheat, which, however, seem to be also appropriate for being genetically well known.

The use of genetical tools as interchanges between chromosomes A and B in maize appears suitable for a prompt detection of the newly arisen mutants as well as for preparing special genotypes convenient in radiation genetics experiments, dealing with the study of environmental and physiological factors modifying the mutation rate. The irradiation of the pollen of appropriate constitution, fertilizing given genotypes, may also be of use in understanding the basic nature of the induced mutation in maize endosperm.

The availability of different inbred lines of maize, with different cytoplasm, may turn out to be of further interest in understanding the genetic effects of radiation in plants.

The experiments planned for tomato and wheat will take advantage of the availability in this Institute of a conspicuous varietal material, and the obtained data may be of use in comparing the genetic effects of radiation in such self-pollinated plants with an open pollinated species as maize.

The programme includes, too, confronting the artificial mutagenesis with different physical and chemical mutagen agents.

Gaul, Horst AT(30-1) 2619  
B1F574 DEVELOPMENT OF SELECTION METHODS FOR INDUCED SMALL MUTATIONS IN HIGHER PLANTS (WITH SPECIAL REGARD TO MUTATIONS OF YIELDING CAPACITY).  
Max-Planck-Institut für Züchtungsforschung, Cologne. February 1962–January 1963.

Several thousand  $X_2$ -spike progenies of barley (variety Haisa II) derived from different and normal appearing  $X_2$ -plants will be grown in 1961. One half of these  $X_2$ -spike progenies has been derived from fertile  $X_1$ -spikes, the other half from partially sterile  $X_1$ -spikes. In the individual progenies there will be determined (a) the 1000-kernel weight, (b) the average number of seeds per spike, (c) the average number of tillers per plant and (d) the total kernel yield. The same data will be obtained from a third part of progenies equally in number, derived from untreated spike progenies of Haisa II. The variances of yield components will be determined of the three types of progenies and by this information of the induced genetic variance will be obtained. 10% of the best  $X_3$ -lines in each of the three groups will be examined in a drilled micro-test in  $X_4$  and further selection of the best 25% will lead to a normal drill-test in  $X_5$ . Promising lines will be tested in further years and possibly at different stations.

At the end of the programme information about the frequency and features of small mutations exerting influence on yield will be available. The mutant lines expected to obtain offer a suitable material for genetic and physiological yield studies, because they may be regarded as isogenic lines. By intercrossing of mutant lines of the three yield components the possibility of a further systematic and "directed" improvement will be investigated.

Reactions of seeds and seedlings will be tested under various artificial and extremely changed laboratory conditions. Utilizing the pleiotropic effect of mutations it will be tried to find indicator characters which allow early screening of mutations. Mutants eventually detected under these abnormal environmental conditions will be thoroughly investigated under normal growing conditions and particularly the question will be focused upon of whether a fraction of them exerts influence on yield.

Hannah-Alava, Aloha AT(30-1)2690  
B1F579 MUTATION RATE AT SPECIFIC AUTO-



## SOMAL LOCI IN DIFFERENT SPECIES OF DROSOPHILA.

Turku, Finland. Univ. January 1962–December 1962.

Estimates of the genetic consequences of exposing human genes to ionizing radiation have been based primarily upon information obtained from mutation studies of the fruit fly, *Drosophila*, and the mouse. However, in *Drosophila*, most of the information concerning the effects of radiation comes from studies of mature sperm, whereas the data from the mouse are largely from spermatogenic cells. The purpose of this research project is, therefore, to accumulate data on mutation rates from *Drosophila* germ cells of different ages, data that will be more suitable to estimate the genetic effects of radiation upon man.

Accumulation of such data will be accomplished by: (1) Studies of comparative mutation rates in germ cells that are in different stages of maturation at the time of radiation, with particular emphasis on rates from mature sperm and from spermatogonia. (2) Studies of differences in spontaneous and induced mutations of specific loci within a chromosome, and differences between chromosomes in mutation rates of dominants. (3) Correlation of the cytogenetic characteristics of induced mutations with the stage of maturation of the germ cells, and ascertainment of some of the differences between spontaneous and induced mutations. (4) Comparison of spontaneous and induced mutation rates between closely related species of *Drosophila*.

Rossi, Harald H. AT(30-1)2740, BP-5 B1F590 THE SOMATIC MUTATION THEORY OF THE AGING PROCESS—THE EFFECT OF TEMPERATURE ON SPONTANEOUS MUTATION RATE AND LONGEVITY IN *DROSOPHILA MELANOGASTER*. Columbia Univ., New York. Coll. of Physicians and Surgeons.

Failla has suggested that the normal aging process is a result of the functional impairment of somatic cells by spontaneous mutation. This hypothesis predicts an inverse relationship between spontaneous somatic mutation rate and lifespan, that is, the mutation rate per generation should be constant for all species.

An experimental protocol has been devised to test this relationship for *D. melanogaster*. The experiment consists of the simultaneous measurement of the spontaneous sex-linked recessive lethal mutation rate (Muller-5 technique) and the lifespan (survival curves) of flies at two environmental temperatures, 17°C and 27°C.

The slope  $\alpha$  of the straight line portion of the Gompertz curve (derived from survival data) is an index of the "rate of aging" and represents the probability of one mutation occurring per cell per year. Thus the ratio of the observed values of  $\alpha$  for fly populations at 17°C and 27°C should be inversely proportional to the ratio of the corresponding lifespans and/or generation times. This is apparently the case for data obtained to date. Results indicate, however, that larger numbers of flies and more frequent observation intervals are required to give more accurate survival and Gompertz curves, hence more reliable values of  $\alpha$ . A more exact determination of the generation time,  $G$ , is also to be undertaken.

The sex-linked recessive lethal mutation rates per generation are found to be approximately equal for the two temperatures, as predicted. The number of chromosomes tested thus far is relatively small, hence further tests are required to give statistically significant results.

Extensive statistical analysis is indicated for all of the experimental data.

## C COMBATING DETRIMENTAL EFFECTS OF RADIATION

### C1A Protective Agents

See also D1D350.

Dent, J. N. AT(40-1) 2978 C1A288 STUDIES ON THE EFFECT OF IMPLANTED HEMOPOIETIC TISSUES ON RECOVERY FROM RADIATION DAMAGE AND ON REGENERATION IN AMPHIBIANS. Virginia. Univ., Charlottesville. OROO. June 5, 1962–May 1963.

The contractor will conduct research on the effect of implanted hemopoietic tissues on recovery from radiation damage and on regeneration in amphibians such as frogs and salamanders subjected to various doses of X-rays or thermal neutrons. The objectives of this research include investigation of (1) the changes effected by radiation in the cells of the limb such that they are no longer capable of supporting regeneration, (2) possible differences in the effects produced by X-rays and those produced by thermal neutrons, (3) creation of radiation chimeras by xenoplastic transplants between irradiated and non-irradiated amphibians, (4) possible indirect effect of injected hemopoietic cells in stimulation of the recovery of other cells, (5) the question of whether injection of hemopoietic cells into irradiated am-

phibians will stimulate regeneration as well as survival, and (6) the role of leucocytes in normal limb regeneration.

Potts, Kevin T. AT(40-1)3016  
C1A384 DERIVATIVES OF SOME FIVE-MEMBERED HETEROCYCLES AS POSSIBLE PROTECTIVE AGENTS AGAINST IONIZING RADIATIONS.

Louisville, Ky. Univ. OROO. SP 3; MYr 2.04.

This research project is aimed at obtaining chemical protective agents against ionizing radiation. Suitable derivatives of the s-triazole ring system and related five-membered heterocycles are to be synthesized; functional groups to be incorporated are the mercapto, amino-, amidino-, and guanidino groups as well as variants of the 3-amino-s-triazole structure, already known to have a certain amount of protective capacity. The study is to be extended to related compounds in the imidazole and tetrazole ring systems as well as to compounds that could be regarded as open-chain analogs of these various ring systems.

Bonner, J. F. AT(11-1)1223  
C1A513 HYPOXIA AND PARAAMIPROPIOPHENONE AS RADIOPROTECTIVE AGENTS.

Indiana Univ., Indianapolis. School of Medicine. SP 3; MYr 1.25.

The mechanism of action of PAPP in the formation of methemoglobin in vivo is being investigated. The metabolic products of PAPP will be determined and the effects of these products in the TPNH dependent methemoglobin reductase system and the DPNH dependent diaphorase system will be determined in vitro. The relationship between hypoxia and methemoglobinemia is being investigated in experimental animals. Metabolic products of PAPP and related compounds will be assayed for protective action in irradiated mice.

DiStefano, Victor AT(30-1)-2192  
C1A514 AN INVESTIGATION INTO THE PHARMACOLOGICAL PROPERTIES OF ANTI-IRRADIATION DRUGS.

Rochester, N. Y. Univ.

## C1B Facilitation of Recovery

*See also D1A97 and D1C200.*

Kurnick, N. B. AT(11-1)34-87  
C1B43 BONE MARROW CULTIVATION.  
California. Univ., Los Angeles. SFOO.

Methods for the preservation of viable bone marrow and better understanding of the dynamics of hematopoiesis continue to be important problems. A culture of bone marrow which would retain its morphologic characteristics would provide a suitable tool for study of these problems. The influence of reagents on such a culture, including hormones and chemotherapeutic agents would then be possible. The method would also provide a test of viability of marrow stored by other methods. The suspension of bone marrow in autologous whole blood and cultured with continuous gentle agitation and dialysis against heated human plasma shows promise of meeting the indicated requirements. This project is concerned with developing the methodology.

Castleman, Benjamin AT(30-1) 2031  
C1B322 THE STUDY OF ANOMALIES OF HUMAN CHROMOSOMES ASSOCIATED WITH IRRADIATION, LEUKEMIA AND CONGENITAL DEFECTS.  
Massachusetts. General Hospital, Boston. NYOO. June 1962-May 1963. SP 3; MYr 3.

Radioautographic studies of human chromosomes with the use of tritiated thymidine and the stripping film technique will be carried out in an attempt to determine the pattern of DNA synthesis. This method has been used to identify a late-replicating X-chromosome by others using normal leukocytes. It is planned to confirm this work and extend similar studies to cases with sex-chromosome anomalies. The pattern of DNA in mongoloid leukocytes will be investigated in this manner as well as other cases of chromosomal anomalies such as chronic myeloid leukemia and multiple congenital defects. Possible alterations in the pattern of DNA synthesis of chromosomes that have been irradiated in vitro will be investigated. Radioautography will also be used in studying asynchrony of DNA synthesis in the interphase nucleus. This will be an extension of work already carried out using normal female peritoneal cells grown in tissue culture. It is planned to study in this manner cases of sex chromosome anomalies that have abnormal sex-chromatin bodies.

Moore, Francis D. AT(30-1)2265  
C1B325 "A PROGRAM FOR THE STUDY OF TRANSPLANTATION OF BONE MARROW, TISSUES, AND WHOLE ORGANS AND OF RELATED TOPICS IN SURGICAL RESEARCH."  
Peter Bent Brigham Hospital, Boston. NYOO.

This research program is devoted toward a better understanding of transplantation of tissues and whole organs. Currently our work is based on studies in the dog, using the homotransplanted bilaterally ne-

phrectomized animal. With this model, employing whole body radiation and chemotherapeutic approaches it is possible to arrive at practical solutions of the immunogenetic problem of histocompatibility rejection.

During the past year, work under this contract has also progressed in relation to human kidney transplants in unrelated individuals. Currently we have two patients both of them in a reasonably fit state of health, who carry unrelated kidneys transplanted after bilateral nephrectomy, and using a chemotherapeutic program based on work in the laboratory.

A correlated piece of work in this field is the study of the localization of the transplant antibody using techniques for fractionation of subcellular organelles, and their testing against a cell suspension of kidney using various techniques for judging cytotoxicity.

Zucker, Marjorie B. AT(30-1)2138  
C1B327 FACTORS AFFECTING PLATELET PRODUCTION.

Sloan-Kettering Inst. for Cancer Research, New York. NYOO. SP 1; MYr 1.4.

Published work from several laboratories, including mine, suggests that plasma may contain a substance which stimulates platelet production (thrombopoietin). Injection of plasma from thrombocytopenic animals, or of extracts from normal human subjects raises the platelet count of normal recipient animals. The peak count is not attained for about four days, suggesting that the active material enhances platelet production. We plan to test blood from humans rather than animals. We will try using mice as recipients since they can be used in large numbers to control for the large variability between individual animals. If this is not successful, we will use rats. We will first test heparinized plasma, serum and boiled filtrate of acidified plasma since there have been no adequate comparisons of their relative efficacy. If an adequate test system can be established as well as a reasonable dose-response curve, we hope to test plasma from a variety of subjects, especially those with abnormal platelet counts induced by diseases, drugs or irradiation. We may also try to determine whether biochemical and morphological changes can be found in the megakaryocytes during the rise in platelet count.

Hollingsworth, J. W. AT(30-1)1926  
C1B328 BIOLOGIC IMPLICATIONS OF ISOLOGOUS AND HETEROLOGOUS BONE MARROW REPOPULATION IN IRRADIATED ANIMALS.  
Yale Univ., New Haven. School of Medicine. NYOO.

After intensive whole body irradiation, the bone marrow of the mouse can be repopulated from a relatively small number of isologous bone marrow cells injected intravenously. These precursor cells, capable of rapid division and differentiation, have been found to be remarkably sensitive to the action of a variety of drugs that exhibit cancer therapeutic potential

In continuing experiments it is hoped to define the mechanism of this sensitivity—whether the inherent nature of the cells, their relatively sparse number, or perhaps even their pattern of location within the irradiated host.

Studies of 6-azauridine, a pyrimidine analogue which is remarkably non-toxic in the normal mouse, have been of particular interest since the regenerating marrow cells have been found quite easily inhibited by this drug. The regenerating cells can be repressed by relatively small radiation dose, and studies are underway of compounds that have synergistic or antagonistic effects with irradiation.

The data suggest that these regenerating normal marrow precursor cells behave similarly to malignant cells biologically and that inhibitive rate of marrow regeneration in these animals can serve as a screen for anti-tumor agents.

Blerman, Howard R. AT(04-3)455  
C1B335 A STUDY OF LEUKOPOIETIC FACTORS IN BLOOD.  
Loma Linda Univ., Los Angeles. School of Medicine. SAN.

A leukopoietic factor capable of stimulating granulocytopenia specifically (Leukopoietin G) has been isolated in crude form from whole blood of leukopenic Wistar rats and from plasma of patients with myeloid metaplasia, leukopenia and acute granulocytic leukemias. The administration of unconcentrated potent Leukopoietin G blood or plasma completely protected 34% of Wistar rats following exposure to 900r. total body radiation. The remaining animals showed active granulocytopenia.

Since the source of Leukopoietin G was limited to highly selected patients and small animals, for studies on identification and concentration, a readily available supply was necessary. Cattle and swine proved to be ample sources of Leukopoietin G in large quantities. Of many tissues studied including lymph nodes, intestine, stomach, liver, lung, and aqueous humor, kidney, plasma, and spleen proved to be the most potent tissues in Leukopoietin G activity. Beef sources were generally higher in potency than that of pork. Kidney extracts were exceedingly potent in Leukopoietin G activity. The activity is

slowly dialyzable reaching a peak at 36 to 52 hours, suggestive of Leukopoietin G binding to a larger molecule. The activities derived from dialyzed beef kidney homogenates exceed that obtained in chronic or acute granulocytic leukemia, exceeding 850 units in some samples, as compared to 100-250 units in normal subjects. Studies on identification and further concentration of Leukopoietin G continue. Highly potent concentrates are being employed to protect animals from lethal radiation.

Ferrebee, J. W. AT(30-1)2005  
C1B355 THE COLLECTION, STORAGE AND FATE FOLLOWING TRANSFUSION OF HEMOPOIETIC CELLS.

Mary Imogene Bassett Hospital, Cooperstown, N. Y. NYOO.

The studies are designed to determine the best means for restoring marrow function in irradiated subjects. Problems under investigation are the time limits of storage of marrow at low temperature,  $-80^{\circ}\text{C}$ ., and  $-190^{\circ}\text{C}$ .; the methods for collecting and handling fresh biopsy marrow, fetal marrow, and cadaver marrow; the clinical supportive care of irradiated subjects: isolation, antibiotics, transfusions; the question of time after irradiation at which marrow infusion is best administered; the relative necessity of marrow infusion versus good clinical supportive care; amount of marrow required for useful infusion; amount of whole-body irradiation following which clinical recovery can be obtained by the use of marrow and/or supportive care. Recent success with marrow transplantation in lethally exposed dogs has focused attention on the importance of typing donor and recipient to ensure that the transplanted marrow is reasonably compatible with its recipient. Efforts to develop typing procedures for transplantation antigens are being pushed.

Prentice, Theodore C. AT(30-1)1829  
C1B397 THE ROLE OF SERUM ERYTHROPOIETIN FACTOR IN ANEMIA OF MALIGNANCY. Roswell Park Memorial Inst., Buffalo. NYOO. SP 6; MYr 4.5.

This investigation concerns itself primarily with the physiological significance of EPF (Erythropoietin) in the regulating mechanisms of red cell production.

Specifically, several subjects within the above framework are now being studied. The chemical and biological differences of plasma and urinary erythropoietin produced under varying stimuli. In particular we are interested in the parallelism, or lack of it, between short term effects such as 24 hour red

cell uptake of  $\text{Fe}^{59}$  and reticulocytosis caused by active extracts, and long term effects such as increase in hemoglobin, hematocrit, red cell count and total red cell volume. Does a short term effect from a given preparation always presage a long term effect? Will certain plasma or urinary sources of EPF give only positive short term results with negative long term ones? Along with this biological type of study we are continuing our chemical characterization of EPF in plasma and urine. After preliminary chemical and column purification, separation by disc electrophoresis promises to give the best characterization to date.

Our search for better and cheaper assay methods continues. We have found that age and weight of hypoxic-polycythemic mice used for bioassay is important. Young (5-6 wks) mice (30-35gms) give more clear cut and dependable results than older heavier mice (40gms or more). The fact that hypoxic-polycythemic mice are very much less erythropoietically depressed than transfusion-polycythemic mice, though at the same hematocrit level, is interesting and worthy of further investigation.

Further study of the Friend virus disease is in progress. Investigation of the Tamarin, a tiny primate whose responses to various stimuli should closely approach those of the human, is also being carried out.

Freter, Rolf AT(30-1)-2628  
C1B409 REDUCTION OF POST-IRRADIATION INFECTIONS BY REPLACEMENT OF THE NORMAL ENTERIC FLORA AND BY SPECIFIC IMMUNIZATION.

Jefferson Medical Coll., Philadelphia.

The following results were obtained during the past year: (1) Postirradiation infection with *Pseudomonas* or *Staphylococcus* could be prevented by establishing an antagonistic strain of *E. coli* in the intestinal tract. (2) Intestinal antibody (= coproantibody), but not systemic antibody was found to reduce the susceptibility of irradiated mice to oral infection with *Pseudomonas*. (3) The mechanism by which *E. coli* antagonises and eliminates certain intestinal bacteria has been studied by means of continuous flow cultures.

The three main lines of investigation to be pursued in the future may be summarized as follows: (a) Factors influencing the permeability of the intestinal tract to bacteria and bacterial antigens. Especially investigated will be the effect of radiation and of coproantibody. Technically, permeability may be measured in various ways, e.g. by determining the passage of radioactively labelled bacteria or by the ability of orally induced bacteria (*Salmonella*, *Pseu-*

domonas) to set up systemic infections. (b) Further attempts will be made to define the type of cell that is effective in preventing postirradiation infection after transfer of bone marrow. This will be studied by transferring other tissues rich in certain types of cells, and culturing the recipients at appropriate intervals. (c) The mechanism of E. coli antagonism will be studied further by comparison of adaptation to growth in continuous flow culture with the simultaneous adaptation to growth in the intestinal tract. If possible, this method will be used in the detection of highly antagonistic strains of E. coli.

Nardone, Roland M. AT(30-1)2564  
C1B456 RADIATION STUDIES ON MAMMALIAN  
CELLS GROWN IN A CHEMICALLY DEFINED ME-  
DIUM.

Catholic Univ. of America, Washington, D. C. NYOO.  
SP 3; MYr 2.5.

Some mechanisms of cellular injury due to ionizing radiation are being studied. Strain L monolayers are being used as the experimental cells and cobalt-60 as the source of radiation.

The capacity of cells to grow, divide, synthesize protein and nucleic acid, and metabolize amino acids is being investigated and correlated with gross nuclear damage. These studies are being made under uniform conditions of cell growth, radiation dose rate, and manipulation cell and culture growth is being measured with a Coulter Counter and Particle Size Analyzer, thus making it possible to determine cell number, average cell volume, and total culture volume. These parameters are being related to protein, total nucleic acid, and RNA content per cell and per culture.

Ancillary studies are being made on the time course of recovery in terms of (1) cell growth and protein and nucleic synthesis, (2) the physiology of the nucleus, and (3) the effect of chemical protective agents on protein and nucleic acid synthesis.

Our studies reveal that the following can be arranged in decreasing order of radiation sensitivity: cell division delay, nuclear blistering, nucleic acid synthesis, protein synthesis, permanent cell division arrest, metabolic death.

Hume, David M. AT(40-1)2459  
C1B467 THE HOMOTRANSPLANTATION OF  
FETAL BLOOD CELLS AND TISSUES IN ANIMALS  
RECEIVING WHOLE BODY RADIATION.  
Medical Coll. of Virginia, Richmond. OROO. SP 14;  
MYr 7.4.

Total body radiation will be carried out with a small portion of the bone marrow shielded to permit survival with otherwise supra-lethal doses. The animals will be

given methotrexate or 6-MP followed by transplants of skin and kidney. In other experiments kidney transplants will be carried out in dogs, followed by the administration of 6-MP plus radiation to the kidney and other localized radiation. Kidney transplants in man will be continued utilizing whole body radiation in sub-lethal doses combined with various drugs. Irradiated rats will be given bone marrow and spleen cells from animals rendered immune to FHA. The recipient animals will then be tested with transplantable rat tumors to determine whether immunity to cancer has been transferred in the same manner as FHA immunity. In other animals lymph node cells will be removed, treated with RNA from a proposed donor and re-infused into the original host following total body irradiation. Tests will be made to determine whether acquired tolerance has been developed. Additional studies of cross-circulation in radiated animals will be carried out in an attempt to produce acquired tolerance.

Mallams, John T. AT(40-1)2913  
C1B470 "STUDY OF BIOLOGICAL RADIATION  
DOSIMETRY IN HUMANS."

Baylor Univ., Dallas. Medical Center. OROO.  
November 7, 1961-March 1963.

An attempt will be made, in patients receiving radiotherapy, to devise a method of biological Dosimetry based on tissue breakdown. High titer anti-serum will be prepared in rabbits to pools of various normal tissues. This serum will be used for determining the presence and quantity of tissue breakdown products in the circulation during the post irradiation period. Animal data indicate that an approximate linear relationship exists between dose of irradiation and tissue breakdown products in the circulation for a 96 hour period post irradiation. The quantity varies with the total dose and with the individual, but seems to be relatively independent of rate, within the dose range of 10-500r. In rats in preliminary tests the system seems to be functional between 3 and 1000r.

Tocantins, L. M. AT(30-1)-1982  
C1B490 TRANSPLANTATION OF PRESERVED  
MARROW BETWEEN ANIMALS AND FROM ONE  
HUMAN BEING INTO ANOTHER.

Jefferson Medical Coll., Philadelphia. NYOO.

Our work in the field of preservation and transplantation of bone marrow is proceeding along the following lines:

1. Attempts to preserve bone marrow by controlled-rate freezing in liquid nitrogen vapor to temperatures of  $-190^{\circ}\text{C}$ . Estimation of viability of frozen cells by measuring the twenty-four hour iron-59 utilization in

irradiated mice injected with the preserved marrow. Attempts to incorporate the tracer into cultures of bone marrow by incubating the marrow with the tracer in the presence of various gas mixtures at different temperatures and after addition of erythropoietin and various tissue extracts.

2. Estimation of blood volume in irradiated mice.

3. Effects of irradiation in mouse skin. Determination of the survival of irradiated skin in isologous and homologous recipients.

4. Attempts at preservation of platelets by freezing in the presence of dimethylsulfoxide. Determination of platelet survival by measurement of clot-retraction-inducing properties of platelets.

5. Modification of immune reaction by infection. Trial of experimental infections in mice. Estimation of the effect of these infections on the survival time of skin homografts.

6. Studies of cultures of bone marrow cells with a high iron uptake. These cells, which retain morphological characteristics of "reticulum cells" display a higher iron uptake than that of an established line of fibroblasts as controls.

Dameshek, William AT(30-1) 1276  
C1B551 PHYSIO-PATHOLOGY OF PLATELETS  
AND THE DEVELOPMENT OF PLATELET EX-  
TRACTS.  
New England Center Hospital, Boston. January 1962-  
December 1962.

Studies on physio-pathology of blood platelets with relationship to platelet transfusion in humans will be continued along the following lines:

1. The "viability" of human blood platelets after short-term preservation at 4°C. Platelet "viability" will be measured by the Cr<sup>51</sup>-technique and the influence of various factors will be investigated. These will include: (a) The effect of various anticoagulants; (b) The effect of pH; (c) The effect of various red cell disintegration products.

2. The study of new preservation media for the maintenance of platelet "viability" at 4°C. will be continued with investigations on the influence of various metabolites interfering with the glycolytic metabolism of the platelets.

3. Other studies are planned on the chemistry of human blood platelets during storage at 4°C.

4. The rate of serotonin uptake of fresh and stored human platelets will also be studied.

5. The effect of fresh and stored blood platelets on hemostasis and on blood coagulation will be investigated by the use of a rabbit model in which "viability" and hemostatic effect of the platelets will be simultaneously measured.

Farber, Sidney AT(30-1)1753  
C1B554 THE NATURE OF BLEEDING IN PAN-  
CYTOPENIA.

Children's Cancer Research Foundation, Boston.  
NYOO. September 1962-August 1963.

Summary:

1. Further studies on long-term preservation of platelets in viable state. The methods developed for storage of platelets at -195°C in the presence of dimethylsulfoxide and hypertonic concentrations of carbohydrates are being explored further.

2. Studies on the relation between platelet components and platelet activities by immunochemical techniques.

3. Clinical evaluation of fresh and preserved platelet preparations in regard to hemostatic efficacy, optimum mode of administration, and effect of survival in pancytopenic patients.

Dameshek, William AT(30-1) 2032  
C1B557 BONE MARROW PRESERVATION AND  
TRANSPLANTATION.

New England Center Hospital, Boston. June 1962-  
May 1963.

Research on bone marrow transplantation will be continued along lines followed in previous years. This will involve human and animal experiments.

a. We plan to continue the assessment of the value of homologous bone marrow infusions in the treatment of aplastic anemia.

b. The initial studies on the intensity and duration of homograft immunity in man induced by bone marrow infusions will be continued.

c. The treatment of graft vs. host reactions by anti-metabolites and corticosteroids is presently in progress and will be continued.

d. An attempt will be made to establish a state of prolonged marrow aplasia in mice, so that the effects of various marrow preparations on aplastic anemia can be assessed.

e. Further studies on the antigenicity of blood platelets are planned. The "tissue antigens" demonstrated in the blood platelets will be investigated as to their nature. It is possible that platelets may contain transplantation antigens. In this case the quantitation of platelet viability may become a useful tool in the study of transplantation immunity.

Hoecker, Gustavo AT(30-1)2488  
C1B565 AN IMMUNOGENETIC STUDY OF THE  
MECHANISM OF PROTECTION AGAINST RADIA-  
TION DEATH BY TREATMENT WITH HAEMOPOI-  
ETIC TISSUES.

Chile. Universidad, Santiago. Instituto de Biología "Juan Noe." December 1961–November 1962.

Scope of research. See research Proposal, 1959. Main results 1959–1960.

A. Protection against radiation death: 1) Combination of donors of bone marrow (BM) and lethally irradiated hosts (L. D. 100, 15 days) differing in their H-genes, indicate the following decreasing order of protective efficiency: H-3 < H-1 + H-3 < H-2 < H-2 + H-3 < H-1 + H+2. 2) Embryonic haemopoietic tissues homotransplanted into irradiated hosts, mature according to their own genotype. Thus the improved protection offered by embryonic tissues seems to be due to their becoming "actively tolerant" towards host antigens.

B. Histocompatibility antigens. 3) Antigens W and R of the mouse belong to the H-2 system. Two new H-2 antigens, M<sub>1</sub> and M<sub>5</sub>, have been found. 4) H-2 antigens from liver and spleen display a remarkable difference in solubility: while the supernatants of spleen in saline or water contain about the same amount of H-2 antigens as the sediment, liver supernatants contain little or none at all. 5) The correlations observed in the appearance of all H-2 antigens during development and in their distribution in different tissues permit the conclusion that H-2 behaves as a "physiological unit" i.e. as one gene.

C. Transplantation immunity. 6) Experiments on adaptive transfer of transplantation immunity have shown a linear relation between quantity of immune tissue and degree of protection against a standard dose of homotransplanted leukemia.

Plans for 1961. In radiation protection we plan to analyze the role of other weak H-loci; to analyze the relative importance of different H-2 antigens and to study the efficiency of hemopoietic tissues transplanted during different periods of maturation of their H-2 antigens to prevent secondary disease in lethally irradiated mice. We will continue studying the properties of H-2 antigens from different tissues and the immunogenetic analysis of the new H-genes and H-antigens already found. We hope to establish a correlation, if any, between number of plasma cells in the donors of immune tissues and the number of homotransplanted leukemic cells destroyed in adaptively immunized hosts.

## C1C Removal of Radioactivity

See also A2B390.

Urist, Marshall R. AT(11-1)34-98  
C1C45 EFFECT OF TETRACYCLINE UPON  
SHORT AND LONG TERM EXCHANGE, AND EX-

CRETION OF ISOTOPES OF CALCIUM AND STRONTIUM IN BONE IN MAN AND ANIMALS. California. Univ., Los Angeles. School of Medicine. SAN. SP 4.

The chemical reactivity of the bone mineral in health and disease will be studied by means of the uptake of oxytetracycline. The amount of oxytetracycline deposited per gram of apatite calcium will be measured during and after precipitation in systems *in vitro* and *in vivo* by means of fluorometric methods of quantitative analysis that depends upon the substitution of magnesium for calcium.

Because tetracyclines are deposited in approximately the same sites as radioactive isotopes of calcium, strontium, and phosphorus, their metal ion complexes will be used to determine the mechanism of formation of the hot spots, and the conversion of the reactive to non-reactive bone mineral. It is postulated that the bone mineral in the hot spots consists of calcium deficient apatite of Posner, while the bone mineral in the relatively non-reactive fraction consists of apatite. Measurements of pyrophosphate in the new bone mineral labeled with oxytetracycline will be made to differentiate the two stages of mineralization.

In patients with osteoporosis under investigation in the metabolic section of the UCLA Medical Center, oxytetracycline labeling is being used in combination with Sr<sup>85</sup> and Ca<sup>47</sup> kinetic studies and conventional metabolic balance methods for calcium, phosphorus and nitrogen. Correlated studies may provide information not obtainable from any single method now in use for the study of deposition and removal of radioisotopes from bone.

Bell, Robert F. AT(11-1)637  
C1C93 THE BIOLOGICAL HALF LIFE OF  
RADIOLEAD AND THE QUANTITATIVE EFFECT  
OF CaNa<sub>2</sub>EDTA ON THE TOTAL BODY RADIOLEAD  
BURDEN IN DOGS.  
Colorado. Univ., Denver. Medical Center. COO.

Urinary and fecal excretion of Pb<sup>210</sup> was studied in dogs up to two years following a single intravenous dose of 1 μc of Pb<sup>210</sup>. The cumulative per cent urinary excretion of this dose was 2.5% in the first day, 8% in the first year and 10% in two years. Urinary excretion of Pb<sup>210</sup> was best expressed by a power function. Fecal excretions were found to be less than 1% of the urinary excretion. The biological half life of Pb<sup>210</sup> is indeterminable.

From 6 to 24 months after the initial Pb<sup>210</sup> infusion, 24 hour urine excretions immediately following a 0.4 Gm/kilo provocative intravenous dose of CaNa<sub>2</sub>EDTA were found to be 0.11% of the calculated remaining

body burden of  $Pb^{210}$ . Recovery of  $Pb^{210}$  from total animal digestion was less than that found in the  $CaNa_2EDTA$  provocative 24 hour urine excretion collected four days before autopsy. We think this anomaly is due to an exchange of  $Pb^{210}$  with a metal in the stainless steel vats used for total animal digestion.

This research may disclose a practical provocative urinary excretion bioassay for approximating the body burden of  $Pb^{210}$  which may be indicative of an individual's integrated exposure to radon and its daughters.

Armstrong, W. D. AT(11-1)838  
C1C195 PHYSIOLOGICAL SITES OF DISCRIMINATION BETWEEN STRONTIUM AND CALCIUM AND REMOVAL OF STRONTIUM RADIOISOTOPES FROM MILK.

Minnesota. Univ., Minneapolis. COO. SP 3.

The rates of intestinal absorption of calcium and strontium in the entire small intestine and in segments thereof of rats are to be investigated. Development of x-ray fluorescent techniques for analytical determination of calcium and strontium is being studied.

Further studies of the differential binding of calcium and strontium by plasma proteins will be carried out.

The differential uptake of calcium and strontium by the isolated limb of the dog during perfusion of blood containing radioisotopes of calcium and strontium will continue to be studied.

Further studies on the removal of radioisotopes of calcium from milk by the use of apatites will be undertaken.

Ray, Robert D. AT(11-1)507  
C1C250 MOBILIZATION OF RADIOACTIVE EMITTERS FROM BONE.  
Presbyterian-St. Luke's Hospital, Chicago. COO, SP 4; MYr 2.

The purpose of this study is two-fold: (a) to investigate the mechanism of uptake and mobilization of radioactive emitters by bone, and (b) to study the factors affecting uptake and mobilization of radioactive emitters by bone.

In line with the first part of the project, it is planned to continue studies correlating the micro-radiographic, autoradiographic and histological morphology of thin sections of undecalcified bone using various radioactive isotopes as well as tetracycline labeling, and also to continue studies on the kinetics of inorganic salt metabolism including additional routes of loss of calcium and strontium from the body (perspiration) and the time required for

uniform distribution of bone seeking isotopes in the body.

Under the second heading it is planned to continue studies on the relation between changes in blood flow, and alterations in bone metabolism, and also to continue studies on the relation between Vitamin D and bone resorption.

Sastry, B. V. Rama AT(40-1)3066  
C1C287 STUDIES ON THE CHEMOTHERAPEUTIC METHODS FOR THE REMOVAL OF RADIOACTIVE MATERIALS FROM THE BODY.  
Vanderbilt Univ., Nashville. School of Medicine. OROO. SP 4; TMYr 1.50; OMYr .40.

The purpose of our investigation is to study chemotherapeutic methods for the removal of radioactive materials, from sources such as fallout and environmental contamination, from the animal body. Particular emphasis will be devoted to the renal excretion of  $Cs^{137}$  because this isotope accumulates in soft tissues and subjects them to the dangers of radiation carcinogenesis and other delayed effects of radiation. The role of  $Cs^{137}$  in the  $H^+$ -exchange system in the kidney in relation to that of K and Na will be studied under a number of conditions, utilizing agents known to affect this system. The chemotherapeutic agents to be utilized will include (1) carbonic anhydrase inhibitors, (2) thiazide diuretics, (3) mercurial diuretics, (4) ammonium chloride, (5) enantiomers of lysine and arginine monohydrochlorides, (6) *cis* and *trans* pairs of dicarboxylic acids, such as maleic and fumaric acids, and (7) steroids, such as desoxycorticosterone. The experiments will be conducted by excretion studies in rats and free flow, stop flow, and slow flow techniques in dogs.

Our preliminary investigations support the view that  $Cs^+$  substitutes for  $K^+$  in the  $H^+$  exchange system and acetazolamide increases  $Cs^{137}$  excretion in the rat by increasing the secretion of this isotope in the renal tubules.

Kroll, Harry AT(30-1)2710  
C1C354 THE DEVELOPMENT OF ORGANIC CHELATING AGENTS FOR ENHANCING THE URINARY EXCRETION OF RADIOSTRONTIUM.  
Eltex Research Corp., Lincoln, R. I. NYOO. SP 3; MYr 1.

The objective of the research program is to develop organic chemicals which will bind strontium in preference to calcium in aqueous solution. The approach to this problem is proceeding in three related directions:

1. The synthesis and evaluation of organic chelating agents exhibiting an affinity for alkaline earth cations.



2. The evaluation of the binding affinities of sodium polyvinylsulfonate for alkaline earth cations.

3. The determination of the metal binding properties of combinations of sodium polyvinylsulfonate with organic and inorganic chelating agents.

The work on the organic chelating agents include studies of the contribution of the stereochemistry of the molecule on the chelation reaction, the metal binding properties of phenolic hydroxy groups, phosphonic acid groups, and pyrimidyl groups on the binding of alkaline earths. The study on the metal binding properties of polyelectrolytes includes the development of simple methods for determining metal affinities. The physiological testing of these compounds will be done by the Biology Laboratory, General Electric Company, Richland, Washington.

Silverman, Leslie AT(30-1)2355  
C1C454 RESPIRATORY PROTECTIVE EQUIPMENT.

Harvard Univ., Boston. School of Public Health.  
NYOO. SP 3; MYr 2.

It is the purpose of this research to evaluate overall performance of respiratory protective devices on sub-micron aerosols and to develop equipment whereby a greater degree of respiratory protection may be assured for highly toxic air contaminants.

Evaluation of the degree of protection afforded by respirators against highly toxic radioactive contaminants such as plutonium and non-radioactive materials such as beryllium has not been possible to date with available techniques. A method has been developed under this research to permit such quantitative assessment of protection. A uranine test aerosol with a geometric mean size (by count) of 0.20 microns with a geometric standard deviation of approximately 2.0 is introduced to an exposure helmet chamber which permits dynamic exposure of a subject wearing the test respirator to concentrations of 1 to 4 mg/cu. m. The uranine aerosol is collected continuously in the chamber and during inhalation only inside the respirator. The detection sensitivity of the uranine fluorescence analysis is 0.1 nanograms per ml which permits evaluation of respirator penetration as low as 0.05% in a ten minute study.

Design concepts have been proposed for maximum comfort-minimum effort respiratory protective devices for application to toxic air contaminants. A self-contained positive air supply respirator with the total air supplied from the wearer's environment through an air purification package consisting of a DC motor, air mover, rechargeable battery pack, and filter or filter-adsorbent combination element has been prototyped

and field evaluated. The package, which supplies 3.8 to 4.0 cfm to a standard air supply facepiece can be worn conveniently on a belt suspension. A normal work cycle of 3 to 4 hours has been achieved without recharging.

Other design concepts are presently being evaluated.

Edmondson, L. F. AT(49-7)1774  
C1C483 REMOVAL OF RADIOACTIVE CONTAMINATION FROM MILK.

Department of Agriculture, Agricultural Research Service, Beltsville, Md. WASH.

A process for removing radioactive strontium from milk has been developed to the pilot-plant stage. Removal of this radionuclide is achieved by passing cold, raw whole milk through columns containing a strong acid ion exchange resin. The resin is prepared by regenerating with a mixed solution containing the major milk cations—calcium, potassium, magnesium, and sodium. Before the milk is passed through the resin column, the pH is adjusted to 5.3 with citric acid. This releases most of the strontium from its complexed state in milk and results in the removal of about 95% by the ion exchange resin. At the normal pH of milk (6.6), less than 50% is removed. The resin-treated milk is neutralized by the direct addition of potassium hydroxide or other suitable bases. The flavor of the milk is satisfactory.

Future work on this project will include the testing of an automated pilot-plant system, the development of a procedure for removing I-131 with an anion resin and the determination of resin treatment on nutritional, chemical and physical changes in milk.

Tests with a movable bed ion exchange contactor for removing radionuclides has also shown encouraging results.

Forbes, Gilbert B. AT(30-1) 1827  
C1C556 METABOLISM OF BONE SODIUM.  
Rochester, N. Y. Univ. School of Medicine and Dentistry. November 15, 1961–November 14, 1962.

This study is concerned with attempting to define the role of skeletal sodium, particularly as it pertains to the sodium metabolism of the body as a whole. To this end we have investigated the sodium content of bone in a number of species, and at varying ages in man; and the uptake of radiosodium in bone as a function of age.

Bone sodium content is a function of age; in fact bone is one of the few tissues of the body where so-

dium content increases as the animal matures. Radio-sodium exchangeability is much greater in young animals compared to old (we have found a similar trend in radiomagnesium exchangeability).

In our hands, it has been difficult to produce, in adult animals, a net decrease in bone sodium as a consequence of hyponatremia and/or acidosis. Small changes were noted, but the magnitude would appear to be of limited significance. Since young animals show a much higher rate of radiosodium exchange, we decided to study net changes in this age group. True to our expectations, a significant change to both hypo- and hypernatremia has been observed. Furthermore, changes in cartilage sodium were also found. Thus sodium in infant skeleton is much more labile than that of adult, due to two factors—increased lability of bone itself, and the presence of large amounts of cartilage.

Recently, in collaboration with John Hursh, we have embarked on a study of estimation of total body fat by determination of potassium-40 content in the whole body counter.

Clark, Irwin AT(30-1) 2530  
C1C569 "STUDIES ON BONE DEMINERALIZATION WITH EMPHASIS ON THE REMOVAL OF STRONTIUM."

Columbia Univ., New York. Coll. of Physicians and Surgeons. January 1962–December 1962.

The effects of various agents known to produce hypercalciuria are being investigated for their ability to remove  $\text{Sr}^{89}$  from bone.

It has been found that either the oral or parenteral administration of magnesium ions accelerates the removal of  $\text{Sr}^{89}$  from bone. This effect is observed shortly after, or a long time after, the ingestion of the isotope.  $\text{Mg}^{++}$  is the most effective element of Group II of the Periodic Table in producing this effect. Preliminary studies indicate that the primary site of action of magnesium is on the kidney. Currently under investigation are the mechanism of the action of  $\text{Mg}^{++}$  on the kidney, the site of removal of  $\text{Sr}^{89}$  from bone using radioautographic techniques and the effects of long term magnesium administration of calcium and phosphorus metabolism under various dietary conditions.

A quantitative study of the alterations in the protein, mucopolysaccharide and mineral components of bone in hypervitaminoses A and D is in progress. Preliminary studies have shown that vitamin A decreases the toxicity of large doses of vitamin D and partially reverses some of the changes in the skeletal system. Studies are in progress to determine how vitamin A exerts this beneficial effect and also the roles of vitamin A and D in bone rarefaction.

## D MOLECULAR AND CELLULAR LEVEL STUDIES

### D1A Bioenergetics and Biophysics

See also A1H293, B1B299, D1C21, D1C228, D1D233, D1D272, and D1D349.

Friedell, Hymer L. W-31-109-Eng-78  
D1A97 RADIATION BIOLOGY.  
Western Reserve Univ., Cleveland. Joseph Treloar  
Wearn Lab. for Medical Research. COO. SP 10;  
MYr 7.5.

The main purpose of the research done under this Contract is to investigate the basic mechanisms by which radiation, particularly ionizing radiation, affects normal biological processes. Our principal emphasis is placed on those immediate and early physical and chemical events which occur between the initial deposition of energy and the biochemical lesions that subsequently lead to observable biological effects. A multi-disciplinary approach is therefore employed so that biochemical and biological observations can be correlated with those of the biophysicists in the hope of eventually inter-relating a whole spectrum of radiation effects. The type of radiation and mode of delivery are important variables in experiments planned to elucidate time-dependent factors in producing physico-chemical changes in biological materials. The mechanism of action of radiation modifiers is evaluated in regard to their effect on the production and fate of free radicals, as well as their capacity to influence radiation injury to, and/or repair of, vital molecules or structures of the cell. Metabolic studies are primarily concerned with the reproductive and regulatory functions of the cell. Although tissue culture or other *in vitro* systems are used for most of these studies, the pathogenesis of certain lesions which develop in the irradiated intact animal are also studied.

Tollin, Gordon AT(11-1) 908  
D1A176 FREE RADICALS IN BIOLOGICAL ENERGY CONVERSION: ELECTRON PARAMAGNETIC RESONANCE STUDIES OF MODEL SYSTEMS.  
Arizona. Univ., Tucson. COO. June 1962–May 1963.

The scope of our studies of light-induced single electron transfer reactions between chlorophyll a and quinones in solution will be enlarged to include other possible donor and acceptor molecules, such as chlorophyll b, the pheophytins, other porphyrins, and pyridine nucleotides, riboflavin, carotenoids,

thioctic acid, etc. In addition, we will attempt to introduce a third component into these systems which could function to donate electrons to the chlorophyll positive ion, e.g. reduced pyridine nucleotide, ferrous ion, p-phenylene diamine, etc.

Our studies of the paramagnetism of solid complexes of flavins and hydroquinones will be continued and enlarged to include investigations of the electrical conductivity of these materials as well. The combination of these two approaches should enable us to achieve a clearer understanding of the nature of these materials.

Work will be continued in our efforts to elucidate the nature of the free radical species which we have found in soil humic acid. Various chemical treatments will be performed on humic acid, including oxidation (e.g.  $\text{KMnO}_4$ ,  $\text{HNO}_3$ ,  $\text{H}_2\text{O}_2$ ) and reduction (e.g. catalytic hydrogenation), the products fractionated and submitted to EPR analysis.

Platt, John R. AT(11-1) 952  
D1A178 QUANTUM THEORY OF EXCITED STATES OF BIOLOGICAL PIGMENT MOLECULES. Chicago. Univ. COO. November 1961–October 1962.

Over the past ten years, quantum theoretical research has finally accounted for the positions and intensities of the principal absorption bands of several classes of unsaturated organic molecules in the visible and near-visible regions of the spectrum. The compounds studied include carotenoids and chain dyes, condensed-ring systems, and porphyrins and metallo-porphyrins. The effects of chemical substitution and metallic complexing can be predicted in many cases; also the classes and heights of unknown energy states; the radiative and radiationless transitions among the states; and the electron density distributions important for excited-state chemistry. This helps us to understand better the reactions produced in excited states and is therefore pertinent to many problems in radiation biology and in the effects of ionizing radiation.

It is proposed to assemble a small group of two or three graduate students and post-Doctoral students in physics, chemistry and biology, to extend these spectral interpretations and theoretical models to additional molecules of biological importance. These molecules include carcinogens; nucleic acids and their complexes; retinenes and their Schiff bases; flavones and anthocyanins; flavins; iron porphyrins, hemes, cytochromes and their complexes; and compounds still more closely related to chlorophyll and bacteriochlorophyll.

Tolbert, Bert M. AT(11-1)690  
D1A181 RADIATION EFFECTS IN BIOCHEMISTRY AND ORGANIC CHEMISTRY. Colorado Univ., Boulder. COO. SP 3; MYr 1.5.

This project deals with the effects of gamma rays on pure solid compounds of a biological nature. Currently under study are lysozyme,  $\alpha$ -chymotrypsin,  $\alpha$ -chymotrypsin-ATP complex, the amino acids, some amino acid chelates and related compounds. Correlations between chemical sensitivity,  $G(-M)$  values, and specific decomposition pathways or free radical intermediates are being sought. Decarboxylation, deamination and ketone yields are being determined. Major decomposition products for leucine are being determined by paper chromatography.

Chromatographically-pure lysozyme and  $\alpha$ -chymotrypsin are being studied at such low levels of radiation that initial modification processes can be observed. In crystalline lysozyme a few megarads of radiation modifies the Sephadex elution pattern. We are preparing and isolating gram quantities of the new products and they are being studied for enzyme activity, amino acid content, end-group analysis, deuterium ion exchange properties and other molecular configuration properties. For  $\alpha$ -chymotrypsin we are also isolating the radiation modified proteins and correlating some of the above changes with heat perturbation changes and with changes in enzyme specificity. Present work points to a sensitivity in the secondary and tertiary protein structure, probably derived by hydrogen bond or thio linkage destruction.

Since chemical assay of dissolved irradiated solids gives only indirect evidence for changes in the solid, we are also studying the irradiated solid itself. We are currently using ESR and infra-red spectrometry, and plan to begin calorimetry of the irradiated solid. All of the work is directed toward obtaining quantitative data to compare with the quantitative chemical data.

McConnell, James V. AT(11-1)825  
D1A192 LEARNING AND REGENERATION IN PLANARIA.

Michigan. Univ., Ann Arbor. COO. SP 2; MYr 1.

Our research, in past years, has had two chief aims: (1) to investigate the effects of x-irradiation upon regeneration, and (2) to study certain biochemical correlates of learning in planarians. Past research with x-irradiation indicates (2) that the  $\text{LD}_{50}$  for planarians lies in the neighborhood of 900 to 1000 roentgens; (b) that animals given 200 r. or less per week can apparently accumulate dosages in excess of 6,000 r. without showing any detrimental

effects; and (c) that if we decapitate the animals immediately following irradiation, they survive supra-lethal-threshold dosages to a much greater extent than do uncut irradiated controls.

Our studies into the biochemistry of memory have yielded the following results: (a) if trained animals are cut in half and allowed to regenerate, both head and tail regenerates from the same animal will show significant retention of the original conditioning; (b) if trained planarians are chopped up and fed to untrained cannibalistic planarians, the latter will have acquired some element of the training via ingestion. Other investigators have shown that RNA-ase apparently interferes with the retention of training in regenerated portions of planarians not containing the original brain. This suggested to us that some molecular change in RNA might mediate memory storage in planarians.

This past year, in a crudely performed pilot study, we obtained evidence supporting the RNA hypothesis. We were able to extract RNA from conditioned animals and inject it into untrained worms. When the latter animals were subsequently conditioned, they showed evidence of learning faster than did appropriate controls.

During the coming year we intend to repeat the RNA study mentioned above utilizing stricter control over our experimental conditions and to continue our study of the effects of regeneration upon tolerance of x-irradiation.

Livingston, R. AT(11-1)894  
D1A196 A PHYSIOCHEMICAL APPROACH TO  
THE STUDY OF THE PRIMARY ACTS IN PHOTO-  
BIOLOGICAL PROCESSES.  
Minnesota, Univ., Minneapolis. COO.

The scope of this project is unusually broad. A variety of physiochemical techniques are employed to study several of the processes and intermediates of importance in the primary stages of photobiological reactions. Included here are the stabilities and chemical reactions of the labile states (including the lowest triplet) of polyatomic molecules and the stabilities of free radicals. Specific problems in each of these areas are separately directed by each of the Senior Investigators.

Dr. J. Wertz is currently studying by electron spin resonance techniques the reactions of organic free radicals and the effects of environment on their ESR spectra. Dr. R. Lumry is investigating the primary act in the Hill reaction, the photochemistry of hemo-proteins and the chemiluminescence of hydrazine. Dr. R. Livingston is studying by flash-photolytic techniques the effects of environment upon the rates

of non-radiative transitions of polyatomic molecules, including some of biological interest. He is also investigating the photochemistry of chlorophyll and energy transport problems involved in the mechanism of vision. Dr. S. Lipsky is measuring electronic energy efficiencies in organic solutions at high "donor" concentrations and the dependence of these efficiencies on the quality of the radiation (uv and gamma) used to excite the donor. Protection effects in the radiation chemistry of simple organic liquids are also being investigated. Dr. A. Moscovitz is currently studying theoretical aspects of optical activity and the implications of rotary dispersion measurements to the determination of molecular structure.

Lumry, R. AT(11-1)794  
D1A198 ENERGY TRANSFER AND UTILIZATION  
IN THE PHOTOSYNTHETIC PROCESS.  
Minnesota, Univ., Minneapolis. COO.

Previous work has indicated a simple relationship between the fluorescence behavior and rate of the Hill reaction of photosynthesis to exist. The present study seeks to establish more detail in this relationship through the determination of the lifetime of fluorescence of the photosynthetic pigments as functions of light intensity, wave length of excited light, temperature and certain specific inhibitors. The present studies are largely of steady-state fluorescence and steady-state Hill-reaction rate. In subsequent years the work will be extended to include illumination with flashing light. A modified Rollefson-type apparatus for fluorescence lifetimes has been built using a Baird-Atomics EOLM unit for light modulation. Time resolutions of the order of 0.01 millimicrosec. are readily attained even under adverse circumstances.

The apparatus is being applied to studies of a few pure pigment solutions primarily for the effect of solvent on the lifetime of the first excited singlet states. There are serious limitations on the accuracy of fluorescence lifetime measurements due to unknown variations in the transit times taken by electrons to move from photocathode to final anode in photomultiplier tubes. At present a very serious attempt is being made to assess and correct for these variations.

The apparatus is being modified for application in the ultra-violet spectral region in order to determine absolute fluorescence lifetimes for protein side chains and the dependence of these lifetimes on solution factors, protein conformation, substrate binding, etc. The modified apparatus will be applied to fundamental problems in protein structure and to

the measurement of protein denaturation thermodynamics and the changes in protein conformation on interaction with substrates.

Spikes, John D. AT(11-1)875

D1A227 RADIATION EFFECTS ON PLANTS.  
Utah. Univ., Salt Lake City. COO. SP 4; MYr 3.

The main areas of research being carried out under this contract may be summarized as follows:

1. Comparative studies of the kinetics and mechanisms of radiation effects on plants including gamma, ultraviolet and dye-sensitized visible radiation. Most of the work is concerned with radiation effects on carbon dioxide fixation, photosynthetic phosphorylation, the Hill reaction, fluorescence phenomena, pigments, etc., using isolated chloroplasts and whole cells.

2. Basic supporting studies (for the above work) on the kinetics of the various reactions listed above in unirradiated plants. The emphasis in this work is on the Hill reaction of isolated chloroplasts and on comparative studies of the photosynthesis and whole-cell Hill reaction in algae.

3. Basic supporting studies (for section 2 above) on the mechanisms of energy transfer in illuminated dye-sensitized systems. This work includes studies on the light-sensitized inactivation of enzymes such as trypsin and ribonuclease, as well as the chemical breakdown of amino acids, using photosensitizing dyes such as chlorophyll, riboflavin, methylene blue, etc. Comparative studies are being made using gamma and ultraviolet radiations on the same systems.

Wharton, David C. AT(11-1)909

D1A232 APPLICATION OF BIOPHYSICAL TOOLS TO THE STUDY OF CELLULAR ENERGY-TRANSFORMING SYSTEMS.

Wisconsin. Univ., Madison. Inst. for Enzyme Research. COO. SP 2; MYr 2.

In our systematic program of study of the mitochondrion various biophysical problems central to the understanding of structure-function interrelationships have developed. (1) EPR studies are being carried out on three iron complexes in the electron transfer chain which show characteristic  $g \sim 2$  signals. One of these complexes has now been isolated in pure form. (2) The mode of binding of phospholipid to mitochondrial protein is being determined by methods developed in the course of studying model systems which involve electrostatic and hydrophobic lipid-protein interactions. (3) The specific requirement for lecithin by the apodehydrogenase that catalyzes the oxidation of  $\beta$ -hydroxybutyric acid is being

probed with a view to elucidating the role of lecithin in the catalytic process. (4) The three basic protein repeating parts of the mitochondrial membrane (structural protein, elementary particle and the primary dehydrogenase complexes) have been isolated and purified; their interaction *in vitro* to reconstitute the mitochondrial membrane structure is being investigated.

Conger, Alan D. AT(40-1) 2579

D1A257 RADIATION AFTER-EFFECT AND LONG-LIVED FREE RADICALS IN SEEDS.

Florida. Univ., Gainesville. OROO. June 1962–November 1963. SP 3; MYr 2 5/8.

The production of biological after-effect (damage which develops postirradiation) and of long-lived free radicals detected postirradiation by electron spin resonance (ESR) in irradiated dry seeds is studied. The mechanism of the after-effect is believed to be the free radicals which persist postirradiation; amount of damage is related to the number of radicals which decay postirradiation. Factors which modify the two effects—after-effect and free radicals—are studied and correlations between the two are sought.

The free radicals produced in seeds and embryos have not been identified. Some specification or localization of what or where they are will be attempted by: (a) using improved ESR techniques to obtain radical signal fine structure, and (b) by studying ESR radical signals from separated cellular components—nuclei, chromosomes, walls, cytoplasm, cytoplasmic particulates, etc.—.

The effect of high temperature heat shocks (ca. 100°C for 1 hr) in modifying after-effect will be studied; it is already known to accelerate the rate of radical disappearance.

The biological effect observed in these experiments has been damage to seedling growth; observations of chromosomal damage (chromosome aberrations) will also be made.

Most of the modifiers of damage and radicals have been gases— $H_2O$ ,  $N_2$ ,  $O_2$ ,  $NO$ ,  $H_2S$ —and they show profound differences in the rate at which they effect their modification. Experiments to measure the rates of diffusion into and out of the seeds and seed embryos by these gases will be made, to correlate with the damage and radical rates.

Gaffron, H. AT(40-1)-2687

D1A261 RESEARCH IN PHOTOSYNTHESIS.  
Florida State Univ., Tallahassee. OROO. SP 3;  
MYr 1 11/12.

Last year's information note mentioned studies on the importance of plastoquinone for oxygen evolution and the likely change in the mechanism by means of X-ray induced mutations in photosynthetic green algae. The most recent results are as follows: many mutations have been found that still have a nearly normal complement of pigments yet in one way or another are incapable of accomplishing complete photosynthesis. The majority have defects leading to a diminished rate for carbon dioxide reduction while their capacity for the Hill reaction is normal. One mutant, however, is normal in every respect except that it will not evolve oxygen, as shown by its inability to do photosynthesis or the Hill reaction, but still it is able to fix carbon dioxide under special conditions. Analyses have shown that plastoquinone is still present—despite the fact that normal cell preparations from which the quinone has been extracted do not evolve oxygen. The role of quinone for oxygen evolution must therefore be considered an indirect one. This is confirmed by experiments in which the effect of short and long wave length red light are compared under aerobic and anaerobic conditions. After adaptation to photoreduction in absence of oxygen the inefficient light at  $\lambda$  705  $m\mu$  becomes normally efficient. This is particularly true for the oxygen mutant just mentioned. Such results help to clarify the role of plastoquinone. A scheme can be set up for the mechanism of photosynthesis which explains the relationship between photoreduction and photosynthesis. In this formulation it appears that plastoquinone must serve as a mediator between the two light reaction systems, which have to cooperate in order that oxygen can be evolved as free gas.

Cormier, M. J. AT(40-1)2741  
 D1A263 MECHANISM STUDIES ON BIOLUMINESCENT REACTIONS WITH EMPHASIS ON ENERGY TRANSFER PROBLEMS.  
 Georgia. Univ., Athens. OROO.

There are many unanswered questions relating to the mechanism of the bacterial bioluminescent reaction. We are thus engaged in an attempt to isolate highly purified bacterial luciferase in order to take another look at the quantum efficiency determinations, mode of FMNH<sub>2</sub> binding to the enzyme, function of the aldehyde and a number of other associated problems.

We are also engaged in studying the properties of the bioluminescent system of Balanoglossus biminiensis. Extracts of this organism require an enzyme (Balanoglossus luciferase), an oxidizable substrate (Balanoglossid luciferin), and H<sub>2</sub>O<sub>2</sub> (or certain other radical generators) for luminescence.

Luciferase has been identified as a peroxidase and, in fact, crystalline horse-radish peroxidase will substitute for luciferase in this system. Since light is a product in the peroxidative reaction catalyzed by luciferase, we have an opportunity to examine this system carefully using the classical kinetic approach. By so doing we have the opportunity of learning more not only about bioluminescence but about the general mechanism of peroxidative action as well.

Philbrook, G. E. AT(40-1)2851  
 D1A265 AN INVESTIGATION OF CHEMILUMINESCENT COMPOUNDS AS RADICAL DETECTORS.  
 Georgia. Univ., Athens. OROO. MYR  $\frac{2}{3}$ .

In connection with this second renewal request we intend to study the properties of 5-chlorophthalazdione and 5-chlorophthalic acid. The chemiluminescence of the 5-chlorophthalazdione will be studied with respect to light emission, fluorescence excitation and emission spectra, and with respect to the kinetics of the reaction. We wish to compare the kinetics from this compound with those of the N-methyl amino derivative of luminol.

Solutions of 5-chlorophthalazdione and 5-chlorophthalic acid will be studied with respect to their excitation and emission spectra and the changes which these undergo when irradiated by ultraviolet light.

Luminol labeled with C-14 in the carbonyl group will be prepared and subjected to the chemiluminescence reaction. Since the intermediates involved in these processes probably never reach high levels, we hope to be able to determine the nature and number of products formed by the autoradiography of paper chromatograms run on the oxidized solutions. At present, we have no definite information on the chemical compounds produced in these reactions. It is intended to study by such techniques as paper chromatography, thin film chromatography, and gas chromatography using the results obtained with a radioactive material as a guide for the work.

Montgomery, P. O'B. AT(40-1)2478  
 D1A278 ULTRAVIOLET IRRADIATION DAMAGE IN LIVING CELL SYSTEMS.  
 Texas. Univ., Dallas. Southwestern Medical School. OROO. November 1961–October 1962. SP 3.

The work to be carried out under this Atomic Energy Commission Division Contract falls into several categories. 1) The development of a new instrument for ultraviolet microbeam irradiation of selected areas of living cells in conjunction with phase contrast television microscopy. The development of this equipment will permit the investigator

to produce focal areas of irradiation damage of the nuclei of living cells, the nucleoli of living cells and the cytoplasm of living cells. These studies will be extended to include the morphologic aspects of viral proliferation in such focally irradiated cells. 2) The study of the effects of P-32 on living cells and the study of the effects of x-radiation on living cells in these studies. The data will be recorded by phase contrast time-lapse motion picture observations, ultraviolet flying spot television motion picture observations and flying spot interference television observations. When these data are completed they will form the basis for a similar series of experiments in which the damaged cells will be effected by selected viruses.

Shalek, Robert J. AT(40-1)2832  
D1A279 RADIATION STUDIES ON BACTERIAL  
AND ANIMAL VIRUSES.

Texas. Univ., Houston. M. D. Anderson Hospital  
and Tumor Inst. OROO. SP 8; MYr 7.

It is proposed to investigate the following problems by means of irradiations of T2r bacteriophage with  $\gamma$ -rays, X-rays, protons and alpha particles up to 5 Mev, and low-energy electrons of controllable energy.

1. The determination of the relative amount of direct and indirect radiation effect upon bacteriophage DNA in a cell environment. The experiments will be with E. coli infected with T2r irradiated above and below the freezing temperature of the cell material. Preliminary experiments have indicated that the inactivation effect upon phage DNA in a cellular environment is approximately evenly divided between direct and indirect radiation effect (250-kv X-rays). Experiments necessary for interpretation are continuing.

2. The effect of environmental conditions upon the relative biological effectiveness of radiation. It is postulated that the oxygen effect and the relative biological effectiveness depend upon a common mechanism involving the competition of restituting events and confirming events. The radiation response of free bacteriophage to radiations of differing LET will be investigated under environmental conditions simulating those in a cellular environment.

3. Studies on the configuration of DNA in T2 bacteriophage using partly and fully penetrating electron beams. Preliminary studies have indicated that the DNA in T2 is located in a shell under the protein coat. A model has been proposed which is consistent with the electron data and available biophysical data. Additional data relating to the

model will be obtained by X-ray diffraction and electron microscopy.

Gregor, H. P. AT(30-1)2279  
D1A292 DETERMINATION OF ACTIVITY OF  
ALKALINE EARTH CATIONS IN BIOLOGICAL AND  
OTHER AQUEOUS MEDIA BY MEANS OF MULTI-  
LAYER MEMBRANE ELECTRODE.

Brooklyn. Polytechnic Inst. NYOO. SP 3; MYr 2.25.

This project is concerned with the preparation of improved multilayer membrane electrodes and their applicability for the determination of the activity of alkaline earth cations in biological media. At the present time there are no electrodes which will allow one to measure the activity of calcium, as an example, in serum or in solutions containing other cationic species. Some successes in the determination of calcium in the presence of other alkaline earth cations has been achieved using multilayer membrane electrodes employing calcium stearate, but these invariably contain small amounts of free acids due to the weak acid strength of stearic acid. This free acid is neutralized by foreign cations, which then interfere. Attempts have been made to use other acids including long-chain phosphonic acids, sulfonic acids and in perfluorocarboxylic acid. With the phosphonic acids, the second ionization constant is too weak to form the dibasic alkaline earth metal salt under the conditions which prevail in a multilayer, so these materials do not appear to be markedly superior to the carboxylic acids. The sulfonic acids can be completely converted into the salt form in neutral pH solutions, but their "heads" are rather too large for optimum packing. The perfluorocarboxylic acids have the requisite acid strength, but certain difficulties have been encountered due to their unavailability and polar nature. However, it does appear that the fluorinated acids can be plated out and these films should show the requisite specificity.

Hutchinson, Franklin AT(30-1)2653  
D1A316 RESEARCH ON THE EFFECTS OF  
RADIATIONS ON BIOLOGICAL MOLECULES, ON  
AGGREGATES OF SUCH MOLECULES IN VITRO,  
AND ON MOLECULES AND AGGREGATES WITHIN  
CELLS.

Yale Univ., New Haven. NYOO.

There are two independent lines of work on this contract.

In one line the effect of ionizing radiation on the DNA molecule is being studied by both physical-chemical means and by study of biological activity (transformation). The irradiations are carried out on DNA preparations and on DNA in vivo, either in

vegetative cells or in spores. The radiosensitizing action of various nucleic analogs is also under study. Strong correlations can be obtained between biological activity and various physical-chemical modes of damage.

The other line of work is the study of effects of various radiations of different LET, from X-rays to heavily ionizing accelerated argon atoms, on Chinese hamster cells in tissue culture. Properties under study are overall survival of cells, mitotic delay, and the induction of chromosomal aberrations.

Allen, Mary Belle AT(04-3)232  
D1A334 ENERGY TRANSFER IN PHOTOCHEMICAL REACTIONS.  
Kaiser Foundation Research Inst., Richmond, Calif.  
SAN. SP 1.5; MYr 1.5.

The pigment systems that carry out the two photochemical reactions of photosynthesis and the transport of energy and electrons from these systems are being studied by (1) isolating the pigment complexes and studying their structure and their reactions *in vitro*; (2) studying the action of these systems in living cells by comparing action spectra and kinetics of the electron spin resonance signals produced on illumination with those of other photobiological reactions.

These studies are being carried out not only with the familiar green plant systems but also with algae of various pigment composition, with emphasis on those containing chlorophyll c.

McGlynn, S. P. AT(40-1)3018  
D1A375 A PHYSICO CHEMICAL INVESTIGATION OF SOME AREAS OF FUNDAMENTAL SIGNIFICANCE TO BIOPHYSICS.  
Louisiana State Univ., Baton Rouge. OROO. June 15, 1962-June 14, 1963. SP 4; MYr  $\frac{7}{24}$ .

The work may be divided into: (a) The Disulfide Linkage: An intensive spectroscopic study of this linkage (i.e., the disulfide bond) is underway, and is being accompanied by a Parr-Pariser-Pople calculation of energy levels and extinction coefficients in order to fixate the types of electronic transition responsible for the 2500A absorption band of this moiety; in particular a large amount of effort is being expended on the energy degradative properties of this linkage with a view to understanding its behavior in native protein. (b) Semi- and Photoconductivity of Organic Crystals: The series of crystals which constitute the polyphenyls and diphenylpolyenes are being investigated in an effort to understand the effect of intermolecular interaction and the way it influences photoconductive ability. The relationship of photoconductive activation energy to defect de-

trapping energies is being pursued. (c) Charge Transfer Complexation: The manner in which formation of a CT complex occasions increase of spin-orbital coupling, whether by an exchange mechanism with environmental species or by borrowing of intensity from a CT transition is being investigated for the complexes of naphthalene and phenanthrene with various acceptors. (d) The utilization of % polarization versus time after excitation of phosphorescence is being investigated as a possible tool for energy transfer studies.

Shields, Howard W. AT(40-1)2835  
D1A382 STUDY OF FREE RADICALS OF BIOLOGICAL SIGNIFICANCE WITH ELECTRON SPIN RESONANCE SPECTROSCOPY TECHNIQUES.  
Wake Forest Coll., Winston-Salem, N. C. OROO.  
SP 4, MYr 2.25.

We are interested in the effects of ionizing radiation on compounds of biological interest. Electron spin resonance, ESR, spectroscopy enables one to study the structure of free radicals resulting from photoionization of matter. Much more detailed understanding of the structure of such free radicals is obtained by studying them in single crystal matrices.

The ESR spectra of D-glucose and D-fructose have been obtained. A more detailed study of sucrose single crystals indicates that the principle result of X-irradiation is the loss of secondary hydroxyl groups. Further localization of the effect must await more information about proton locations in the unit cell.

Single crystals of the isomers of valine, leucine and  $\alpha$ -hydroxyisobutyric acid have been obtained, and the effects of ionizing radiation studied by ESR. Work in this area is continuing, including the effect of isotopic labeling and temperature on the spectra.

Weinreb, A. AT(30-1)2949  
D1A407 A STUDY OF LIQUIDS UNDER OPTICAL AND IONIZING EXCITATION WITH EMPHASIS ON EXCITATION IN THE VACUUM ULTRAVIOLET.  
Hebrew Univ., Jerusalem. SP 4.

Start of Contract-March 1st, 1962.

Purpose-Augmented understanding of radiation effects in organic materials.

Scope-Experimental: Investigation of absorption, fluorescence and energy transfer properties of liquids and vapors (when necessary, also solids and plastics) as a function of incident photon energy, starting from optical wavelengths through the vacuum ultraviolet up to X-ray.

Evaluation: 1. Absorption data: Energy levels, transition probabilities, predissociation, ionization.



Possible application of the results: prediction of particle excitation probabilities and comparison with particle excitation data where available.

2. Fluorescence data: Probabilities for internal nonradiative transitions. The influence of solvent, quenchers, etc. on the quantum yield at high level excitation.

3. Energy transfer data: Probabilities for interactions from higher excited states. Protection effects. Elucidation of nature of transfer processes (e.g. quantum mechanical resonance vs. electron release) in materials which can be excited by vacuum u.v. only.

Wang, Shih Yi AT(30-1)-2798  
D1A414 CHEMICAL STUDIES ON THE EFFECT OF ULTRAVIOLET IRRADIATION OF NUCLEIC ACIDS AND RELATED COMPOUNDS.  
Johns Hopkins Univ., Baltimore. School of Hygiene and Public Health.

Photoreactivation is a phenomenon related to the ultraviolet effect on microorganisms in which the ultraviolet damage can be partially repaired by subsequent irradiation with light of longer wavelengths. Since the discovery of the reversible formation of thymine-dimer from its monomer, current interest has been focused on the identification of thymine-dimer as responsible for photoreactivation.

In order to assure this point, we have prepared thymine-dimer, thymidine-dimer, thymidylic acid-dimer and TpT (thymidylyl-(5'-3')-thymidine-dimer). If these dimers are the cause of or similar to the UV lesion repaired by the photoreactivating enzyme (PRE) in irradiated DNA, they should compete with the irradiated DNA when added to a reaction mixture of the PRE and UV irradiated DNA. However, they exhibit no competitive inhibition. These findings suggest that some supporting structure is required if thymine-dimer is responsible for the UV lesions. In addition, UV irradiated poly GC (contains no thymine moiety) exhibits competitive inhibition while poly T and apurinic acid (both contain thymine) do not. Clearly, these observations suggest that thymine-dimer may not be related to photoreactivation.

Currently we are studying the photochemistry of dinucleotides and oligonucleotides, and also we are attempting a partial hydrolysis of UV irradiated DNA in the hope that a substrate for the PRE can be obtained both by synthesis and by isolation.

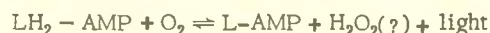
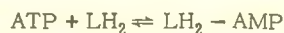
Santamaria, Leonida AT(30-1)2734  
D1A430 ENERGETICS TRANSFER IN THE PHOTODYNAMIC REACTION.

Milan. Università. Istituto di Patologia Generale. SP 5.

The study of the photodynamic action is presented with a research program involving both theoretical and experimental approaches. The photodynamic phenomenon is explained as an energy transfer of importance in biology and medicine as well as of interest in physical chemistry. The findings obtained in a study carried out with the help of ESR and theoretical considerations permit to propose a scheme where the sensitizer is excited to triplet state, which combines with oxygen to form an "oxyradical"; the latter reacts then with the substrate producing an oxidation product (SANTAMARIA L., Bull. Soc. Chim. Belg. (1962), 71, 889-905). The importance of photodynamic action in biology is showed by the photosensitizing activity of several enzymes, vitamins, drugs and carcinogenic agents (SANTAMARIA L., Recent Contributions to Cancer Research in Italy, 1960, 1, 167-288). The study of the reaction to light of retinas showed that this behaves in photodynamic fashions (PIERPAOLI W. and SANTAMARIA L., Atti Soc. Ital. Patol. 1961, 7, 867-874); the energetics transfer of this phenomenon is studied in relation to glycolysis and respiration as energy sources for amino acid incorporation. The problem of quantum yield measurements in simple photodynamic systems is examined and its solution is in progress.

McElroy, W. D. AT(30-1)2514  
D1A431 STUDIES ON BIOLUMINESCENCE AND ENERGY TRANSFER MECHANISMS.  
Johns Hopkins Univ., Baltimore.

New chemical evidence has been obtained which indicates the structure of luciferin and shows that the carboxyl group on the thiazoline ring is the site of action for ATP to form the luciferyl adenylic acid derivative. It is significant that one of the most potent competitive inhibitors of the light reaction is 2-phenol benzothiazole. Attempts have been made to inactivate the first activation step without affecting the second step of the following two reactions catalyzed by luciferase:



The binding of  $\text{LH}_2$ -AMP to a specific part of the polypeptide chain may be the essential step for oxygen activation and consequently may not depend on the secondary and tertiary structure of the enzyme as might be the case for the ATP activation step.

The idea that the primary action of the enzyme in the light emitting step was to complex the  $\text{LH}_2$ -AMP

so that oxidation could occur led to the notion that luminescence might be observed in a hydrogen bonding organic solvent. A non-enzymatic chemiluminescence of  $\text{LH}_2$ -AMP as well as that of the phosphate and methyl ester in dimethyl sulfoxide was observed although the quantum yield was low.

Hoffman, Joseph G. AT(30-1)2462  
D1A433 MONTE CARLO COMPUTATIONS OF  
TISSUE CELL GROWTH.

New York, State Univ., Buffalo.

Conditions of stability of volume distribution of cells as determined by growth curve for the individual cell will be made in cell populations which are subject to turnover. The effect of the time parameters of the life cycle of the cell on the resultant cell volume distribution is to be determined. In stationary populations the effect of variable generation time on the rate of turnover of cells will be examined in terms of mitotic index, average cell volume, and age structure of the population. The problem of an unstable volume distribution being made effectively stable by cell turnover will be examined when cell removal is age dependent.

Augenstein, Leroy AT(11-1)1155  
D1A448 PHYSICAL MECHANISMS IN THE INACTIVATION OF PROTEINS BY RADIATION.  
Michigan State Univ., East Lansing. COO. SP 2; MYR 2.

The immediate goal of this program is to understand the molecular processes in proteins which are initiated by radiation and result in inactivation. Such an understanding will aid in the ultimate elucidation of radiation effects at the cellular level and will enhance the use of radiation as a specific tool in the study of macromolecular conformations. This objective will be pursued by carrying out biochemical and solid-state studies on enzymes irradiated in solutions and in dry preparations. Much of the work will involve a comparison of the effects of UV and ionizing radiation on such systems. The basis for this work is the hypothesis that inactivation occurs when a sufficient amount of the absorbed energy becomes localized in a cluster of disulfide and hydrogen bonds which are crucial to the maintenance of the unique topography of the active site. Using 2537-Å light the involvement of cystine and hydrogen bonds in the inactivation procedure has been shown. However, such a wavelength was chosen as the most favorable to show this effect. Thus, it is now important to compare these results with the effects observed at other wavelengths and with ionizing radiation. The basic hypothesis above would predict that molecular rearrangements which are initi-

ated by ionizing radiation essentially at random within the molecule become localized at only a restricted number of sites. Evidence consistent with this notion has been provided by studies of thermoluminescence from proteins and amino acids. The past and present studies on powdered samples irradiated at liquid-nitrogen temperatures will be continued and extended to solutions and solids at a variety of temperatures.

Whipple, G. Hoyt AT(11-1)1205  
D1A451 EFFECTS OF MONOENERGETIC SOFT  
X-RAYS.

Michigan Univ., Ann Arbor. COO. SP 10; MYR 4.0.

The effects of monoenergetic soft X-rays in producing damage in biological systems are being investigated as a function of the X-ray energy, dose-rate, total dose, and sample thickness.

Previous studies using  $10^{-7}\text{M}$  catalase suggest that, per unit energy absorbed, the damage to catalase increases markedly at an X-ray energy of 7 keV, the iron X-ray K-absorption edge.

The luciferase of luminous bacteria is also being subjected to monoenergetic X-rays. *In vitro* studies show that luciferase is stable to radiation doses capable of producing marked depression of *in vivo* luminescence.

Mouse fibroblasts mammalian cells were irradiated as monolayer cells *in vitro* with monoenergetic X-rays. The survival curves (dose/photon absorbed vs. survival) show a minimum effect of X-rays at 5.9 keV and maximum at 7.5 keV over the range 5.4 to 8.6 keV. The ratio of X-ray effectiveness was found to be about 4 to 1 for the 7.5 keV-5.9 keV comparison.

A total absorption thermal calorimeter was constructed and is being used to determine directly the X-ray flux and serve as a standard in the determination of ferrous-sulfate G values as a function of X-ray energy.

Williams, Donald B. AT(30-1)3102  
D1A461 CYTOLOGICAL AND ULTRAVIOLET  
RADIATION STUDIES ON THE CILIATE SPATHIDIUM  
SPATHULA.

Vassar Coll., Poughkeepsie, N. Y. NYOO.

The purpose of this research project is to study various responses of the predaceous ciliate Spathidium spathula to ultraviolet light (2537 Å) and compare these results to responses known to occur after X radiation.

The experimental design calls for irradiating synchronized log phase cells at 15 minute intervals during the first hour following cytokinesis and at 30 minute

intervals during the remaining four (approximately) hours before the next cell division—any sensitive periods could thus be detected. In addition, the timing of macronuclear DNA synthesis during the generation cycle will be studied using autoradiographic techniques. Any relationship between DNA synthesis and UV sensitivity would then be detected.

The effects of inanition upon UV sensitivity will also be studied by comparing well-fed, starved, and starved animals fed immediately before irradiation. The purpose is to see if starved predators are more sensitive to UV than well-fed forms and if feeding shortly before irradiation confers any resistance, either due to physical screening by food vacuoles or by incorporation of nutrients derived from ingested prey ciliates.

Some additional observations to be performed include, (1) length of generation time and number of daily divisions, (2) behavior of irradiated cells as revealed by phase and bright light microscopy, particularly ciliary behavior, feeding inhibition, vesiculation and cytolysis, (3) effect of dose (ergs/mm<sup>2</sup>) on death rate, (4) recovery after irradiation—either in terms of number of generations or time, (5) morphological abnormalities, particularly giantism, macronuclear fragmentation and hypertrophy, and micronuclear changes.

Branson, Herman AT(30-1) 892  
D1A497 KINETIC AND MASS SPECTROMETRIC STUDIES OF BIOPHYSICAL SYSTEMS WITH RADIOACTIVE AND STABLE ISOTOPES.  
Howard Univ., Washington, D. C. November 1961–October 1962.

1. Study of P<sup>32</sup> in red blood cell of duck. Results treated mathematically following scheme  $A \rightleftharpoons B \rightleftharpoons C$  with time dependent transfer coefficients.

2. Conclude initial work on morphology of red blood cell of sickle and normal individuals. Anne Coble's thesis will contain the results.

3. Continue work on 60° mass spectrometer studying electron impact on CH<sub>3</sub>NH<sub>2</sub> (P. Mehta). The theory is being studied by Charlie Harper. It will be part of his Ph.D. dissertation.

4. Jonas and Lederberg are working on C<sup>13</sup> and C<sup>14</sup> analyses. Will apply to serine<sup>14</sup>  $\rightleftharpoons$  glycine<sup>13</sup> in rat liver homogenates.

5. Mathematical studies of transport continue using the analog computer: a.  $\rightleftharpoons$ serine  $\rightleftharpoons$  glycine  $\rightleftharpoons$  system is being treated as a 12 component interacting system. b. Serine-glycine in terms of 2 and 3 carbon precursors as a four component system. c. Reversible denaturation of proteins as a 4 component system.

Kasha, Michael AT(40-1)-2696  
D1A516 RESEARCH PROGRAM IN MOLECULAR BIOPHYSICS.  
Florida State Univ., Tallahassee.

Seliger, H. H. AT(30-1)-2802  
D1A520 A STUDY OF BIOLUMINESCENT MATERIALS.  
Johns Hopkins Univ., Baltimore. McCollum-Pratt Inst.

Ginoza, William AT(30-1)-3116  
D1A521 RADIATION STUDIES ON TRANSFORMING DNA, ON TNV-RNA AND  $\phi$  X174-DNA.  
Pennsylvania State Univ., University Park.

Pollard, E. C. AT(30-1)-2804  
D1A522 BASIC ASPECTS OF THE ACTION OF IONIZING RADIATION ON MICROORGANISMS.  
Pennsylvania State Univ., University Park.

Weber, G. AT(30-1) 2550  
D1A570 A STUDY OF RESEARCH PROJECT ON FLUORESCENCE-POLARIZATION SPECTROPHOTOMETRY AND THE POLARIZATION SPECTRUM OF PROTEIN FLUORESCENCE.  
Sheffield, England. Univ. April 1962–March 1963.

The purpose of this research project is to measure the principal polarization spectra of fluorescent molecules, particularly of the proteins. These spectra are obtained as plots of the maximum polarization of fluorescence (observed in dilute solutions of high viscosity) against the wavelength of exciting light. In sample molecules, polarization spectra reflect the relative orientations of the transition moments associated with the absorption and emission of light and, therefore, permit identification of electronic bands and their distinction from vibrational detail.

Analysis of the polarization spectra of proteins is less straightforward. The polarization spectrum expected on the basis of the content of aromatic amino acids is modified in a manner characteristic of the particular protein. This specificity is believed to arise from energy transfer among the aromatic residues and from the interaction of the indole nucleus of tryptophan with the polansible backbone of the molecule.

This research project will provide further information about the effect of environment on electronic transitions and the influence of secondary structure of proteins on their polarization spectra. To fulfil this purpose, it is proposed to build a spectrophotometer which will automatically record polarization spectra. Design studies for such a spectrophotometer have already been made.

Friedberg, Felix AT(30-1) 2735  
D1A584 CHEMICAL EFFECTS OF IONIZING RADIATIONS ON THE INDIVIDUAL AMINO ACIDS WITHIN INTACT AND PURE PROTEIN MOLECULES.  
Howard Univ., Washington, D. C. Coll. of Medicine.  
March 1962-February 1963.

(1) Exposure of one gram of the enzyme creatine transphosphorylase to about two curies of tritium gas for two weeks.

(2) A few ml of 0.56 enzyme solution to be irradiated with approximately  $0.2$  to  $4 \times 10^{80}$  ev/ml of x-rays or  $5$  to  $6 \times 10^{10}$  eV/ml of gamma rays. After the exposure, the protein will be hydrolyzed in 6N HCl and the amino acids which remained intact will be quantitated by column ion exchange chromatography (Moore and Stein). The amounts of amino acids in the irradiated protein will be compared to those normally present in the unexposed material. An attempt shall also be made to isolate and identify the decomposition products.

Fuller, R. C. AT(30-1) 2801  
D1A598 STRUCTURE AND ACTIVITY OF THE PHOTOCHEMICAL APPARATUS IN PHOTOSYNTHETIC BACTERIA.  
Dartmouth Coll., Hanover, N. H. Dartmouth Medical School. May 1962-March 1963.

Recently, we have discussed what we consider to be a naturally occurring "subunit," in another organism the green sulfur bacterium Chlorobium. This intriguing organism apparently contains no formed structural elements of the molecular dimensions found in other photosynthetic cells. On the contrary, electron micrographs of thin sections show a granulated cytoplasm very similar to that observed in such organisms as E. coli. We have been able to disrupt the cell and isolate and define particles from the cytoplasm of the organism that contains all the chlorophyll and carotenoids of the cell. The exciting outlook of this is that rather preliminary studies of sedimentation rates and other physical-chemical properties of these particles indicate they have a molecular weight of not more than one million. We are now at hard work trying to determine the photochemical activities of the particles. One of the major approaches that will be undertaken immediately at Hanover and which we would hope would be supported by a grant from the Atomic Energy Commission, would be the direct approach of looking into the formation of ATP from light by these particles. Then would follow the break down and further chemical definition of the particles with the hope that we would indeed find a minimal unit capable of converting light to chemical energy. Just the small

size of these naturally occurring particles, which are smaller by orders of magnitude than say the electron transport particles from mitochondria, we feel would offer a real clue as to the nature of the necessary elements in an electron transport system capable of producing ATP.

Again of prime interest during the first year will be the establishment of ATP formation by photophosphorylation with these define photochemical particles from Chlorobium and the chemical definitives of the electron transport constituents essential for this process.

Rich, Marvin A. AT(30-1)3120  
D1A603 STUDIES ON THE MECHANISM OF RADIOSENSITIZATION OF MAMMALIAN CELLS BY EXPOSURE TO HALOGENATED PYRIMIDINES.  
Albert Einstein Medical Center, Philadelphia.

The halogen substituted pyrimidines 5-chloro, 5-iodo and 5-bromouracil may be considered structural analogs of thymine for which the Van der Waals radii of the halogen atoms are approximately equal to the radius of the methyl group. Exposure of bacterial and mammalian cells to the compounds results in enhanced radiosensitivity of UV and ionizing radiation.

Exposure of H.E.P. No. 1 cells, a line originally derived from a human cervical carcinoma, to 5-bromodeoxyuridine (BrUDR) in culture results in partial replacement of DNA thymine by 5-bromouracil. The ability of these cells to form colonies following exposure to 200 KVP X-rays has been determined. Cells exposed to BrUDR show a 1.5 to 2.0 fold increase in radiosensitivity as compared to cells not exposed to this compound. Incorporation studies with tritiated BrUDR and base analysis of the DNA indicate a one-percent incorporation of 5-bromouracil under these conditions.

While exposure of mammalian cells to BrUDR is accompanied by incorporation of 5-bromouracil into the DNA and increased radiosensitivity to X-rays, the causal relationship between the two has not yet been unequivocally established. Preliminary experiments in which exposure to BrUDR without incorporation of 5-bromouracil could be accomplished, were carried out. These suggested that under conditions where the incorporation of the fraudulent base could be prevented, exposure to BrUDR still resulted in enhanced radiosensitivity to X-rays. The proposed studies will attempt to substantiate and extend these observations so as to elucidate the role of incorporation per se in the radiosensitization of mammalian cells by these compounds.

## D1B Intermediary Metabolism

See also A1A300, B1B254, B1B271, D1A263, D1A265, D1C142, D1D19, D1D314, D1D357, D1D442, K1B224, K1B230, K1B420, and L-366.

Saltman, Paul AT(11-1)113-14  
D1B57 STUDIES ON A PHOTOSYNTHETIC  
"DARK C-14O<sub>2</sub> FIXATION BY LEAF HOMOGE-  
NATES."  
University of Southern California, Los Angeles.  
SAN. SP 2; MYr 2.

We have developed a cell-free preparation of spinach leaves which is able to incorporate C<sup>14</sup>O<sub>2</sub> by metabolic pathways identical to those observed in intact leaves. The response to light and dark is such that one observes no incorporation of C<sup>14</sup>O<sub>2</sub> into carbohydrates of phosphorylated derivatives in the dark. We are attempting to determine what is the nature of the material produced in the light which could be added to such a cell-free preparation in the dark to mimic the light fixation. One such compound is ribulose diphosphate (RuDP). We are now investigating the mechanism by which light either activates this enzyme, involved in RuDP synthesis, or provides energy in the form of ATP or some other energy-rich phosphate compound at a site within the chloroplast where the enzyme is localized. To this end, we are investigating the transport of ATP by the illuminated and dark chloroplast. We are also studying the kinetics of Pi<sup>32</sup> incorporation by isolated chloroplast in the light and dark.

In parallel experiments, we are studying the pathways of C<sup>14</sup>-acetate incorporation by a mutant of *Chlamydomonas*, unable to photosynthetically incorporate C<sup>14</sup>O<sub>2</sub> by the pathways normally seen in the algae. Its acetate metabolism in the light is directed primarily towards lipids. We are investigating the metabolic pathways involved as well as the conversion of light energy into reducing power and ATP.

Barker, H. A. AT(11-1)34-66  
D1B141 SYNTHESIS AND DEGRADATION OF  
ORGANIC COMPOUNDS BY MICROORGANISMS.  
California. Univ., Berkeley. SAN.

We plan to investigate several enzymatic reactions catalyzed by extracts of *Clostridium tetanomorphum*. The enzyme catalyzing the conversion of glutamate to β-methylaspartate will be further purified in order to eliminate certain interfering activities. The kinetics, specificity and equilibrium of the reaction will be studied and the role of the B<sub>12</sub> coenzyme will be investigated. An attempt will be

made to develop a convenient and precise assay for glutamate racemase and the enzyme will be purified and its properties studied. The kinetics, specificity and cofactor requirements of the enzyme converting mesaconate to citramalate will be determined. The nature of the enzymatic reaction causing an incorporation of various hetero cyclic bases into coenzyme B<sub>12</sub> will be investigated.

Schuetz, R. D. AT(11-1)1034  
D1B188 AN INVESTIGATION OF THE BIOSYN-  
THESIS OF ORGANO SULFUR COMPOUNDS IN  
PLANTS.

Michigan State Univ., East Lansing. SP 3; MYr 1<sup>1</sup>/<sub>4</sub>.

Sulfur-35 has been shown to be incorporated into the α-terthienyl during the biosynthesis of the latter compound in marigold plants by feeding experiments with sodium sulfate-S-35. Sulfur-35 was found not to be incorporated into the Marigold biosynthesis α-terthienyl when the sulfur-35 was part of L-Methionine-S-35 by feeding experiments with the latter material. Further, it was demonstrated that carbon-14 was not incorporated into Marigold biosynthesis α-terthienyl when carbon-14 was part of the structure of DL-methionine-1-C-14. These experimental results indicate the following conclusions. First, the biosynthesis, in the Marigold plant, of inorganic sulfur, initially as sulfate ion, going to α-terthienyl does not involve the sulfur containing-four carbon amino acids. Secondly, the carbon skeleton of methionine and homocystine as such is not incorporated into the Marigold biosynthetic α-terthienyl.

Proposed work, to be initiated soon, will involve experiments feeding inorganic sulfur as the hydro-sulfite to Marigold plants. Other work will involve feeding sodium acetate-1-C-14 to the plants based on proposals that polyacetylenes are precursors in the biosynthesis of thiophene derivatives, since sodium acetate has been shown to be a precursor to the natural occurring polyacetylenes. Similar feeding experiments will be conducted with carbon-14 labeled acetylene derivative of thiophene, such as 5-(3-buten-1-ynyl)-2-2'-bithienyl since organic sulfur compounds of this nature have been isolated from the Marigold.

Pentz, E. Irene AT(11-1)789  
D1B202 THE EFFECT OF X-IRRADIATION ON  
CERTAIN ASPECTS OF SALT AND SULFUR  
METABOLISM IN ADRENALECTOMIZED RATS.  
Northwestern Univ., Chicago. Medical School. COO.  
June 1962-May 1963.

Adrenalectomized rats, maintained on salt and on various cortical hormones, will be trained to fast for six hours daily, so that urine may be collected. Just

prior to an exposure to 400 r of x-irradiation the animals will be injected with Na<sup>22</sup> and Rb<sup>86</sup>. Urine will be collected daily for a suitable period and examined for total sodium, potassium, Na<sup>22</sup>, Rb<sup>86</sup>, and taurine.

It is anticipated that these experiments will yield information as to the movements of intercellular and extracellular ions as well as body water in response to x-irradiation. Further, since the literature suggests that there is some relationship between adrenal cortical steroid metabolism and sulfur metabolism, it is hoped that some elucidation of this relationship may become apparent.

Wood, Harland S. AT(11-1)1320  
DIB229 A STUDY OF THE INTERMEDIARY  
METABOLISM OF CARBOHYDRATES WITH ISO-  
TOPICALLY LABELED COMPOUNDS.  
Western Reserve Univ., Cleveland. COO. SP 7;  
MYr 4.15.

Two investigations are planned.

1. Estimation of pathways of carbohydrate metabolism. It has been shown by Rose and co-workers, when a specific hydrogen of dihydroxyacetone is replaced by deuterium, the aldolase reaction is inhibited approximately 50%. Glycerol-1 (A)-D, 3-C<sup>14</sup> will be synthesized enzymatically. This specifically labeled glycerol will be fed to animals. The glycogen will be isolated and from the distribution of C<sup>14</sup> it should be possible to determine whether aldolase is a rate-limiting reaction in glycogen synthesis.

2. Phosphoenolpyruvic carboxytransphosphorylase and CO<sub>2</sub> fixation. This enzyme catalyzes the following reaction: CO<sub>2</sub> + P-enolpyruvate + P<sub>i</sub> ⇌ oxaloacetate + P-P<sub>i</sub>. Thus far the enzyme has not been extensively purified. Further purification will be undertaken, the equilibrium of the reaction determined, and the mechanism of the reaction will be studied using H<sub>2</sub>CO<sub>3</sub><sup>18</sup> and H<sub>3</sub>PO<sub>4</sub><sup>18</sup>.

Johnston, P. M. AT(40-1)1775  
DIB252 THE UTILIZATION OF RADIOISOTOPES  
BY VERTEBRATE EMBRYOS.  
Arkansas. Univ., Fayetteville. OROO. SP 1; MYr 1/8.

This project is concerned with the metabolism of sulfur as sulfate in the chick embryo using sulfur 35 as a tracer.

Radioactive inorganic sulfate will be injected into fertile eggs to study the formation of cystine and methionine from sulfate. The day-to-day changes in distribution of the label will be followed using radiochromatography and chemical analyses for cystine and methionine.

Preliminary work has shown that there is a considerable interconversion of cystine with methionine and that the 15th day of incubation is a critical period. It is postulated that the liver and the yolk sac are the sites of transsulfuration and *in vitro* studies involving the yolk sac, embryonic liver slices, embryo homogenate, yolk, and liver homogenate will be done.

Fritz, George J. AT(40-1)2834  
DIB259 METABOLISM OF MOLECULAR OXYGEN  
BY PLANTS.

Florida. Agricultural Experiment Station, Gainesville. OROO. SP 3; MYr 2 1/4.

The incorporation of molecular oxygen into plant tissue and its direct addition to organic substrates is being studied; isotopic oxygen-18 tracer technique is utilized and O-18 is determined by mass spectrometry. Metabolic reactions of the type under investigation are catalyzed by enzymes called oxygenases and hydroxylases; oxygenases catalyze the addition of two atoms of oxygen gas to one molecule of substrate and hydroxylases catalyze the incorporation of one atom of oxygen gas into substrates. The research program includes investigation in such areas as (1) the ability of plant seedlings such as soybean, pea, castor bean, corn and wheat to fix molecular oxygen directly into organic substrate(s), including the variability of such ability with seedlings age, (2) the effect of various environmental factors (temperature, oxygen tension) upon the ability of plants to fix oxygen gas, and (3) the identification of the product(s) of molecular oxygen fixation. In this last category, more specifically, current work involves the isolation of hydroxyproline from tissue slices, which produce hydroxyproline from proline in the presence of labelled oxygen gas; studies are being conducted to show that hydroxyproline is labelled with O-18. Also, other work has the purpose of showing that lipid peroxides produced by maize seedlings in the presence of labelled oxygen gas are labeled with O-18; in this case, attempts are being made to increase lipid peroxide content of seedlings by irradiation of plant material with X-rays and gamma rays.

Cerecedo, Leopold R. AT(40-1)2914  
DIB273 A STUDY OF THE PHYSIOLOGY OF  
THIAMINE AND THIAMINE ANALOGUES.  
Puerto Rico. Univ., San Juan. School of Medicine.  
OROO. Feb. 1, 1963-Jan. 31, 1963. SP 2; MYr 1.6.

1. Experiments *in vivo*: (a) Using techniques that are well standardized, the fate of sulfur-35-labeled oxythiamine, thiamine disulfide, thiamine diphosphate, and if available, 2-n-butyl-thiamine, will be studied in the rabbit and in the rat. Doses in the physiological

range will be administered orally and parenterally, and the urinary sulfur will be partitioned into inorganic sulfate, ethereal sulfate, and neutral sulfate. Excretion of these fractions will be determined. (b) Anti-thiamine effect of 2-n-butylthiamine will be studied, utilizing mice with an appropriate thiamine-free diet. ,

2. Experiments in vitro: The influence of n-butylthiamine on certain enzymic reactions will be studied in detail, using procedures developed and employed in earlier studies, to include: (a) The effect of the antagonist on the highly-purified carboxylase preparation isolated from wheat germ according to the method of Singer and Pensky (J. Biol. Chem. 196: 375, 1952). (b) The effect of the analogue on the phosphorylation of thiamine in presence of a purified thiamine ATP-phosphokinase, prepared according to the method of Leuthardt and Nielsen. (Helv. Chim. Acta 35: 1196, 1952).

Wood, Norris P. AT(40-1)2578  
D1B275 THE FORMATE-PYRUVATE EXCHANGE REACTION IN STREPTOCOCCUS FAECALIS. Texas. Agricultural and Mechanical Coll., College Station. OROO. SP 1; MYr 2½.

This project is a continuation of a study of factor requirements for the exchange of the carboxyl carbon of pyruvate with the isotopic carbon ( $C^{14}$ ) of formate by Streptococcus faecalis. The system has defied resolution because of the extreme liability of the enzymes involved. A knowledge of factor requirements should aid in the understanding of the mechanisms underlying this reaction and in understanding the pyruvate thioclastic and and formate hydrogenlyase reactions. The latter was reported to be closely associated with nitrogen fixation in certain bacteria.

Preliminary investigations have shown that yeast extract is required for formate incorporation by intact cells but not by cell extracts. The only exogenous factor required for extracts is a low oxidation-reduction environment. A group of amino acids and peptides will replace the yeast extract requirement for whole cells.

One line of investigation is now centered on the influence of amino acids and peptides on pyruvate transport and pyruvate utilization. A second line of investigation is directed towards the resolution of the enzymes of the formate-pyruvate exchange system and eventually toward the determination of the mechanisms underlying the reaction. The kinetics of the pyruvate transport system will be studied. Energy requirements, inhibition data, transport specificity, and saturation data will be obtained.

Wiggans, Donald S. AT(40-1)1988  
D1B281 THE METABOLISM OF SERUM PROTEINS. Texas. Univ., Dallas. Southwestern Medical School. OROO. SP 2; MYr 2.

The blood proteins of the lobster will be examined to determine the importance of the role of one protein to serve as a specific carrier for free amino acid molecules in the circulating hemolymph. Results to date strongly suggest the absolute stereospecificity of this mechanism. A degree of competition for active sites between different amino acids is evident. Studies will be extended to examine possible similar mechanisms of amino acid handling in other species. Nutritional relationships based on possible variations in the carrier transport of amino acids will be examined.

Darby, William J. AT(40-1)1033  
D1B282 A STUDY OF THE METABOLISM OF LIPIDS AND RELATED METABOLITES AND OF THE ALTERATIONS WHICH MAY OCCUR IN ACUTE RADIATION INJURY. Vanderbilt Univ., Nashville. School of Medicine. OROO. November 1961–October 1962. MYr 1.8.

Effects of total-body x-irradiation on fatty acid composition of gonads are being studied in rats irradiated when weanlings and in rats born of mothers irradiated during pregnancy. Investigations are also underway of possible changes in fatty acid composition of brain tissue of adult and young rats given doses of total-body x-irradiation large enough to cause nervous system collapse.

Unsaturated fatty acid metabolism is being studied in rats placed on a fat-deficient diet and supplemented with a specific polyunsaturated fatty acid. In addition to making determinations of the fatty acid composition of tissues of these animals, the metabolic fates of administered  $C^{14}$ -oleic acid are being studied.

Artom, Camillo AT(40-1)2794  
D1B283 AGING EFFECT OF IONIZING RADIATIONS AND ITS RELATIONSHIPS TO ATHEROSCLEROSIS AND LIPID METABOLISM. Wake Forest Coll., Winston-Salem, N. C. Bowman Gray School of Medicine. OROO. SP 2; MYr 1½.

Severe atheromatous lesions, quite similar to those found in humans, occur with a high frequency and at a relatively early age in certain breeds of pigeons (e.g., White Carneaus), whereas in other strains (e.g., Show Racers) only small lesions are found occasionally at a more advanced age. In both strains the frequency and severity of the disease is

enhanced by dietary cholesterol. Because of these observations, it was thought that pigeons might offer a good opportunity of studying the relationships between radiation, aging and atherosclerosis.

In previous experiments, pigeons of both atherosclerosis-susceptible and atherosclerosis-resistant breeds, fed either cholesterol-free or cholesterol-enriched diets, were subjected to repeated X-ray irradiations up to cumulative doses between 250 and 3000 r. No acceleration of the development of the lesions in White Carneaux, and no increased incidence in Show Racers were detected. These experiments will be continued to test the possibility that delayed effects of radiation may become apparent in longer periods. Moreover, since pigeons proved to be surprisingly resistant to radiation, new series of experiments will be carried out with X-ray doses higher than those used previously. The possibility of long-range effects on the biosynthesis of lecithin and cholesterol in the isolated tissues of the irradiated animals will also be investigated.

Foster, J. M. AT(30-1)1845  
D1B290 ENZYMOLOGY OF THE FORMED ELEMENTS OF HUMAN BLOOD.  
Boston Univ. School of Medicine. NYO. SP 4; MYr 2.

Additional information on the mechanism of orthophosphate uptake by human erythrocytes is being sought by determining individually the specific activities of the phosphates on 2,3-diphosphoglyceric acid (DPG) (which are derived by different pathways) formed by incubation of erythrocytes with  $P^{32}$ . DPG is isolated by Dowex chromatography, the 2-phosphate hydrolyzed with hot acetic acid, and rechromatographed. So far the two phosphates have been equally labeled in all preparations studied. This may be due to randomization via phosphoglyceromutase. The exchange is being measured in separate experiments with purified enzyme. Present studies are with cells depleted of DPG by preincubation, then incubated for very short times with tracer doses of high specific activity  $P^{32}$ .

Oxidative phosphorylation by normal human leukocytes, freed of erythrocytes by phytohemagglutinin sedimentation and brief osmotic lysis, is being investigated. An oxygen microelectrode in a specially designed cell measures respiration;  $P_1$  uptake is determined by radiophosphate uptake of microenzymatic ATP assay. Some  $P^{32}$  uptake with the properties of respiration-linked phosphorylation is demonstrable, but with very low P/O ratios. Some progress is being made at reducing the high endogenous activity by prior dialysis or by using particles

from cells ruptured with a French press. The goal is to explore control mechanisms in leukocytes, which are easily susceptible to "injury," producing a "tumor" type of metabolic pattern.

Rittenberg, David AT(30-1)1803  
D1B297 THE ACTIVATION OF HYDROGEN BY BACTERIA CATALYSTS.  
Columbia Univ., New York. NYOO.

A. We are investigating conditions which will activate the enzyme hydrogenase in extracts of Desulfovibrio desulfuricans without the use of dithionite. The reason for this is that when dithionite is used for activation the enzyme system can be inhibited by CO, but cannot be reactivated by light. In comparison with the hydrogenase system of Proteus vulgaris we suspect dithionite of inhibiting the photochemical reactivation.

We are studying the action spectrum of CO inhibited hydrogenase of Proteus vulgaris.

B. We have begun a program for the determination of the abundance of deuterium in naturally occurring organic compounds. Our results thus far show that fatty acids and cholesterol have concentrations of deuterium less than that of New York City tap water (-22 and -34 parts per million respectively. New York City tap water has a concentration of deuterium of 152 parts per million) Glucose has more deuterium than tap water (+5.5 parts per million), but on fermentation by yeast yields alcohol having a concentration of -20 parts per million. The source of this fractionation is under study.

Schwarz, Henry P. AT(30-1)1864  
D1B307 THE EFFECT OF X-RAY IRRADIATION ON THE LIPIDS OF THE SKIN.  
Philadelphia General Hospital. NYOO.

The effect of whole body x-ray irradiation on the lipids of different tissues such as skin or liver mitochondria has been examined with chemical, chromatographic, and spectroscopic procedures capable to characterize and quantitate such little known lipids as cardiolipins, phosphatidyl glycerol, and others. It was thus found that the irradiation increased the total lipid phosphorus of the liver mitochondria and that thereby phosphatidyl glycerol increased out of proportion of other phosphatides.

Current studies deal with the relation of these lipids to the enzyme lipoproteins and their change upon whole body x-ray irradiation. The mitochondrial lipoproteins are solubilized and fractionated to separate into distinct fractions cytochromes and/or any other fraction rich in those phosphatides which previously were found to be elevated after x-rays.



The reaction of such lipids to the associated enzymes is studied. P32 incorporation into phospholipids of intact liver mitochondria is examined to obtain further information about the turnover rates of the individual phosphatides particularly those found to be affected by the irradiation. Studies will be carried out to determine the metabolic precursors and possibly metabolic pathways of some of the little known phosphatides changing after whole body irradiation.

Pincus, G. AT(30-1)918  
D1B315 STEROID METABOLISM.

Worcester Foundation for Experimental Biology,  
Shrewsbury, Mass. NYOO. SP 7; MYr 4.

Steroids, important for biosynthetic and analytical studies, will be labeled with C<sup>14</sup> and H<sup>3</sup>. In this category are the following projected compounds: testosterone-19-C<sup>14</sup>, 17 $\alpha$ -hydroxycholesterol-7 $\alpha$ -H<sup>3</sup>, 17 $\alpha$ -hydroxycholesterol-22-C<sup>14</sup>, 17 $\alpha$ ,20 $\alpha$ -dihydroxycholesterol-7 $\alpha$ -H<sup>3</sup>, 17 $\alpha$ ,20 $\alpha$ -dihydroxycholesterol-22-C<sup>14</sup>, desmosterol-7 $\alpha$ -H<sup>3</sup> and desmosterol-22-C<sup>14</sup>. In the area of steroid biosynthesis, the following projects continuing: the possible formation of dehydroepiandrosterone from cholesterol without a C<sub>21</sub> intermediate, regulators of the biosynthesis of estrogens, particularly the desmolase step, the action of trophic hormones on cell free systems, particularly affecting the biosynthetic steps from cholesterol to pregnenolone. Studies will be continued on secretion rates in humans of representative, important steroid hormones.

In other studies, we are emphasizing studies on the control of adrenocortical biosynthesis which are expected to have important bearing on adrenal changes due to irradiation.

Kinoshita, Jin H. AT(30-1)1368  
D1B321 CARBOHYDRATE METABOLISM OF  
OCULAR TISSUES.

Harvard Univ., Boston, Massachusetts Eye and Ear  
Infirmary. SP 3 $\frac{1}{2}$ ; MYr 3 $\frac{1}{2}$ .

We have been studying the carbohydrate metabolism of ocular lens with the use of labeled substrates to learn the essential metabolic requirements for the maintenance of the viability of this tissue. The lens relies primarily on glycolysis for biological energy production. Although the citric acid cycle functions, its contribution to the overall energy production appears small. In fact, as long as the lens is adequately supplied with glucose it appears to meet all its energy requirements through the anaerobic mechanism. This is consistent with the observations that in lens the cation transport mechanism and amino acid incor-

poration into lens proteins—energy requiring processes—can be entirely supported by anaerobic glycolysis provided glucose is available.

We are also investigating the changes which occur in the metabolism of the lens when it is subjected to the cataractogenic action of high levels of galactose and to ionizing and non-ionizing radiations.

Po-Chedley, Donald S. AT(30-1)2814  
D1B345 THE EFFECTS OF X-IRRADIATION ON  
THE FREE A-AMINO NITROGEN FRACTION OF  
THE MEAL WORM, TENEBRIO MOLITOR, OVA.  
D'Youville Coll., Buffalo, NYOO.

The work here represents long term studies. The general pattern remains about the same as previously reported.

The resistance of insects to irradiation effects cannot be interpreted solely on the basis of diminished mitotic activity. The influence of biochemical and metabolic mechanisms appears to be worthy of thorough examination.

The present project is directed towards the internal environment of the insect which is rich in free amino acids. Reportedly, as amino acids have some protective potential, the radio-resistance of insects may be interpreted, in part at least, by that biochemical consideration.

The current aspect of the study is concerned with metabolic differences in biochemical properties detectable during various stages of embryological growth of the meal worm. Data obtained for the meal worm embryo indicates that radiation resistance increases with embryological age, that the ova are rich in free amino acids, that ova exposed to sublethal (damaging) doses of x-rays liberate a labile factor (protein) which disappears as the embryo continues its growth and development. These considerations of the internal mechanism operating for the replenishment of the metabolic pool via protein degradation and the interplay of amino acids with the associated recovery-restorative processes are being examined.

Cornatzer, W. E. AT(11-1)479  
D1B362 PHOSPHOLIPID AND SULFATIDE ME-  
TABOLISM.  
North Dakota, Univ., Grand Forks, School of Medi-  
cine, COO.

Mitochondria are composed of 21% phospholipids. A number of the enzymes involved in oxidative phosphorylation have been shown to contain phospholipids. Experiments were undertaken to investigate the effects of oxidative phosphorylation inhibitors on the synthesis of mitochondria phospholipids. Rats will be

injected with Arsenate 14 mg/kg, bilirubin 3.3 mg/kg, oligomycin 0.83 mg/kg, dinitrophenol 30 mg/kg, and saline given to controls. Inorganic P-32 will be administered to trace phospholipid synthesis. Mitochondria will be prepared, lipids extracted, chromatographed on silicic acid impregnated glass paper. Radioactivity and chemical P determined on each fraction. It has previously been shown that heart mitochondria isolated from rats fed a magnesium deficient diet for 4 to 8 days exhibit uncoupling of oxidative phosphorylation and the enzymatic conversion of phosphoryl choline into lecithin requires magnesium. Rats will be fed a Mg-deficient diet for 0, 4, 7, 11 and 18 days. Control animals will receive similar diet supplemented with Mg. Tissues will be removed, mitochondria prepared, and lipids separated by silicic acid chromatography. Radioactivity and chemical P will be determined on each fraction. The thyroid hormone has been shown to stimulate oxidative phosphorylation. The turnover of mitochondria nucleotides ATP, CTP will be investigated following the administration of different doses of thyroxine. The effects of various thyroid states on mitochondria phospholipid synthesis will be investigated. The synthesis and concentration of the mitochondria phospholipids in various tissues following administration of thyroxine and propylthiouracil will be investigated. It has been demonstrated that x-irradiation uncouples oxidative phosphorylation in the brain. The synthesis of sulfatides from inorganic sulfate requires ATP. The effects of whole-body x-irradiation on the synthesis of brain sulfalipids will be investigated.

Beevers, Harry AT(11-1)330  
 D1B363 CARBOHYDRATE CATABOLISM IN  
 PLANTS.  
 Purdue Univ., Lafayette, Ind. COO.

The utilization of ethanol by plant materials will be further investigated. The conversion to fats which occurs in germinating pea cotyledons will be examined using slices for kinetic experiments with ethanol-C<sup>14</sup>. Attempts will be made to reconstruct a cell free system from pea cotyledons which will convert ethanol-C<sup>14</sup> to long chain fatty acids.

Experiments on the specific transport of leucine-C<sup>14</sup> from mature to meristematic cells in root tips will be continued and the bearing of this process on the restricted ability of meristematic cells in excised roots to produce protein will be investigated.

Attempts to define "turnover" and "storage" pools of organic acids in plant tissues will be continued, using acetate-C<sup>14</sup>. The relationship between the specific activities of the respired CO<sub>2</sub> and of the carboxyl

groups of individual acids will be determined on selected tissues. The effects of agents which alter permeability barriers on those relationships are expected to yield valuable information on the intracellular compartmentation of organic acids.

L'Heureux, M. V. AT(11-1)955  
 D1B372 THE EFFECT OF PARATHYROID  
 HORMONE ON CARBOHYDRATE METABOLISM.  
 Loyola Univ., Chicago. COO.

The effect of parathyroid hormone on the utilization of acetate-1-C-14, glucose-1-C-14, succinate-2,3-C-14 and citrate-1,5-C-14 by kidney homogenates has been studied. The amount and specific activity of radioactive carbon dioxide evolved by the homogenates was determined and the activity incorporated into the organic acids of the Krebs cycle have been measured.

The utilization of succinate-2,3-C-14 and glucose-1-C-14 by the kidneys of parathyroid hormone-treated rats was only slightly different from that of the control animals. When the homogenates were incubated with acetate-1-C-14 and citrate-1,5-C-14 those from the parathyroid hormone-treated rats evolved less radioactive carbon dioxide than did the control kidney homogenates.

The radioactive organic acid profiles of the kidney homogenates, after incubation with these substrates revealed that kidneys obtained from parathyroid hormone-treated rats utilized significantly less acetate-1-C-14 and citrate-1,5-C-14 than did the control kidneys. The amount of activity incorporated into the organic acids of the Krebs cycle was more in the experimental kidneys in spite of the decreased utilization of these substrates. The evidence suggests that a direct effect of parathyroid hormone on kidney metabolism is a result of an inhibition of oxidation of substrates of the Krebs cycle in this tissue.

Investigations on the influence of the hormone on the metabolism of citrate-1,5-C-14 are being continued with the use of kidney mitochondria preparations. Time course studies of the radioactive carbon dioxide formation and of the incorporation of the label into organic acids of the Krebs cycle during the incubations are being followed.

Wood, John L. AT(40-1)1637  
 D1B386 THE ORIGIN AND FATE OF THIOCYANATE ION IN METABOLISM.  
 Tennessee. Univ., Memphis. School of Basic Medical Sciences, OROO. SP 2; MYr 1/2.

This project is designed for a study of the origin of thiocyanate in the body, the mechanism of its physiological action, and the nature of its metabolism

products, particularly in relationship to iodide metabolism and the generation of sulfhydryl groups.

The origin of thiocyanate. The nature and function of the transsulfurases have only partly been revealed. Further work along this line is indicated. Our work has shown that the enzyme accepts the sulfur from the substrate and then releases it to an acceptor which may be cyanide, sulfite, cysteinesulfonic acid, or the environment (as free sulfur). Other acceptors may be present in biological systems. In view of the large amount of enzyme present in tissues and the very small amount of substrate other functions of the enzyme may be anticipated but these are unknown.

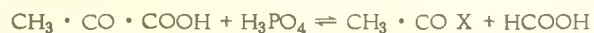
Reactions of cyanide. Cyanide reacts to split disulfides into sulfhydryl groups and 2-iminothiazolidine-4-carboxylic acid derivatives. We have shown the latter to be excreted when cyanide is administered to animals treated with labeled cystine. Most of the cyanide detoxication product is thiocyanate, however. Thiocyanate is released and sulfhydryl groups generated when cyanide is reacted with proteins. This finding has implications in the study of effects of sulfhydryl groups in systems exposed to ionizing radiation. The kinetics of the reaction of cyanide with proteins and other disulfide-containing compounds will be studied further to establish the rate at which sulfhydryl groups are generated in biological systems. Also the metabolism of the protein-cyanide reaction product will be studied and the excretion products investigated.

Labeling with  $C^{14}$  and  $S^{35}$  will give specificity to biological studies.

Krampitz, L. O. AT(11-1)1252  
D1B402 MECHANISM OF ACTION OF PHOSPHOROCLASTIC REACTION.

Western Reserve Univ., Cleveland.

An attempt will be made to elucidate the mechanism of the phosphoroclastic reaction in Escherichia coli. The reaction is as follows:



The reaction can be shown to be reversible in that  $C^{14}$  formic acid exchanges readily with the carboxyl group of pyruvate. The  $C_2$  moiety has never been elucidated. Other investigations in this laboratory have shown that a hydroxy ethyl group substitution at position 2 of the thiazole moiety of thiamin diphosphate is an intermediate in most reactions where pyruvate metabolism is involved. Since the phosphoroclastic reaction is thiamin diphosphate dependent and the  $C_2$  moiety involved is in all probability on the level of oxidation of an acetyl group, we will en-

deavor to implicate acetyl thiamin diphosphate as an intermediate in the above reaction. The acetyl substitution in this case will be at the two position of the thiazole moiety of thiamin diphosphate.

Laskowski, M., Sr. AT(11-1)293  
D1B438 NUCLEOLYTIC ENZYME.  
Marquette Univ., Milwaukee. School of Medicine.  
COO. SP 3; MYr 2.5.

The action of micrococcal nuclease on DNA will be investigated with respect to endo- or exonucleolytic character. The frequency of occurrence of nucleosides at either of the terminal positions of oligonucleotides will be determined.

The specificity of DNase II during the course of the reaction will be studied. The frequency of nucleosides appearing in the terminal positions of fragments of different length will be determined.

Wood, W. A. AT(11-1)695  
D1B440 TRACER STUDIES OF CARBOHYDRATE INTERCONVERSIONS BY MICROBIAL ENZYMES.  
Michigan State Univ., East Lansing. COO.

1. Complete studies of 6-phosphogluconic dehydrase and 2-keto-3-deoxy-6-phosphogluconic (KDPG) aldolase.

a. Complete the NMR studies of spontaneous or chemical enolization in formation of KDPG by obtaining and comparing spectra of KDPG(2H) KDPG(2D) and KDPG(D) (the enzymatic product).

b. Crystallize and obtain the physical characteristics of KDPG aldolase.

c. Establish specificity of KDPG aldolase.

d. Elucidate the nature of the "substrate-carbonyl-enzyme" compound by borohydride reduction studies.

2. Determine the mechanism of acetyl formation by phosphoketolase, or the mechanism of dehydration of dihydroxyethylthiamin diphosphate.

a. (With Dr. L. O. Krampitz, Western Reserve University) Test the conversion of dihydroxyethylthiamin diphosphate to acetate with  $C^{14}$  labeled thiamin derivative and isolation of acetate.

b. Prepare specifically tritio-labeled dihydroxyethylthiamin diphosphate to study the mechanism of dehydration, i.e., ketonization of an enol or hydride shift mechanism.

3. Study the mechanism of threonine dehydration.

a. Mechanism of activation by adenosine-5-phosphate (Sedimentation studies).

b. Detect the presence of dehydration tautomers by reduction with borohydride.

c. Study the shifts of H using D or T incorporation from water or migration from specifically labeled substrates.

Gunsalus, I. C. AT(11-1)903  
D1B444 MECHANISM OF BIOCATALYSIS AND OF  
METABOLIC CONTROL.  
Illinois. Univ., Urbana. COO.

Succinic thiokinase from succinate grown cells has been shown to be enriched approximately 30 fold by growth on succinate rich media. This enzyme has been purified to a specific activity of 4,000 (turnover number about 15,000 based on assumed molecular weight of  $10^5$ ). These preparations represent an essentially pure enzyme, which can be produced in quantity, to permit studies with substrate level of enzyme. Studies are in progress to determine the reaction sequence and possible nature of intermediate enzyme substrate compounds.

Five organisms, pseudomonads and diphtheroids, have been isolated by enrichment on camphor; in two of the pseudomonads, strains C<sub>1</sub> and C<sub>5</sub>, the reaction sequence from camphor to a six-membered lactone of a branch chain dicarboxylic acid, has been shown to occur by three types of reaction a lactonization of the 1,2 bond of camphor (forming 1,2 camphyllide) and subsequently the 4,5 bond forming the lactone of 3,4,4-trimethyl-5-carboxymethyl- $\Delta^2$ -pimelic acid- $\delta$ -lactone.

The effect of camphor on growing cells and a selection of mutants of culture C<sub>1</sub> have been undertaken. A toxic or selective action of camphor has been seen with these pseudomonads similar to that described by Roper (1952) and by Ogg and Zelle (1957). These physiological studies to determine the mode of attack of camphor and the site of its action will be pursued together with genetic experiments to elucidate the pathways and to understand the enzyme induction patterns encountered.

Talmage, Roy V. AT(40-1)-284  
D1B462 ENDOCRINE AND METABOLIC STUDIES  
UTILIZING RADIOISOTOPES AND LABELED HORMONES.  
Rice Univ., Houston, Tex. OROO. SP 7; MYr 4.5.

The work proposed under this contract will be concerned primarily with aspects of the control of calcium homeostasis in the mammalian organism. The main emphasis, therefore, will be with a continued study of parathyroid function particularly in its relationship and control of bone turnover. The following projects are underway or planned:

1. A continued study of the relationship of parathyroid function to hydroxyproline metabolism. This is being studied by determination of changes after endogenous parathyroid secretion is stimulated. Parameters measured are changes in plasma and lavage fluid content and form of the imino acid, and radioautographic studies of bone after administration of tritiated proline.

2. A continued study of the interplay between basic processes for the equilibration of calcium levels in extraosseous spaces with the solid phases of bone and the removal of calcium from bone by parathyroid action. This study is concerned with the nature of these two opposing processes and utilizes the techniques of fluoride administration via peritoneal lavage, the effects of other hormones, particularly steroids on the system, and the role played by the osteoclasts in parathyroid function.

3. A continued study of the importance of a controlled calcium ion concentration in membrane permeability and function as studied by the effects of a lowered plasma calcium ion level on the content of milk in lactating rats.

4. A proposed study of the effect of combined radiation from high level administration of Ca-45 and of plutonium on the ability of bone to respond to parathyroid stimulation.

Wang, Chih H. AT(45-1)1387  
D1B475 RADIOTRACER STUDIES OF BIOSYNTHETIC AND RESPIRATORY PATHWAYS.  
Oregon State Univ., Corvallis. SP 2; MYr 1.45.

The proposed research is aimed at the elucidation of catabolic pathways of carbohydrates, particularly hexoses and amino acids in microorganisms. Emphasis will be placed on the utilization of hexoses or amino acids as the carbon source (or nitrogen source) to fulfill respiratory and biosynthetic functions in microorganisms. Radioisotope labeled compounds will be used as tracing substrates.

Microorganisms selected for these studies are Azotobacter vinelandii, Acetobacter xylinum and several autotrophs. These organisms were selected on the basis that they are known to rely to a variable extent on the pentose phosphate pathway for the utilization of hexoses. It is hoped that by the use of respirometric experiments and incorporation experiments one can better understand the interplay of the pentose phosphate pathway with other catabolic sequences for hexose utilization.

Also proposed is the study of the utilization of amino acids by A. vinelandii, a nitrogen fixing microorganism. Specifically, the aim of this study will be an evaluation of the role played by amino acids in A. vinelandii metabolism. For example, it is desirable to know whether the amino acids can serve as a carbon source as well as a nitrogen source and the pathway involved in the utilization of simple amino acids such as alanine.

Sherman, F. G. AT(30-1) 2570  
D1B492 BIOSYNTHESIS OF PROTEINS BY LIVING

## CELLS AND CELL FRACTIONS.

Syracuse Univ., N. Y. April 1962–March 1963.

1. Experiments with mutants of *E. coli* requiring exogenous pyrimidines for growth will be continued. The mutant we are using can also utilize 5-methyldeoxycytidylic acid for growth when it is present in the medium in large amounts. We plan to compare the levels of deoxycytidylic deaminase present when the cells are grown with 5-methyldeoxycytidine or thymidine. If this enzyme is synthesized in considerable amounts in response to 5-methyldeoxycytidine, it may be possible to use this as an index of specific protein synthesis.

2. We are continuing our studies on the fractionation of soluble proteins from cells grown in the presence of 5-bromouracil. We have obtained preliminary evidence which suggests that some of the soluble proteins not synthesized by the control cells are not made when cells of the same strain are grown in the presence of 5-bromouracil.

3. The incorporation of C14 labeled leucine or C14 labeled valine into protein will be studied. We have found that less protein per unit dry weight is synthesized by cells which have been grown in the presence of 5-bromouracil.

4. Partial reversals of growth inhibition due to the presence of 5-bromouracil, 5-hydroxyuridine and 5-aminouridine have been obtained by the addition of purines and pyrimidines in various combinations. We plan to harvest cells after various periods of incubation in medium containing 5-substituted pyrimidine in sufficiently high concentration to inhibit growth approximately 50 per cent, wash and incubate in complete medium containing thymine. The amount of growth obtained will be a measure of irreversible changes induced by 5-bromouracil (or other inhibitory analog). We will also plate aliquots on solid medium (complete) to determine the number of viable cells present.

Markert, Clement L. AT(30-1)2194  
D1B499 PATHWAYS OF METABOLISM IN EMBRYONIC DEVELOPMENT.  
Johns Hopkins Univ., Baltimore. March 1962–February 1963.

This research program has two main objectives; (1) to investigate the relationship between the metabolic activities of the yolk-sac membrane and the developing tissues of the chick embryo and (2) to search into the significance of a gradual change in isozyme patterns in developing tissues in terms of cell function and structure.

In an approach to the first objective, the biochemical pathways of the yolk sac membrane and the liver

(although ontogenetically different tissues, each plays a role in glucose metabolism in embryonic life) will be investigated by (1) determining and comparing their enzymatic content (and other proteins) at different stages of development by techniques of histochemistry and by starch gel electrophoresis of tissue homogenates and (2) introducing C<sup>14</sup> labeled glucose into the yolk and tracing its passage into the yolk sac entodermal cells, thence into the blood of the embryo and ultimately into the liver. In a similar manner the metabolic pathways by which phosphorus is made available to the embryo from yolk phosphoprotein is to be investigated by introducing P<sup>32</sup>C<sup>14</sup> labeled phosphoserine into the yolk.

That the isozyme patterns of developing tissues not only change gradually until the adult pattern is achieved and that each tissue has its own characteristic pattern of isozymes (for several different enzymes) pose a real challenge in the interpretation of cellular mechanisms for protein synthesis. In an approach to this intriguing problem an analysis of the physical-chemical differences among the isozymes of a single enzyme (e.g., lactate dehydrogenase) will be made. Further, the possibility that isozymes are interconvertible will be tested by "pulse labeling" of proteins for restricted periods during tissue differentiation and by measuring radioactivity of cellular proteins (including isozymes) at subsequent stages of differentiation to gain an insight into the relative rates of synthesis and degradation of various proteins.

Zamecnik, P. C. AT(30-1)-2643  
D1B515 MECHANISMS OF PROTEIN AND NUCLEIC ACID SYNTHESIS, AND THEIR POSSIBLE RELATIONSHIP TO RADIATION DAMAGE.  
Harvard Univ., Boston.

Chow, B. F. AT(30-1)-1203  
D1B519 STUDIES OF VITAMIN B-12 ABSORPTION.  
Johns Hopkins Univ., Baltimore. School of Hygiene.

Hempelmann, L. H. AT(30-1)1286  
D1B552 MECHANISMS OF BIOLOGICAL DAMAGE OF THE MOLECULAR, CELLULAR, AND TISSUE LEVELS.  
Rochester, N. Y. Univ. School of Medicine and Dentistry. February 1962–January 1963.

A study of considerable interest is the defect of creatine metabolism noted in animals as well as in radiation therapy patients and in persons exposed to accidental nuclear reactions. This defect, which is reflected in the excretion of excessive amounts of creatine in the urine of these irradiated patients

and animals, may be associated with the muscular weakness experienced by these individuals. In certain respects, this metabolic defect is not unlike that seen in patients with muscular dystrophy.

We are also studying the effect of radiation on the breakdown of several tissue components of animals, e.g., collagen, protein and nucleic acids.

Finally, we are studying the chemical changes which occur in enzymes and other cellular components irradiated after isolation in the pure state.

Malamos, B. AT(30-1) 2769  
D1B596 "THE EFFECT OF IONIZING RADIATION ON LIPID METABOLISM OF BLOOD AND BONE MARROW CELLS."  
Athens. Univ. School of Medicine. May 16, 1962-March 14, 1963. SP 3.

The effect of ionizing radiation on leucocytes was studied. It was found that a radiation dose of 1000 rad under the conditions of our experiments was without effect on the metabolism of leucocyte lipids as can be deduced from the incorporation of acetate-1-C<sup>14</sup> into total lipids.

After irradiation with a 5000 rad dose, a small decrease in the incorporation of the acetate-1-C<sup>14</sup> to the total lipids was shown.

It is proposed that the study of the effect of ionizing radiation on leucocyte lipids metabolism by fractionation of total lipids and by analyzing the percentage and radioactivity of the fatty acid content of each fraction be continued.

When bone-marrow cells were irradiated and incubated with acetate-1-C<sup>14</sup> the observed incorporation in comparison to non irradiated cells, depended upon the temperature and the time lapse between irradiation and incubation.

When incubation took place immediately after irradiation the incorporation of acetate-1-C<sup>14</sup> into total lipids was 10-30% less than that of nonirradiated. It appears that, when the time lapse was greater and the cells maintained in a low temperature (7°C), the incorporation of the irradiated cells reached that of the nonirradiated, on the contrary, when the cells maintained in a temperature of 37°C, the incorporation of irradiated cells was much less than that of the nonirradiated.

It is proposed that this study be continued in order to clarify the causes of the above mentioned incorporation differences.

It is further proposed that the fatty acid pattern and the incorporation of acetate-1-C<sup>14</sup> into each separate acid of both irradiated and nonirradiated samples be studied.

## D1C Macromolecules

See also B1A274, B1A337, B1B20, B1B175, B1B294, B1B394, D1A192, D1A334, D1B281, D1B438, D1D197, D1D358, D1D442, and D1D449.

Bowe, Robert L. AT(40-1)2947  
D1C9 RELATIONSHIP BETWEEN THE INCREASED PLASMA VISCOSITY SEEN IN ACIDOSIS AND OTHER BIOCHEMICAL CONDITIONS.  
South Carolina. Medical Coll., Charleston. OROO. MYr <sup>1</sup>/<sub>3</sub>.

It has been reported that in acidosis both erythrocyte size and plasma viscosity increase considerably. No study has been made of possible effects of these two alterations upon the cardiovascular system, nor upon the exacerbation of the acidosis condition itself because of cardiovascular and biochemical alterations induced by these acidosis linked changes in blood.

In this study, the degree of erythrocyte enlargement and plasma viscosity increase will be determined at various pH levels and at pO<sub>2</sub> and pCO<sub>2</sub> pressures both *in vitro* and *in vivo*.

Red blood cell diameter will be determined by a camera lucida apparatus by which the image of red blood cells, magnified 2000 times, will be projected and measured. Plasma viscosity will be determined by a modified Ostwald viscosimeter.

Correlations with cardiovascular changes will be made by the determination of myocardial contractile force, measured by the Walton-Brodie strain gage arch, and by cardiac output, circulation times, peripheral resistance and blood volumes, determined by RISA and Cr<sup>51</sup> tagged red blood cells.

Biochemical alterations of carbonic anhydrase activity will be investigated and blood and tissue electrolytes determined by flame spectroscopy.

Donohue, Jerry AT(11-1)113-15  
D1C21 STRUCTURAL STUDIES ON DEOXYRIBONUCLEIC ACID.  
University of Southern California, Los Angeles. SAN. SP 2; MYr 0.7.

X-ray crystallographic studies will be carried out on compounds related to DNA. The results will be used to formulate atomic coordinates for DNA itself. After preliminary studies, compounds will be selected for study among the various purines, pyrimidines, sugars, phosphates, and related compounds. Particular attention will be paid to obtaining structural parameters concerning not only precise values for the bond distances, but also the bond angles and

torsion angles. Thermal vibration parameters will be determined where feasible.

A critical survey of existing structural data will also be made. Information on the above mentioned structural features, and on the values for the external bond angles of the ring systems will receive special attention, as will interactions between non-bonded parts of these systems. Properties of hydrogen bonds will also be studied intensively.

These studies will be made by standard x-ray crystallographic methods. Three dimensional data accessible to  $\text{CuK}\alpha$  radiation will be used, and the refinements will be by Fourier and full matrix least squares procedures.

Mandell, Joseph D. AT(04-3)471  
D1C86 THE ISOLATION OF MACROMOLECULAR DEOXYRIBONUCLEIC ACID OF MICROBIAL ORIGIN.

Palo Alto Medical Research Foundation, Calif. SAN.

The proposed research is the first phase of a program to analyze the genetic material (DNA) of a bacterium and a bacterial virus at the macromolecular level by the use of column chromatography.

Past work by the Principal Investigator, by Dr. A. D. Hershey and his collaborators has demonstrated that it is possible to extract quantitatively the DNA of bacteriophage T2 almost entirely as a population of intact molecules. The homogeneity of the T2 DNA preparation was first shown by rechromatography experiments on a methylated bovine serum albumin-Celite column. The first and second breakage products of T2 DNA molecules resulting from stirring at carefully controlled speeds were successfully separated on the column from unstirred DNA and were shown to be heterogeneous by rechromatography experiments.

The proposed work is an extension of the same techniques to the DNA of the bacterium Bacillus subtilis. A method must first be worked out for the rapid quantitative extraction of DNA from the cells in an undegraded state. This is a much more complex problem than extracting DNA from T2. Progress in achieving this first goal will be monitored both by column chromatography and by genetic transformation of a group of linked markers.

Wildman, S. G. AT(11-1)34, No. 8  
D1C125 STUDY OF PLANT VIRUS AS APPROACHED THROUGH STUDY OF NORMAL PLANT PROTEINS.  
California. Univ., Los Angeles. SAN. SP 2;  
MYr  $2\frac{1}{4}$ .

This project is concerned with the process of infection of plant cells by tobacco mosaic virus (TMV). In the past year, it was found possible to make cell-free extracts from TMV-infected plant tissue which will catalyze the formation of additional infectious TMV-RNA when supplied with ATP, GTP, CTP, and UTP. Omission of one or more of the four riboside triphosphate nucleotides greatly reduces the synthesis of TMV-RNA. Synthesis is prevented by pretreatment with heat or the presence of RNAase in the incubation mixture. The synthesis is time and temperature dependent. Purification of the system has reached the point where extracts have a composition that approximates 1 RNA: 1 DNA: 1 Protein. These extracts not only catalyze the formation of TMV-RNA but also catalyze the incorporation of C14 triphosphate nucleotides into a material with the properties of RNA. Since the general properties of the system suggest that a polymerase enzyme is responsible for the synthesis of TMV-RNA, our present endeavors are aimed at further purification and characterization of the enzyme, and also from the standpoint of whether DNA or RNA, or a DNA-RNA complex is involved as template for the synthesis of the virus.

Borsook, H. AT(04-3)51  
D1C142 BIOLOGICAL SYNTHESIS OF PROTEIN.  
California Inst. of Tech., Pasadena. SAN.

Erythroid cell maturation changes its course when there is an emergency call for red blood cells, by the formation of cells which are larger, contain more hemoglobin per cell, leave the marrow earlier and are shorter-lived than normal erythrocytes. We propose to obtain more information on the relation of DNA, RNA and hemoglobin synthesis under normal and emergency conditions by autoradiographic studies on marrow cells using three labeled metabolites: a DNA precursor; an RNA precursor; and an amino acid.

We have found when rabbit reticulocytes were incubated with a labeled amino acid that there were, in certain chromatographic fractions, materials which behaved as if they were intermediates (of high molecular weight) in protein synthesis. We plan to isolate and characterize these substances. It appears that the findings may bear on the mechanism of protein synthesis in general.

Hemoglobin synthesis proceeds at different rates in cells of each maturation stage. In some cells in each of the three last stages hemoglobin synthesis stops. We shall try to obtain information on what brings hemoglobin synthesis to a stop in relatively early as well as late stages of maturation.

In order to obtain more information on the factors determining amino acid sequence in mammalian cells we plan to add the DNA-Messenger RNA complex of one species to the marrow cells of another and observe whether the cells synthesize a species of hemoglobin corresponding to that of the DNA-RNA complex added.

Haurowitz, Felix AT(11-1)209  
D1C183 COMBINATION OF ANTIGENS AND ANTIBODIES. BIOSYNTHESIS AND SPECIFICITY OF NORMAL AND IMMUNE PROTEINS.  
Indiana Univ. Foundation. Research Div., Bloomington. COO.

The principal scope of this work is to get more insight into the mechanism of protein biosynthesis. We intend particularly to continue an investigation on the structure and formation of antibodies since this is one of the few instances of protein biosynthesis which can be arbitrarily influenced by the injection of suitable antigens. The mammalian organism, after the injection of antigens, forms antibodies, i.e.,  $\gamma$ -globulins whose shape is complementarily adapted to that of the determinant portion of the antigen. We try to get more insight into this process by degrading antibodies by papain and subsequent tryptic digestion of the large antibody fragments. We hope that two-dimensional chromatography and electrophoresis will show us whether the amino acid sequence of antibodies against an acidic antigenic group is different from the amino acid sequence of an antibody against a basic antigenic group. Since proteins are formed intracellularly from free amino acids, we are also interested in the process of amino acid transport into cells against the concentration gradient. An attempt will be made to elucidate the energy sources for this active transport.

Picken, J. C., Jr. AT(11-1)902  
D1C187 EFFECT OF GAMMA RADIATION ON BIOLOGICAL PROPERTIES RELATED TO STRUCTURE OF SELECTED ANIMAL VIRUSES.  
Iowa State Univ. of Science and Tech., Ames. COO.  
May 15, 1962-Mar. 14, 1963. MYr  $2\frac{1}{2}$ .

The proposed work is a continuation of the investigation of structural aspects of Newcastle disease virus related to the thermostabilities of the hemagglutinating, infective, hemolytic, pathogenic and immunogenic properties. Four paired substrains of the virus, selected for extremes in thermostabilities of the hemagglutinating properties, i.e., HA heat sensitivity or resistance, form the main virus substrate of the research. Both qualitative and quantitative relationships between the heat inactiva-

tion characteristics of the five properties are being studied. Evaluative procedures, stressing similarities or differences in the response to the stress of heat, appear to be pointing to a common structural aspect of the virus that varies in its thermostability. This structural aspect of the virus appears on its reaction to the stress of heat to affect adversely the manifestation of the hemagglutinating, infective and hemolytic properties in the same order of magnitude. Gamma radiation inactivation studies of the inactivation rate characteristics of the hemagglutinating, infective and hemolytic properties are being undertaken. Evidence for like radiation sensitive volumes of the various properties for each of the substrains would support the suggestion that a common structure of variable thermostability is responsible for the parallelisms in heat stability of the biologic and serologic that have been observed.

Schultze, M. O. AT(11-1)1220  
D1C200 INTERACTIONS BETWEEN A NEW SULFUR MUSTARD AND E. COLI.  
Minnesota. Univ., St. Paul. Inst. of Agriculture. COO.

The sulfur mustard referred to in the title is S-(1,2-dichlorovinyl)-L-cysteine (DCVC) a compound which first aroused interest because of its ability to induce, in very small amounts, aplastic anemia in the bovine animal. DCVC, which we are synthesizing in this laboratory, inhibits the growth of and induces abnormal morphology in a susceptible strain of E. coli B. A DCVC-tolerant strain of E. coli B has been developed in this laboratory. These two strains of E. coli B provide useful model systems for the study of the interaction of DCVC with components of biological systems. Likewise, they may be valuable for investigating the differences in biochemical reactions of biological systems which are respectively highly susceptible or highly resistant to a chemical agent. Using these two strains of organisms the effect of DCVC will be studied on:

- a. the ability of the system to incorporate amino acids into proteins, to synthesize purines and pyrimidines and to incorporate them into ribo- and deoxyribonucleic acids. Radioactive tracers will be used for this purpose;
- b. qualitative and quantitative changes in the nucleotides and related compounds which appear in the medium in which bacteria grow;
- c. the combination of DCVC with components of the bacteria or products of their metabolism; DCVC-labeled with  $S^{35}$  and/or with  $C^{14}$ , (in the latter instance both the L- and the D-isomers) which we have syn-



thesized, will be used for this purpose; attempts will be made to identify the products formed;

d. the metabolism, particularly the degradation of DCVC by *E. coli*. For this work, also, the radioactively labeled specimens of DCVC will be used.

Cohn, Norman S. AT(11-1)826  
DIC203 THE NATURE OF CHEMICAL BONDING  
IN THE CHROMOSOME.  
Ohio Univ., Athens. COO.

The investigations are concerned with several experimental approaches to the nature of chromosomal breakage and reunion. The two basic approaches consist of studies of root tissues and cells of *Vicia faba* and *Pisum sativum* grown *in vivo* and *in vitro*. Excised roots are grown on defined synthetic media and treated with various radiometric agents and X rays for analyses of induced chromosomal damage. Complete medium and media deficient for specific ions will be utilized. A more refined technique for the growth of single cells in culture will be used for similar experimental studies. This will provide a system of greater control of the environment of the cell. In addition, biochemical analyses of specific sites of activity of X rays and other agents will be undertaken. These analyses are based upon chromatographic and spectrophotometric methods. Differences in the mode of action of the treatment agents will be evaluated on the basis of amino acid, protein, and nucleic acid profiles of treated and untreated tissues.

Cochran, George W. AT(11-1)1150  
DIC226 BIOSYNTHESIS OF INFECTIOUS VIRUS  
RIBONUCLEIC ACIDS IN CELL-FREE MEDIA.  
Utah State Univ., Logan. Mar. 1, 1963-Feb. 29,  
1964. SP 8; MYr 3+.

The reacting components of our tobacco mosaic virus ribonucleic acid synthesizing system will be isolated, purified and characterized chemically. The kinetics of the nucleic acid formation will be studied and followed using radioactive Carbon 14 or tritium-labeled precursors. An attempt will be made to detect intermediates in the nucleic acid-forming systems. The actual mechanism will be studied to determine if a template is a part of the system, and if it is, whether it is composed of RNA, DNA or protein or a combination of these types of materials. The action of viral RNA in priming its own synthesis will be studied along with the effectiveness of the plant viral RNA synthesizing system in increasing virus mutants. Carefully designed synthesis experiments with labeled precursors will be used to follow the synthetic steps and intermediate and end products

will be characterized by measurements of 1. Radioactivity, 2. Infectivity, 3. Spectral absorption in ultra violet, visible, near infrared and infrared regions.

Weed, Lawrence L. AT(11-1)944  
DIC228 BIOLOGICAL ACTIVITY OF DEOXYRI-  
BONUCLEIC ACIDS.  
Western Reserve Univ., Cleveland. COO.

Previous work has shown that small colony variants of *B. subtilis*, strain 168, appear in a population of organisms exposed to copper. The variants can be maintained after many transfers in the absence of copper. Associated with the changes in colonial morphology are changes in the base composition of the DNA, increased resistance to ultra-violet irradiation, and altered behavior as demonstrated by transformation analysis.

The proposed work will deal with the mechanism of action of the copper. Preliminary data suggest that the combined action of high incubation temperature and copper cause alteration on the DNA. The work of Eichhorn, G. L. (*Nature*, 194, 474-475, 1962) showing that copper lowers the "melting point" of DNA *in vitro* has already suggested such a mechanism. Studies will be performed which will be directed at this copper-temperature relationship.

Preliminary studies have also shown that the chemical composition of the cell walls of the variants is significantly different from that of the original *B. subtilis*. In addition, a muco-peptide component heretofore undescribed has been detected and will be isolated and characterized. A third detailed study of the increased resistance to ultra-violet irradiation will also be undertaken.

Rustad, R. C. AT(40-1)2730  
DIC256 IDENTIFICATION OF THE SITE RE-  
SPONSIBLE FOR RADIATION-INDUCED MITOTIC  
DELAY.  
Florida State Univ., Tallahassee. OROO. SP 11;  
MYr 5.8.

Our earlier studies have shown that radiation-induced mitotic delay can result from damage to a single system which functions during 10 to 15% of the cell division cycle. This system controls the activities of the centrioles. Cytoplasmic damage was also demonstrated.

Two types of experiments will be employed to study the location of the site or sites of damage. Suspected target organelles will be irradiated with a U.V. microbeam. Cells stratified by centrifugation will be cut into anucleate fragments containing organelles with different densities. The fragments of

known composition will be inseminated with control and irradiated sperm following their irradiation. These experiments should locate the sensitive target(s) and demonstrate whether or not the less sensitive cytoplasmic system interacts with the primary sensitive system.

Cytological studies on the time of loss of radiation sensitivity and the sequence of delayed stages will be continued.

Billen, Daniel AT(40-1)2695  
D1C277 ALTERATIONS INDUCED BY IONIZING RADIATIONS IN THE SYNTHESIS AND MAINTENANCE OF MACROMOLECULAR COMPONENTS WITHIN MICROORGANISMS.

Texas. Univ., Houston. M. D. Anderson Hospital and Tumor Inst. OROO. SP 4; MYr 2-1/2.

Studies are being continued on the influence of radiation (X-rays and ultraviolet radiation) on the synthesis of the various RNA components, i.e. ribosomal RNA, transfer RNA, and DNA-like RNA in Escherichia coli. An important question is the influence of DNA degradation on the subsequent synthesis of RNA and whether or not physiological conditions which stabilize the DNA also enhance the post-irradiation synthesis of RNA.

Studies on the nature of DNA-protein complexes prior to and following treatments leading to DNA cessation in E. coli 15T- mutants have been started. The first objective is to determine whether a DNA-polymerase complex exists during any phase of the DNA replication cycle.

The nature of the physiological determinants of radiosensitivity in bacteria is also under investigation using auxotrophs that allow the selective accumulation of DNA, protein, or RNA.

Herrmann, Robert L. AT(30-1)3093  
D1C291 A CHEMICAL STUDY OF DNA FROM E. COLI K-12.

Boston Univ. School of Medicine. NYOO. SP 1; MYr 1/5.

As an approach to the definition of mutation in chemical terms it is intended to bring about conjugation of a radioactive Hfr donor strain (C-14 thymidine-grown) of E. coli K-12 selected for transfer of the Lac+ region at high frequency and a non-radioactive F-acceptor strain (which lacks the ability to utilize  $\beta$ -galactosides) by a synchronous-mating technique. After a short interval the conjugation process will be interrupted and the radioactive Hfr organisms lysed by a specific phage. The still-intact F-cells, now containing a short strand of radioactive chromosome from the Hfr cells and now

able to grow on lactose, will be separated by centrifugation and their DNA isolated. Extreme care will be taken to avoid denaturation of the DNA during subsequent isolation and separation procedures.

On the basis of recent estimates of the minimum size of the DNA molecule it is reasoned that if conjugation times have been short then the chromosomal segment transferred should be considerably smaller than a single molecule of DNA. Chromatographic isolation of this radioactive fragment on the basis of size will be followed by assay of its  $\beta$ -galactosidase activity by use of the Novelli system.

The entire procedure will be repeated for a lac-Hfr derived from the original lac+ organism by UV irradiation. Structures of lac+ and lac- DNA fragments will be compared by fingerprint-analysis to determine the precise chemical alterations involved in the mutation.

Price, T. Duane AT(30-1)2208  
D1C296 STUDY OF THE CONDENSING UNITS IN NUCLEIC ACID BIOSYNTHESIS.

Columbia Univ., New York. Coll. of Physicians and Surgeons. NYOO. SP 9; MYr 6.

The broad objective of this program is to obtain further knowledge on mechanisms of synthesis, structure and function of nucleic acids in surviving animal cells.

Continuing investigations on the minor nucleotides of rat tissues will consist of study of metabolism of the free cyclic nucleoside 3',5'-monophosphates and the trace pyrimidine nucleotide components of transfer RNA. Studies using the technique of linear sequential degradation of RNA of mammalian ribosomes will be extended to determine intrachain distributions of major 5'-nucleotides and incorporated isotopes under selected biological conditions: correlation of structure and synthesis with the function of the ribosomes is sought.

Other subjects of current interest include (i) investigation into the cause(s) of previously recognized heterogeneous rates of P-labeling for the pentose-bound P groups of different acid-soluble 5'-ribonucleotides, (ii) appraisal of possible alternative condensing units for nucleic acid biosynthesis, and (iii) precursor-product relations among nucleic acids in different parts of a cell.

Schwarz, Henry P. AT(30-1)2568  
D1C306 THE EFFECT OF X-RAY IRRADIATION ON THE DESOXYRIBONUCLEIC ACIDS OF THE SPLEEN AND RADIOSENSITIVE TISSUE.  
Philadelphia General Hospital. NYOO.

The effect of x-ray irradiation on the macromolecular structure of tissue DNA has been studied by ion exchange chromatography, infrared spectroscopy, and electrometric titrations.

DNA's were isolated from spleens of rats two hours or 24 hours after the animals had been irradiated at 1000 r, 2000 r, or 3000 r or from non-irradiated controls. Chromatography of the DNA's on ECTEOA cellulose columns showed that the DNA's from the controls contained constantly about 15% of small molecular material (eluted with 0.05-0.8 M sodium chloride at pH 7). The amount of small molecular DNA increased to almost 32% two hours after the irradiation at 3000 r. Simultaneously occurring other chromatographic changes, which were found after whole body irradiation at 1000 r, but not after higher doses of x-rays, indicate the existence of elevated amounts of more polymerized DNA which could be eluted only at rather strongly alkaline pH. This finding possibly suggesting cross-linking of the irradiated DNA, however, requires further study since it occurred also in 3 out of 7 preparations of control DNA. The results of infrared spectroscopy and electrometric titrations are still evaluated.

Rabson, Robert AT(40-1)2888  
DIC339 AN INVESTIGATION OF AMINO ACID  
INCORPORATION INTO PROTEIN IN CELL FREE  
PREPARATIONS FROM LEAVES AND SEEDS  
DURING DEVELOPMENT AND AGING.  
Houston, Texas. Univ. OROO.

The relationship between cell-free amino acid incorporation into protein and the aging of leaves is under study. One of the first questions being asked is which cell organelles are apparently most active in cell-free incorporation of radioactive amino acids. Preparations are made by differential centrifugation of homogenates of leaves at different stages of development and their incorporation ability measured. The subcellular changes in these fractions in terms of physical and chemical characteristics will also be examined as a function of aging.

Using the developing seeds of a legume which contains a blood group specific agglutinin an attempt will be made to demonstrate cell-free synthesis of this specific protein by taking advantage of its agglutination properties in conjunction with radioactive amino acid incorporation.

Colter, John S. AT(30-1)2967  
DIC344 THE BIOLOGICAL ACTIVITIES OF THE  
NUCLEIC ACIDS.  
Alberta. Univ., Edmonton. NYOO. SP 2; MYr 2-1/2.

Investigations of three variants of Mengo encephalomyelitis virus will be continued. These variants, though serologically indistinguishable, may be distinguished one from the other on the basis of plaque size and morphology and of hemagglutinin production. The unique biological properties of each is transmitted by the corresponding infectious ribonucleic acid. Studies in progress are aimed at elucidating the mechanisms underlying the differing biological properties of the three variants, —first in biological terms, and ultimately at the molecular level.

Among the lines being pursued are investigations of the rates of attachment of the agents to susceptible cells, of their rates of diffusion through agar, their rates of thermal inactivation, their pathogenicity to mice, their rates of replication and burst sizes, and the effects of such parameters as pH, temperature and osmolarity on their attachment to cells.

Methods are being developed for the purification of the variants. This will permit studies of the morphology of the agents by electron microscopy, and allow us to make accurate estimates of total particle: infectious particle ratios. It is hoped that development of satisfactory purification procedures will make it feasible to examine more carefully the interaction of cells with homogeneous, viral ribonucleic acids, and to attack the problem of the amino acid composition of the viral protein.

Abrams, Richard AT(30-1)1818  
DIC348 PATHWAYS OF NUCLEIC ACID SYNTHESIS.  
Montefiore Hospital, Pittsburgh. NYOO. SP 2;  
MYr 2.

Studies on the biogenesis of RNA in the mammal resulted in the isolation from thymus nuclei of an enzyme which specifically synthesized polyadenylate from ATP. Recent reports of non-mammalian enzymes which can synthesize poly A have appeared, though none of these has the high degree of specificity of the thymus enzyme. Poly A has been shown to occur naturally in thymus nuclei and to act as a specific primer for its own synthesis. These findings suggest that poly A may have a significant biological function. Aspects of this project which are now under investigation include: (a) The mechanism of priming by poly A. (Preliminary results suggest the primer functions as a template rather than a source for chain elongation. Further purification of the enzyme is necessary for progress here, particularly the removal of a contaminating nuclease); (b) The function of poly A in the cell. (Investigations include assay of various cell types for poly A content, dependence of poly A content on metabolic state of the tissue in

regenerating liver and kidney, possible role of poly A as a repressor of protein synthesis in mammalian and bacterial ribosomes, possible role of poly A as a messenger for lysine rich histone synthesis). The synthesis of poly C also occurs in thymus nuclei and the mechanism is being studied, as is the role of homopolymers in general.

Hanawalt, Philip C. AT(04-3)-326-7  
D1C367 A CORRELATION OF RADIATION SENSITIVITY WITH THE BACTERIAL DNA REPLICATION CYCLE.

Stanford Univ., Calif. SAN. SP 2; MYR 1.

We are concerned with the general problem of the relation of ultraviolet light (UV) induced chemical changes in DNA to the observed physiological effects in living cells. We would like to be able to distinguish between mutation damage to DNA and damage to the replication or transcription mechanisms which may also lead to lethality. It might be expected that the relative importance of those two types of damage might change as a function of the DNA replication cycle and the cell growth cycle.

Utilizing a bacterium E. coli strain TAU-bar we have shown that a very striking increase in resistance of colony formation to UV occurs in cells which have completed DNA replication [Maaløe and Hanawalt, J. Mol. Biol. 3 144 (61); Hanawalt Proc. 3rd Int. Cong. Photobiol. 305(61)] but that no concurrent increase in resistance of protein or RNA synthetic processes occurs. DNA hydrolysates from bacterial cultures in the different physiological states will be examined for yield of thymine-dimer and other photoproducts as resolved by paper chromatography.

Following a UV dose to an exponentially growing culture, which should cause extensive cross-linking of DNA strands we have followed DNA replication, using a density label, 5 bromouracil. The skewed density distribution (in CsCl density gradient) obtained for newly synthesized 5BU-containing DNA following UV is consistent with the hypothesis that a UV damaged DNA molecule may undergo partial replication [Pettijohn and Hanawalt Biophysical Society Abstracts Feb 1963]. We intend to test this hypothesis critically by examination of the kinetics of DNA synthesis following UV and through studies of physical properties of the newly synthesized DNA as regards molecular weight and density heterogeneity, melting behavior, photoproduct content, nuclease degradation, etc. Techniques for double-labeling ( $C^{14}$  thymine and  $H^3$ -5 bromouracil) of DNA and subsequent simultaneous assay in the scintillation spectrometer have been worked out by us as applicable to the proposed research.

Dickman, Sherman R. AT(11-1)-305  
D1C370 "PANCREAS METABOLISM STUDIES WITH RADIOACTIVE TRACERS."

Utah. Univ., Salt Lake City. COO. SP 4.

For a number of years the research of this project has been centered on the mechanism of protein biosynthesis, specifically as carried out by mammalian pancreas. Beef pancreas was selected for such studies because it is the source of more proteins of known structure than any other tissue and because of its high rate of protein synthesis. While beef pancreas would thus seem to be the tissue of choice for cell-free biosynthetic studies, actually it suffers from the grave disadvantage of possessing large amounts of ribonuclease, an enzyme which hydrolyzes ribonucleic acid, and acts as a potent inhibitor of amino acid incorporation into protein in such systems. We have recently been successful in preparing active ribosomes from this source through successive precipitations with  $Mg^{++}$  and treatment with anti-ribonuclease globulin. Such ribosomes routinely incorporate  $100 \pm 20$  cpm/mg from a number of  $C^{14}$ -amino acids in an energy-dependent series of reactions. The incorporated  $C^{14}$ -amino acid has been identified in two types of compounds (1) Transfer-RNA- $C^{14}$ -amino acid (2) Proteins. Further purification and characterization of these products are in progress. We are also attempting to increase the incorporating activity of beef pancreas ribosomes.

Doudney, C. O. AT(40-1)2139  
D1C379 NUCLEIC ACID FORMATION AND GENETIC EVENTS IN BACTERIA.

Texas. Univ., Houston. M. D. Anderson Hospital and Tumor Inst. OROO. SP 7; MYR 6 1/2.

The project is an attempt to understand the molecular basis of certain genetic mechanisms in Escherichia coli. One part of the study is devoted to the understanding of induced mutation. The results have shown that the post-irradiation event which fixes the UV induced mutation in the cell is the initial replication of deoxyribonucleic acid. However, before the mutation is fixed into DNA, it is possible to reduce the number of mutations by various treatments, especially those blocking RNA and protein synthesis. The synthesis of ribonucleic acid is under study as to site of formation in the bacterial cell. The structure and function of the various RNA fractions are being studied. A relation of "complementary" or "messenger" RNA to the so-called "membrane fraction" of the bacterial cell has been demonstrated. It has been hypothesized that the RNA is formed on the DNA and then is fixed at its functional site to particulates bound to the membrane of

the cell. Another aspect of the study is concerned with the control of DNA synthesis in the bacterial cell. The nature of the function of the protein necessary to DNA replication is under study. A further aspect of the study is related to the nature of recovery of DNA synthesis in the bacterial cell after UV exposure. The involvement of RNA in this recovery phenomenon has been proposed. The studies suggest a special mechanism which comes into play after radiation exposure to reactivate the DNA and allow its replication. The evidence suggests that this special RNA and protein system is involved in the mechanism of UV- induced mutation. Finally, the nature of the recombination event in *E. coli* is under study. Considerable attention is being given to the mapping of the bacterial chromosome with various HFr strains and to the physical state of the donor DNA after injection into the recipient strain.

Looney, W. B. AT(40-1) 2889  
D1C381 THE EFFECTS OF IRRADIATION ON  
NUCLEIC ACID SYNTHESIS.  
Virginia, Univ., Charlottesville. OROO. June 15,  
1962-June 14, 1963. MYr 2,7.

The primary objective of the project is the elucidation of the mechanism by which irradiation effects DNA synthesis. The secondary objective is the study of the process of DNA replication in mammalian cells. Regenerating rat liver is being used since the system is semi-synchronous. DNA synthesis can be separated from other important cell processes such as mitosis, with proper experimental design.

Biochemical studies of the effects of irradiation on DNA synthesis are being made by quantitative autoradiography and microspectrophotometry. Biochemical studies will be made on aliquots of the same biological specimens in order that the two aspects of the study can be coordinated.

Cytogenetic studies of the chromosomes of hepatocytes labelled with tritiated thymidine at the time of irradiation will also be made in an attempt to obtain a better understanding of the relationship between the effects of irradiation on DNA synthesis and the chromosome abnormalities produced by irradiation.

Thomas, C. A., Jr. AT(30-1)-2119  
D1C413 THE ORGANIZATION OF BACTERIO-  
PHAGE DNA.  
Johns Hopkins Univ., Baltimore.

The arrangement of polynucleotide sequences in T2 and T5 bacteriophage DNA molecules is being explored by reannealing experiments. Similar experiments are being done on lambda bacteriophage DNA possessing genetic deletions.

Finnerty, William R. AT(11-1) 1256  
D1C432 CONTROL OF THE BIOSYNTHESIS OF  
ALKALINE PHOSPHATASE.  
Indiana Univ., Indianapolis. School of Medicine.

This project has undertaken to definitively establish that alkaline phosphatase is being synthesized in a cell-free system prepared from *Escherichia coli*. Also under investigation are the mechanisms underlying the phenomena of repression and derepression with respect to the biosynthesis of alkaline phosphatase.

An alkaline phosphatase negative mutant will serve as the source for soluble fraction and ribosome preparations. Synthesis of messenger RNA by the RNA polymerase and gene specific DNA (DNA extracted and purified from derepressed *E. coli* cells actively synthesizing alkaline phosphatase) will provide the gene specific message for the biosynthesis of alkaline phosphatase. The synthesis reaction will be done with all amino acids totally labelled with C<sup>14</sup> isotope. Subsequent column purification and finger printing of the product will enable conclusions to be drawn as to whether net alkaline phosphatase synthesis has taken place in the presence of constituent labelled amino acids.

The control of alkaline phosphatase biosynthesis will be approached as follows:

If DNA does direct the synthesis of repressor molecules (possibly RNA-like) under conditions of high phosphate, the RNA polymerase system should be able to translate the repressor message from the regulator gene(s). The reaction involving purified DNA, high inorganic phosphate, nucleoside triphosphates, and RNA polymerase should, if the hypothesis is correct, synthesize informational RNA lacking the alkaline phosphatase message. Consequently, no increased alkaline phosphatase should be observed following a time course. This cell-free system therefore represents a biological assay for repressor activity and the molecular species responsible for this activity becomes susceptible to biochemical analysis.

Van Bruggen, J. T. AT(45-1)1754  
D1C481 EFFECT OF RADIATION UPON MEM-  
BRANE METABOLISM AND ACTIVE TRANSPORT.  
Oregon, Univ., Portland. Medical School.

The frog skin will be used as a model system to study the effects of radiation upon several aspects of the active transport systems of this tissue. The participation of key metabolites in active transport will be determined by the addition of C<sup>14</sup> labeled compounds to the bathing fluids and the subsequent assay of CO<sub>2</sub> and other metabolic products. Radiation will be given to both *in vitro* and *in vivo* skin prep-

arations and its effects upon skin potential, short circuit current and metabolic reactions will be determined. The mechanism by which the frog skin is able to transport sodium will also receive study. Cholinesterase, which has been implicated in transport, will be related to the metabolic reactions and to radiation induced changes. The inner, basal layer of the frog skin which contains cholinesterase will be dissected and skin E.M.F. and short circuit currents will be determined. The relation of short circuit currents to  $\text{Na}^+$  and  $\text{Cl}^-$  influx and outflux will be measured. Localization of the site of active transport will be correlated with the effects of several kinds of radiation.

Woods, Philip S. AT(30-1)2939  
D1C500 NUCLEIC ACID AND PROTEIN METABOLISM IN CELLS STUDIED BY TRITIUM AND OTHER ISOTOPICALLY LABELED PRECURSORS AND AUTORADIOGRAPHY.  
Delaware. Univ., Newark. February 1962–January 1963.

This is a new project and was started Feb. 1, 1962. At the time of writing this report (June 8, 1962) not all of the equipment has been received and consequently research has been limited.

Purpose and Scope of the Project: To study sites of synthesis of various types of nucleic acids and proteins within cells and to follow their movement from one cell compartment to another as the cells grow and divide. Biochemical analysis of various cell fractions or extracts will also be performed.

Kasimer, Philip R. AT(30-1)2480  
D1C501 SEPARATION AND IDENTIFICATION OF PEPTIDES IN BACTERIA USING CARBON 14 AND SULFUR 35.  
Quinnipiac Coll., Hamden, Conn. February 1962–January 1963.

The peptides of Mycoplasma Gallisepticum (Avian PPlo 5969) and other PPLO strains will be examined by separating enzymatic digests of their proteins by paper electrophoresis followed by two dimensional chromatography or ion exchange columns. By growing these bacteria in a medium containing carbon 14 amino acids, labeled peptides as well as unlabeled peptides can be used.

Since Avian PPLO 5969 has a diameter of only .25 microns and other PPLO strains even smaller diameters, the hypothesis that their smaller diameters, the hypothesis that their smaller size limits the amount of D.N.A. and thus the number of peptide combinations will be tested.

De Bernard, B. AT(30-1)-2632  
D1C517 STUDY AND COMPARISON BETWEEN NECROLYTIC AND RADIOLYTIC LESIONS AT THE MITOCHONDRIAL LEVEL (LYSOSOMES) IN ASEPTICALLY PERFUSED BEEF HEART MUSCLE.  
International Atomic Energy Agency, Trieste. University.

Herriott, Roger M. AT(30-1)-1371  
D1C542 A. THE TRANSFORMATION OF E. COLI B FROM VIRUS SENSITIVE TO VIRUS RESISTANT OR VICE VERSA. B. CHEMICAL AND NUTRITIONAL STUDIES OF BACTERIAL VIRUSES.  
Johns Hopkins Univ., Baltimore. School of Hygiene and Public Health.

#### Accomplishments:

##### 1. Mechanism of Renaturation of Transforming DNA. (Herriott and Yamashita)

A. The initial rate of reformation of two individual genetic markers as well as the hybrid was found to be bimolecular. This means two physically independent units are needed for reformation.

B. A clonal analysis does not support the notion that the number of hybrid units is greater than observed which might have been lost by segregation.

C. The hybrid units formed during renaturation are not affected by Lehman's phosphodiesterase.

##### 2. The Residual Activity in Heat Denatured DNA. (Barnhart and Herriott)

The activity remaining in heat denatured and quenched transforming DNA is resistant to the phosphodiesterase of Lehman and is therefore different from over 90 per cent of the DNA preparation.

##### 3. Protoporphyrin Utilization by H. Influenzae. Y. C. Hsu)

The change from hemin to protoporphyrin utilization is a two step genetic mutation. Each step is transformable and one of the steps renders the cell sensitive to visible light while the other one erases the sensitivity.

##### 4. Chemical Mutagenesis. (Horn and Herriott)

Large numbers of mutations to low level resistances to antibiotics were induced into single stranded (denatured) DNA by nitrous acid. Renaturation was required to assay the effect. Similar treatment of native DNA failed to yield mutants.

#### Proposed Work:

Continue along similar lines.

Brown, Raymond A. AT(30-1)2567  
D1C571 THE BIOLOGICAL ROLE OF RNA.  
Wistar Inst. of Anatomy and Biology, Philadelphia.  
May 1962–February 1963.

1. Studies will be conducted to determine the sub-unit size of RNA. Techniques will include sedimentation, viscosity and electron microscopy.

2. The inactivation of infectious viral RNA by x-rays both *in vivo* and *in vitro* will be studied. The biological systems which will be used for these studies include: the Mengo virus, and Mengo RNA and mouse L-cell systems.

3. An attempt will be made to measure the turnover between macromolecular RNA and soluble RNA. This will be done in L-cells using P<sup>32</sup>.

## D1D Cell Physiology and Biochemistry

See also A1B473, A1E129, A1H313, A1J67, B1A217, B1A253, B1A383, B1B298, D1A97, D1A181, D1A198, D1A227, D1A232, D1A261, D1A278, D1A292, D1B57, D1B252, D1B363, D1C125, D1C296, D1C481, and D1E360.

Barber, Albert A. AT(11-1)34-49  
D1D19 THE METAL BINDING CAPACITY OF TISSUES AND TISSUE FRACTIONS AND ITS RELATIONSHIP TO ANTIOXIDANT ACTIVITY. California. Univ., Los Angeles. SAN. SP 3; MYr 1.47.

Some lipids found in tissues form peroxides when irradiated and the toxicity of these peroxides on certain biological systems is similar to the toxicity of radiation. These observations have implicated lipids in radiation damage. Although lipids are widespread in biological tissues, their peroxides are not formed under normal conditions. The absence of the peroxides is due, presumably to the activity of specific inhibitors referred to as antioxidants. Small amounts of lipid peroxides, however, have been identified in certain tissues from irradiated animals indicating antioxidant inactivation by irradiation. Little is known regarding the details of peroxide formation in tissue extracts or the variety of antioxidant mechanisms available to tissues. Research in our laboratory has been concerned with both of these problems.

Several cell fractionation techniques have been applied in these studies on the mechanisms of peroxide formation and antioxidant activity in tissues. Homogenization and centrifugation studies have established the subcellular distribution of the various components necessary for these reaction. Isolation and purification of the specific peroxidation and antioxidant components of tissues has also required

various electrophoretic and chromatographic techniques.

Several mechanisms of antioxidant activity have already been established and others are indicated. These mechanisms differ in their radiation sensitivity when exposed to either gamma and ultraviolet radiations. The antioxidant activity of testis soluble protein, for example, is more radiosensitive than is the antioxidant activity of the serum proteins. Present studies are concerned with extending the survey of tissue antioxidants mechanisms and establishing their radiosensitivity both *in vivo* and *in vitro*. The comparative radiosensitivity of antioxidants from a variety of tissues will be compared to the known tissue radiosensitivity, as established by pathological studies.

Lates, George G. AT(11-1)34-61  
D1D22 STUDY OF THE METABOLIC CONTROL OF SALT TRANSPORT IN PLANT TISSUES. California. Univ., Los Angeles. SAN.

The isotherm for chloride absorption by potato disks from KCl solution is exponential at 0 C, and classically hyperbolic at 25 C. The time course of Cl uptake is biphasic at 0°C and linear at 25 C. The foregoing observations have been further investigated with the end in view of elucidating the means whereby ions are absorbed into the cytoplasm and vacuole, respectively. The shape of the absorption isotherm for Cl has been found to depend upon the counter-ion. The isotherm for Cl uptake from CaCl<sub>2</sub> solutions at 0 C is classically hyperbolic. Extensive observations have led to the deduction that the nature of the salt determines the magnitude of the electrical potential across the plasma membrane, and that the change in electrochemical potential with concentration determines the shape of the isotherm. The model stemming from the data suggests that ion permeation of the plasma membrane is diffusive, while one or more ion pumps exist at the tonoplast.

With respect to the biphasic course of absorption at 0 C, it has been determined that the competitive relation of given ions to each other which characterizes anion absorption in the second or steady-state period, is equally manifest in the initial rapid phase of absorption. The question is under examination of whether the two absorption phases reflect the consecutive control in time of salt transport by different membranes bounding different cell compartments.

Finally, metabolically implemented chloride transport into corn root tips has been achieved anaerobically. The utilization of ferricyanide as a respiratory electron acceptor in the absence of oxygen results in salt uptake which is sensitive to substrate-level

respiratory inhibitors while being independent of electron flow through the respiratory terminal oxidase.

Ducoff, Howard S. AT(11-1)878  
D1D182 RECOVERY FROM RADIATION-INDUCED  
DIVISION BLOCK IN PROTISTS,  
Illinois Univ., Urbana. COO.

Metabolic activities are required for recovery from the temporary suppression of division which follows irradiation of most cell types. Elucidation of the metabolic factors involved should contribute to understanding the nature of the original lesion and the processes involved in normal cell division.

There are three major lines of investigation. One concerns the nature of the division suppression which follows apparent recovery from the initial ultraviolet-induced block. Experimentation involves measurement of levels of protein, RNA, and proteolytic enzymes in Chilomonas paramecium during and after protein depletion and/or irradiation, as well as studies on photoreactivation and on additivity of X-ray or nitrogen mustard effects with those of ultraviolet. A second investigation is a study of the response of Brachionomonas submarina to X- or UV-irradiation, including cytochemical and autoradiographic experiments, and attempts to achieve a high degree of division synchrony by manipulation of the lighting cycle. The third line involves the effects of certain chemical agents, particularly the halogenated pyrimidines and mercaptoethanol, on X-ray-induced division block in Chilomonas and in Tetrahymena. In addition, there is a comparison of phagotrophic and saprozoic nutrition in Tetrahymena, with special reference to metabolic pathways.

Christensen, John A. AT(11-1)1038  
D1D184 THE RELATIONSHIP OF VIRUSES TO  
IRRADIATION-INDUCED TUMORS,  
Indiana Univ., Indianapolis. Medical Center. COO.

Studies reported by H. S. Kaplan and Ludwig Gross on the induction of lymphomas in mice by fractionated total-body irradiation have been confirmed in this laboratory. In C57 BL/6 mice, 59.4 per cent (41/69) of irradiated animals developed lymphatic leukemia in an average period of 5.8 months. In C57 BL/10 mice, the incidence was 45.9 per cent (27/59) with an average latency of 5.2 months. Leukemic tissues thus obtained are being used in studies related to a possible viral etiology of X-ray-induced mouse leukemia.

In our efforts to isolate a causative virus from X-ray-induced mouse leukemia, the tissue culture

technique has been used extensively as a means of "intermediate" incubation and serial passage of leukemic tissue inocula. These culture fluids are later injected into newborn mice, largely from two inbred mouse strains (C57 BL/10 and C57 BL/6) and two non-inbred strains (Swiss and ICR). To date, data have been collected on 628 injected mice. Of this number 27 were found to have tumors, for an overall incidence of 4.3%. Only 4 of the 27 tumors could be classified as leukemias.

However, it is hoped that the low incidence of leukemia encountered by the methods used thus far in our laboratory can be increased. More extensive use will be made of a C57 BL/6 transplantable tumor, which originated in this laboratory from a primary X-ray-induced leukemic spleen. The transplantable tumors will be concentrated by recognized methods and this concentrated material used for mouse injection and tissue culture passage. Methods have been developed for the successful culture of mixed spleen and thymus cells from healthy 1-2 week old mice. Cultures of this type will be used for inoculation and serial passage of material from X-ray-induced leukemic tissue.

Kemp, Norman E. AT(11-1)1050  
D1D191 EFFECTS OF IONIZING RADIATION ON  
SUBMICROSCOPIC STRUCTURE AND RESULTING  
ALTERATIONS IN METABOLIC FUNCTION,  
Michigan Univ., Ann Arbor. COO. SP 1; MYr 1.

Cytological effects of high dosages of gamma radiation from a Co<sup>60</sup> source are being analyzed in radio-sensitive tissues of tadpoles and adult frogs. Sections of skin, stomach, intestine, liver, pancreas, ovary and kidney are examined both by light microscopy and by electron microscopy in order to detect structural alterations. Changes are followed in tissues fixed immediately after irradiation and at regular intervals during the hours or days of survival. Condensation of nuclear elements and aggregation of cytoplasmic mitochondria and endoplasmic reticular elements may occur in susceptible cells. How the observed structural changes are related to altered metabolism is being investigated by analyzing the rate and localization of uptake of radioactive tracers administered after irradiation. Glycine-C<sup>14</sup>, phenylalanine-C<sup>14</sup>, thymidine-H<sup>3</sup> and uridine-H<sup>3</sup> are being used to measure fluctuations in levels of synthesis of proteins and nucleic acids. Radioactivity is assayed by autoradiography of tissue sections or chromatographs, and by Geiger or scintillation counting of fractionated tissues. Histochemical techniques will be used to supplement evidence obtained by tracer methodology.



Jacobson, Baruch S. AT(11-1)1117  
D1D197 MECHANISMS OF LETHAL RADIATION  
DAMAGE AND RECOVERY IN ALGAL FLAGEL-  
LATES.  
Minnesota, Univ., Minneapolis. COO.

Under normal conditions, mitosis in *Chlamydo-  
monas reinhardi* and in *C. moewusii* involves two to  
three divisions occurring in rapid succession. When  
this process is blocked by x-irradiation of single  
cells on agar, undivided cells are later found, as are  
colonies of 4, 8 or sometimes 16 cells, and larger  
colonies formed by the survivors in the original pop-  
ulation. Two-celled colonies are rare. Chloramphen-  
icol treatment produces a similar effect. Analysis of  
colony-size distributions and cytological observations  
are consistent with the assumption that lethal mitotic  
inhibition occurs primarily in cells preparing to be-  
gin a series of mitoses, but not in cells that have al-  
ready undergone the first division of the series.

The nature of the radiation-blocked stage in the  
mitotic cycle is to be investigated and characterized  
by analysis of the rates of protein, DNA and RNA  
synthesis in normal, irradiated and chloramphenicol-  
treated cells, by testing the effects of several other  
antimetabolites on normal and irradiated cells, and  
by further cytological studies, including autoradiog-  
raphy with  $H^3$ -thymidine and other suitable tracer  
compounds. Using cultures synchronized by periodic  
illumination, correlations will be obtained between  
the occurrence of postirradiation mitosis and the  
stage in the division cycle at the time of irradiation.

Green, David E. AT(11-1)1151  
D1D233 STUDIES ON INTEGRATED ENZYME  
ACTIVITY IN ANIMAL TISSUE.  
Wisconsin, Univ., Madison, Inst. for Enzyme Re-  
search. SP 12; MYr 11.2.

Studies will be continued along the following lines:  
(1) The structural and functional role of phospholipid  
in the mitochondrion with particular reference to the  
phospholipid micelle; (2) the isolation and character-  
ization of the three coupling factors and the high en-  
ergy complexes to which they give use; (3) the prin-  
ciples underlying the arrangement of oxidation-  
reduction components within the four complexes of  
the electron transfer chain; (4) the role of structural  
protein in mitochondrial structure; (5) a generalized  
scheme for the structure of membrane systems  
generally; (6) the mechanism of reaction of the  $\beta$ -  
hydroxybutyric dehydrogenase; (7) the reconstruction  
of the mitochondrion from its component repeating  
units.

Woolfrey, Bertram F. AT(11-1)-1089  
D1D246 A COMBINED IN VITRO RADIOAUTO-  
GRAPHIC, RADIOANALYTIC AND HISTOCHEMICAL  
STUDY OF SYNTHETIC PATTERNS IN NORMAL,  
BENIGN PROLIFERATIVE AND MALIGNANT TIS-  
SUES.  
Minnesota, Univ., Minneapolis. COO.

Investigation is being continued and expanded con-  
cerning the synthetic patterns of nucleic acids in  
normal, benign proliferative, and malignant animal  
and human tissues. This incorporates histochemical,  
radioautographic, and radiochemical methods. Under  
development and being applied is an in vitro proce-  
dure utilizing thin tissue sections, semi-tissue cul-  
ture techniques, and subsequent applications of the  
analytical methods. Various nucleic acid precursors,  
and co-factors tagged with tritium and/or carbon-14  
are being used and uptake rates, cellular and sub-  
cellular localization, and population growth param-  
eters are being measured by autoradiography and by  
liquid scintillation spectrometry.

Clark, J. Bennett AT(40-1)2956  
D1D272 AN INVESTIGATION OF PHOTOPRO-  
TECTION AND OTHER VISIBLE LIGHT INDUCED  
EFFECTS IN MICROORGANISMS.  
Oklahoma, Univ., Norman, Research Inst.

The study of photoprotection against x-ray inacti-  
vation in microorganisms will be continued. Work  
on visible light dosage for maximum effect and on  
visible light motion spectrum will be continued.  
Additional studies will be done on the few micro-  
organisms found which are sensitized to x-irradia-  
tion by prior visible light irradiation. The dose-  
rate dependence of x-irradiation found in  
demonstration of the photoprotective effect will be  
investigated. This will be done initially by studying  
the kinetics of inactivation of microorganisms at  
low dose rates (300r/minute) and comparing those  
results with those obtained at higher dose rates  
(3000r/minute).

Rubini, Joseph R. AT(40-1)2731  
D1D285 RADIOBIOLOGICAL SIGNIFICANCE OF  
B-AMINOISOBUTYRIC ACID.  
Texas, Univ., Dallas, Southwestern Medical School,  
OROO.

A satisfactory technic for the estimation of urin-  
ary beta-aminoisobutyric acid (BAIBA) levels has  
been developed using high voltage paper electropho-  
resis. Quantitative determination of 50-1000 micro-  
moles of BAIBA per liter is easily accomplished.

Since BAIBA may arise either from DNA-thymine degradation or from pre-DNA thymine diversion, efforts to trace the source of BAIBA excretion are planned, using clinical patient material and experimental animals. Correlative clinical studies on patients receiving radiation therapy will be carried out. Correlative studies will also be carried out on irradiated animals.

Roppel, Richard M. AT(30-1)2961  
D1D289 "EFFECTS OF RADIATION UPON RE-  
AGGREGATION OF DISSOCIATED EMBRYONAL  
CELLS."

Battelle Memorial Inst., Columbus, Ohio. NYOO,  
SP 1.

Chicken embryonic organ cells are dissociated by enzymatic methods and resulting cell suspensions are irradiated to selected dose levels. The cells are then caused to reaggregate into histotypic masses. Effects of irradiation upon the reaggregation process are assayed by several methods: counts and measurements of aggregates; counts of unreaggregated cells; and study of the degree of differentiation and/or organization in the aggregates.

Large differences are found in the sensitivities of cells of various organs to irradiation, as assayed by residual reaggregative potential. Neural retinal cells are much impaired in ability to recombine at doses of a few hundred R and fail to form histotypic masses at doses greater than 1400 R. Liver and kidney cells form characteristic structures at doses up to 80,000 R.

During the next period of work, studies will be extended by irradiation of freeze-dried cell suspensions with the purpose of avoiding water-mediated effects. Dose-effect measurements will then be analyzed according to appropriate target theory models. Electron micrographic studies of tissues formed by normal cells have shown that initial aggregates are largely syncytial in character. Cells irradiated to the extent that aggregation is impaired form tissues in which cell membranes appear to be nearly complete. During the next period, electron microscope studies will be extended to cells derived from other organs.

Post, Joseph AT(30-1)2778  
D1D303 EFFECTS OF H-3 THYMIDINE AS A DNA  
LABEL IN THE RAT LIVER.  
New York Univ., New York. Medical Center. NYOO,  
SP 3; MYr 2 1/2.

Following the observations concerning the production of polyploidy of liver cell nuclei, in the growing

rat, by a labeling dose of H<sup>3</sup>TDR (Rad. Res. 14, 713, 1961), studies have continued in two areas: A) Biological Effects of H<sup>3</sup>TDR and B) Aspects of Cell Proliferation.

A. Experiments are in progress on the effects of different dosage levels of H<sup>3</sup>TDR on the induction of polyploidy in the liver cell nuclei. In addition, studies are being performed on the effects of these varying dosages on the cell replication time and pattern in an attempt to understand better the mechanisms involved in the induced polyploidization, as one effect of radiation.

B. Other experiments are concerned with the time for new liver cell formation in growing rats of different ages. The results on 3 weeks old animals show that only about 4% of the total cell population is engaged in new cell formation at any time. The generation time is about 21.5 hours, DNA synthesis about 9 hours. The same group of cells has been followed through several cycles of division. These studies are continuing in newborn, 8 weeks old and fully grown (6 months old) rats. Further experiments are concerned with these replication patterns after injury, and in tumor cells. The measurement of these time intervals represents useful technique in the study of cells under many experimental conditions.

Flipse, Robert J. AT(30-1)1849  
D1D304 PATHWAYS OF METABOLISM IN BO-  
VINE GERM CELLS.  
Pennsylvania State Univ., University Park. NYOO,  
SP 3; MYr 1.4.

Cellular uptake and C<sup>14</sup>O<sub>2</sub> production by washed ejaculated spermatozoa were measured following incubation with sorbitol-C<sup>14</sup> under various conditions. Cellular uptake occurred both aerobically and under nitrogen. With a constant tracer dose of sorbitol-C<sup>14</sup>, the relative yields of C<sup>14</sup>O<sub>2</sub> with unlabeled sorbitol, glucose, and fructose were 100, 18, and 43, respectively. Fatty acids were less effective than the sugars in competing with sorbitol. These results plus the response to inhibitors such as malonate, fluoride and cyanide indicate that sorbitol metabolism in sperm is closely related to the metabolism of glucose and fructose. Products and intermediates of sorbitol metabolism are to be isolated and identified in order to delineate the pathway of sorbitol metabolism.

Kobayashi, Yutaka AT(30-1)2085  
D1D314 STUDIES ON BIOLOGICALLY ACTIVE  
AMINES.

Worcester Foundation for Experimental Biology,  
Shrewsbury, Mass. NYOO.

The work on the purification of diamine oxidase will be continued. Our present data suggest that diamine oxidase is a heterogeneous group of enzymes. Our data also suggest that neither pyridoxal phosphate nor FAD are co-factors for this group of enzymes as suggested by others.

The possible association of histidine decarboxylase with radiation damage will be studied. Early studies indicate that lethal doses of X-irradiation given to the rat result in the rapid loss of this enzyme from the stomach tissues. Further work will involve the use of fractional doses of radiation and the use of selected shielding to determine the sensitive organ for this phenomenon. The relationship between these observations and Schayer's hypothesis, *Science* 131, 226 (1961) will be investigated.

The possible use of the diamine oxidase assay developed in these laboratories as an early test for human pregnancy will be investigated. See Okuyama and Kobayashi, *Arch. Biochem. and Biophys.* 95, 242 (1961).

Morowitz, Harold J. AT(30-1)2687  
D1D317 THE STRUCTURE AND SYNTHESIS OF THE CELL MEMBRANE OF MYCOPLASMA GALLISEPTICUM AND THE RELATION OF STRUCTURE TO THE FUNCTION OF THE MEMBRANE AS A DIFFUSION BARRIER.  
Yale Univ., New Haven. NYOO.

Membranes of pleuropneumonia-like organisms (as well as other cells) can be disrupted by the addition of tertiary amines. Studies of ultracentrifugal patterns of the resulting membrane subunits indicate a reasonably homogeneous preparation of sedimentation constant the order of 2.5s. The present study deals with the further characterization of these subunits by: determination of chemical composition; studies on the partial specific volume and electron microscopic examination of the initial membranes, the deaggregated material and the reaggregated material. This last study necessitates a more thorough study of the reaggregation process in this system. From preliminary studies this is a function of amine concentration as well as the concentration of divalent metal ions. The process will be studied as a function of the concentration of these parameters.

Weiss, Charles AT(30-1)1727  
D1D318 ENZYMIC AND BIOCHEMICAL STUDIES OF EPIDERMIS WHICH HAS BEEN IRRADIATED WITH BETA PARTICLES.  
Albert Einstein Medical Center, Philadelphia.  
NYOO. May 15, 1962-May 14, 1963. SP 4; MYr 3.35.

Twenty-four hours after irradiation with a single skin surface dose of 3000 rep beta from an  $\text{Sr}^{90}-\text{Y}^{90}$  sealed source, we observed an increase in the activities of DNase I and RNase of guinea pig epidermis (*Radiation Research* 15, 785, 1961) and of extracellular nucleases of the skin surface (*Nature* 190, 921, 1961). Six specific acid and alkaline phosphatases as well as the nucleases present in normal epidermis are being investigated in order to compare their activities with those released after irradiation. This study, it is hoped, will enable us to obtain a sequential pattern of enzymic changes, to detect some immediate or early alterations and to discover a clue as to the primary site(s) of ionizing radiation injury in epidermal cells.

Experiments are also under way, with urethane as "initiator" and beta radiation as the "promoter," to determine whether or not the two-stage theory of carcinogenesis, known to be effective in mice and rats (*Brit. J. Cancer* 7, 472, 1953, and 11, 77, 1957), also holds for guinea pigs.

Harding, Clifford V. AT(30-1)2456  
D1D319 STUDIES ON TRANSPORT AND METABOLISM OF ISOTOPICALLY-LABELED MATERIALS IN THE EYE.  
Columbia Univ., New York. Coll. of Physicians and Surgeons. NYOO. SP 2; MYr 1.

In the broadest sense this project represents a study of the biological factors which regulate cell production in ocular tissues. It includes a study of both normal tissues and tissues injured by physical (including X-irradiation) and chemical means. It has been shown that small mechanical injuries to the epithelium of the ocular lens *in vivo* can initiate an activation of DNA synthesis and cell division which passes in wave-like fashion slowly outward from the site of injury. With sufficiently large injuries, this first wave is followed by a second, resulting in the formation of two concentric rings of DNA-synthesizing cells. In a second phase of the study an activation of DNA synthesis and cell division has been obtained in the isolated lens maintained in organ culture. This activation, which occurs in lenses which were not injured, appears to be a response to the isolation and culture procedures. Presently, the chemical and physical requirements for this *in vitro* activation are being studied. The purpose of the study is to obtain information on the conditions required to initiate or suppress DNA synthesis and cell division in organized tissues.

Solomon, A. K. AT(30-1)2453  
D1D320 PERMEABILITY OF MEMBRANES.

Harvard Univ., Cambridge, Mass. NYOO. SP 6;  
MYr 3 3/5.

The past year has seen three interesting developments about alkali cation transport across biological membranes. The first concerns potassium transport in the proximal tubule of the kidney of the *Necturus*, an amphibian characterized by extremely large kidney tubules, large enough for us to obtain samples of fluid as it flows through the tubule *in situ*. We have been able to confirm our previous finding that the proximal tubular potassium concentration increases as water is absorbed from the tubule. Intensive examination of the data so far obtained has led to the interesting suggestion that there may be a pump on that side of the cell facing the tubular lumen which pumps out of the tubule in exchange for potassium which is returned to the tubular lumen. This situation is analogous to the sodium potassium exchange pump which has long been assumed to operate on the other side of the cell, the one adjacent to the blood supply.

In another tissue, the frog skin, Dr. P. F. Curran has obtained evidence that the permeability of the cells in frog skin to sodium depends upon the sodium concentration of the environment. This suggests that the ion transport system is closely regulated in accordance with external stimuli, by means of a control system which adjusts to conditions in the external world.

Another piece of evidence along the same line has been obtained in our studies of the intestinal bacterium, *Escherichia coli*, which maintain a high intracellular potassium concentration in a medium with a potassium concentration lower by a factor of 100 or so than that in the bacterium. Present evidence suggests that an adaptive enzyme system may be concerned in this process. If this is indeed the case, it would provide evidence for a sensitive mechanism to adjust the potassium pump to the external situation. The total import of these observations leads to the suggestion that the whole apparatus of ion transport is intimately connected with the delicate balance of internal metabolism and external environment.

Doody, Edward AT(40-1)2005  
DID338 METAL COMPLEXES INVOLVING THE  
NUCLEIC ACIDS AND RELATED COMPOUNDS.  
Christian Bros. Coll., Memphis. OROO.

The apparent formation constants of metal complexes with the various ligands of the Krebs cycle are being determined in the presence of the living cells of yeast. Under proper conditions the metal uptake can be increased to over ninety percent thus allowing the equations of ion exchange equilibrium to

be applicable to living yeast. The metals studied are the manganese, cobalt, zinc, strontium and uranyl ions. Precision potentiometry coupled with programs for a digital computer yield the necessary formation constants of the metal complexes of ligands that have not yet been reported. Studies also on the uranyl complexes with ADP and ATP are also under study. Chronopotentiometric techniques are applied to the metal complexes of important body acids as well as pyrimidine derivatives to study effect of metals on the redox and hydrolysis reactions.

Mullins, L. J. AT(30-1)2464  
DID347 ACTIVE TRANSPORT OF IONS IN NITELLA.  
Maryland. Univ., Baltimore. School of Medicine.  
NYOO. SP 1; MYr 10/10.

Measurements of sodium ion fluxes in both directions across the cell membrane of *Nitella* are being made with tracer Na-24 and Na-22. The response of these fluxes to various environmental factors is under study. Cells are being cultured in Na-free culture solutions with the result that after some months the cultures are substantially Na-free. These cells will be examined for fluxes of K, Cl and of Na at tracer levels in order to further determine the behavior of the Na transport system. Measurements of membrane potential with glass microelectrodes are being carried forward concurrently with the flux studies in order that a precise estimate of the driving force for flux can be obtained.

Similar sorts of flux measurements, as well as equilibrium studies are being made on the cell wall envelopes obtained from *Nitella*. There are ion exchange systems with a reasonably high ion exchange capacity.

Bioelectric studies on *Nitella* are concerned with the measurement of ion movements associated with the action potential. Presently, cells are being equilibrated with special high specific activity Cl-36 for periods up to 90 days in order to have the maximum sensitivity possible for the measurement of the loss of the isotope. Similar experiments are planned for K, Rb, and Cs in order to evaluate the contributions that such ions may make to bioelectric phenomena in plants.

Klein, Richard M. AT(30-1)2587  
DID349 MECHANISMS OF ACTION OF X-IRRADIATION ON PLANTS.  
New York Botanical Garden, New York.

Studies on the interaction of ionizing and visible radiations as affecting plants will be directed towards the investigation of the following:

1. To determine whether the far red (760 m $\mu$ ) augmentation and the red (660 m $\mu$ ) amelioration of the deleterious responses of plants to X-irradiation are a general phenomenon in that a variety of cellular functions are similarly affected.

2. To determine whether the action spectra for these interrelated responses fits the absorption spectrum for the known red- far-red pigment, phytochrome.

3. To determine whether the far red augmentation and the red amelioration of the X-ray effect can be replaced with one or more biologically effective oxidants and reductants.

Bruce, A. K. AT(30-1)2571  
D1D350 A STUDY OF LETHALITY AND PERMEABILITY CHANGES IN IRRADIATED MICROORGANISMS.  
New York. State Univ., Buffalo. NYOO.

#### MODIFICATION OF THE RADIATION RESPONSE OF A HIGHLY RADIORESISTANT BACTERIUM.

The radioresistant bacterium *M. radiodurans* has been studied. Extracts have been demonstrated to contain a radioprotective compound which behaves similar to the sulfhydryl protective agent  $\beta$ -mercaptoethylamine (MEA). The reagent hydroxymercuribenzoate (HMB) if present during irradiation of this bacterium brings about a very great increase in its radiosensitivity, 0.1  $\mu$ mol/ml of the reagent reducing the resistance from an LD/90 of 450 Kr to approximately 80 Kr, a factor of about 6. Similar concentrations of HMB reduce the resistance of a related non-resistant organism by only a factor of 2-3. This is compatible with the hypothesis that the HMB removes the sulfhydryl protection and increases the contribution of indirect effects of radiation.

Proposed studies include an investigation of the binding properties of the cell for both the radioprotective compound, and of the sulfhydryl reagent HMB, to localize and quantitate their distribution. Attempts will be made to ascertain the amount of degradation of the cells radioprotective compound to the disulfide form during the rather drastic extraction process involving pressing and extended sonication. A chemical reduction of the cell extracts by various reagents will be carried out and the ability of the treated extracts to protect a sensitive test organism determined.

Novikoff, Alex B. AT(30-1)2786  
D1D352 CYTOCHEMICAL AND ELECTRON MICROSCOPIC STUDIES OF RADIATION DAMAGE.

Yeshiva Univ., New York. Albert Einstein Coll. of Medicine. NYOO.

There is urgent need to learn more about the earliest, still reversible, changes in cells that occur in radiation damage. This project is designed to use electron microscopy and staining reactions for different enzyme reactions for this purpose.

In the thyroid of rats given high doses of I<sup>131</sup> and in the intestinal mucosa in rats given lethal doses of total body irradiation the earliest and most dramatic changes occur in lysosomes. These are the newest of cytoplasmic particles to be described, chiefly by de Duve and his collaborators in Belgium. They contain a variety of hydrolytic enzymes capable of degrading most, if not all, cell constituents. Our studies show the lysosomes to increase markedly in size early in the course of cell injury. Other organelles such as Golgi apparatus and mitochondria change much later.

In contrast, the injury to lymphocytes, in thymus and lymph nodes, appears not to involve lysosomes in any dramatic fashion. To begin with, these cells have very few lysosomes; and they do not appear to change appreciably during cell death that follows total body irradiation or cortisone administration.

Alivisatos, S. G. A. AT(11-1) 1221  
D1D357 PROBABLE INVOLVEMENT OF HISTAMINE NUCLEOTIDE FORMATION IN MAST CELLS DURING HYPERSENSITIVE PHENOMENA.  
Chicago Medical School. Inst. for Medical Research. COO.

Histamine, in the presence of certain mammalian enzymes, interacts with pyridine coenzymes. The products of these interactions, di- and tri-phosphohistamine nucleotides, were isolated and identified. The probable implication of such interactions in the metabolism of histamine and in hypersensitive phenomena is under study. (a) Histamine dinucleotides were isolated from the carcass of guinea pigs after administration of 2(ring)-C<sup>14</sup>-labeled histamine and from cellular and subcellular preparations. (b) The fate of 2(ring, histamine)-C<sup>14</sup>-labeled dinucleotides after administration to mice and guinea pigs is under study. A limited number (probably, three) of split-products appears in the urine of such animals. One of them was identified as histamine ribonucleoside. Work is now in progress for the identification of the others. (c) It is expected that when the pattern of excretion products of histamine dinucleotides in animal species will be known, experiments with specific inhibitors (e.g., nicotinamide) in conjunction with inhibitors of other routes of histamine catabolism will further our understanding of the role of

various pathways of histamine catabolism in hypersensitive phenomena.

Hanson, J. B. AT(11-1) 790  
D1D358 THE ROLE OF RIBONUCLEIC ACID IN  
THE ACCUMULATION OF IONS BY PLANT CELLS.  
Illinois. Univ., Urbana. COO. June 1962-October  
1962.

The composition of plant membranes will be determined, using mitochondria as a source of membranous material. The formation of membranes during cell expansion will be followed with electron microscopy. The RNA associated with membranes will be examined in terms of extractability and base ratios, and associated cations. The possibility that RNases associated with mitochondrial membranes can polymerize cyclic nucleotides will be explored. The development of RNases during growth will be further studied.

An investigation will be made into the reasons for greater rates of ion accumulation in elongating cells as compared to meristematic cells. The diurnal variation in rates of salt uptake and respiration in roots will be studied.

The uncoupling of mitochondria by RNase will be studied with respect to whether RNase is inhibiting by virtue of being a basic protein or an RNA-degrading enzyme. The inhibition produced by basic proteins is presumably due to binding of the polycation to some negatively-charged group on the membrane. An attempt will be made to identify the compounds furnishing these acidic groups.

Portela, Adolfo AT(40-1)2700  
D1D374 EFFECTS OF X-IRRADIATION ON  
MUSCLE MEMBRANE.  
Emory Univ., Atlanta. OROO. May 1962-April  
1963. SP 2; MYR 2.

In this research program, entitled "Effects of X-irradiation on muscle membrane," it was specifically proposed to undertake a comprehensive study of some biophysical and biochemical properties of the muscle cell and its membranes before and after x-irradiation. The results are supporting the hypothesis that one of the early effects produced by high doses of X-ray is damage to membranes. The early effects of *in vitro* irradiation of frog muscles with 100 kr include prolonged relaxation time, more rapid fatigue, increased rates of oxygen consumption, decreased ATP content and P/O ratios, unchanged Ca-activated ATP-ase activity of muscle homogenates, increased Mg-activated ATP-ase activity of mitochondrial preparations, unchanged succinic dehydrogenase activity, and lowered membrane poten-

tials (due to an increase of Na permeability). Electron microscope examination of irradiated and normal muscles revealed extensive deterioration of mitochondrial structure after irradiation. The biochemical findings, along with these morphological changes in the mitochondria structure, suggested that radiation can uncouple oxidation from phosphorylation by damaging mitochondrial organization. High doses of X-rays, therefore, produce uncoupling of oxidation and phosphorylation, increasing respiration and allowing the accumulation of ADP. The rate of glycolysis is thereby accelerated, but since glycolysis alone cannot provide sufficient ATP to satisfy the energy needs of the cell, the ATP level drops. No evidence requiring the hypothesis of direct early damage to the contractile system was obtained. The effects of DNP and IAA have been studied in irradiated muscles and demonstrated that irradiation produces uncoupling, without significantly damaging other parts of the oxidative chain. This study is also in progress in skeletal muscles from mice. Fundamentally, a comparative study of the effects of x-irradiation on control mechanisms of respiration of muscle cells of cold- and warm-blooded animals will provide some understanding as to the mechanisms of radioresistance or radiosensitivity of this type of cell.

Bélanger, Leonard F. AT(30-1)2779  
D1D396 ALPHARADIOGRAPHY WITH POLONIUM  
AND PLUTONIUM SOURCES.  
Ottawa. Univ. NYOO. SP 1; MYR 2.

(1) A safe, practical type of polonium source containing 5 mc  $Po^{210}$  per sq. inch and manufactured in the U. S. has been adapted and could be made commercially available.

(2) Spectroscopic plates type V-O and type 649-0 (Eastman Kodak Ltd.) have been adopted as standard recorders.

(3) A critical source to object distance of 24-25 mm and an exposure time of 12-24 hrs. are now routine procedures.

(4) Studies of fixatives in relation to colloid of thyroid gland have revealed greater alpha density, histochemically related to the protein content, following ethanol-formaldehyde as compared to aqueous formaldehyde fixation.

(5) High density mucus (neutral) has been confirmed in the surface cells of stomach of different species as compared to low density mucus (acid) of neck cells.

(6) Most of the research program has been centered on the problem of bone resorption. Alphasradiography in combination with X ray microradiography

has revealed a mechanism of resorption related to enlarged osteocytes, involving loss of salt and organic matrix in chick, rat, dog and man.

Levitt, J. AT(11-1)683  
D1D439 THE MECHANISM OF THE ABSORPTION OF RADIOISOTOPES BY PLANTS. Missouri. Univ., Columbia. COO.

Mitochondria will be separated from roots and tubers and their absorption of radioisotopes (of Ca, Rb, P, S) followed at different pHs. The mitochondria will be treated in different ways to determine the effects of such treatments on their ability to take up the isotopes. The treatments will involve removal of one of the components—the lipids, the nucleic acids, or the proteins. In this way, it is hoped to find out which of the mitochondrial groups of substances actually bind the isotopes.

Microsomes will be investigated in the same way.

Hanson, J. B. AT(11-1)791  
D1D442 THE ROLE OF RIBONUCLEIC ACID IN THE ACCUMULATION OF IONS BY PLANT CELLS. Illinois. Univ., Urbana. COO.

The composition of plant membranes will be determined, using mitochondria as a source of membranous material. The information of membranes during cell expansion will be followed with electron microscopy. The RNA associated with membranes will be examined in terms of extractability and base ratios, and associated cations. The possibility that RNases associated with mitochondrial membranes can polymerize cyclic nucleotides will be explored. The development of RNases during growth will be further studied.

An investigation will be made into the reasons for greater rates of ion accumulation in elongating cells as compared to meristematic cells. The diurnal variation in rates of salt uptake and respiration in roots will be studied.

The uncoupling of mitochondria by RNase will be studied with respect to whether RNase is inhibiting by virtue of being a basic protein or an RNA-degrading enzyme. The inhibition produced by basic proteins is presumably due to binding of the polycation to some negatively-charged group on the membrane. An attempt will be made to identify the compounds furnishing these acidic groups.

Koenig, Harold AT(11-1)1180  
D1D449 A STUDY OF NUCLEOPROTEIN METABOLISM IN NORMAL, DEGENERATING, REGENERATING AND STIMULATED NERVE CELLS WITH RADIOISOTOPIC TRACERS.

Northwestern Univ., Chicago. Medical School. COO. SP 4; MYr 1 2/3.

Incorporation of labeled methionine and lysine into protein and adenine and orotic acid into nucleic acid is studied in motoneurons of cat spinal cord at various time intervals following axonal sections. Quantitative autoradiography will be employed to compare uptake into control and experimental neurons.

In a similar manner, the effect of electrical stimulation of peripheral nerves on uptake and loss of radioactivity from sensory and motor neurons will be investigated. Paralled biochemical studies will be carried out on dissected ventral gray columns and spinal ganglia involving extraction and measurement of specific activity of RNA.

Wilbur, Karl M. AT(40-1)2919  
D1D471 STUDIES ON THE EFFECTS OF RADIATION ON MUCOSAL AND FOETAL BRAIN ENZYMES AND RADIATION RECOVERY STUDIES ON SINGLE CELLS.

Duke Univ., Durham, N. C. OROO. SP 5.

A. Studies on phospholipases. The antioxidant activity of rat intestinal mucosa in the mitochondrial-ascorbic acid system has been identified as a phospholipase. After whole body radiation an activator for the enzyme disappears, the enzyme is inactive and the antioxidant effect disappears. The mucosas of the guinea pig, hamster and cat contain little or no phospholipase. Experiments will be done to determine whether these mucosas have antioxidant activity, and whether radiation affects it. Other tissues, such as thymus, bone marrow, and testis of various animals will be tested.

Histological studies to determine the locus of the phospholipase and activation in rat intestinal mucosa will be made.

B. Radiation recovery of single yeast cells (*Schizosaccharomyces pombe*). A comparison will be made between cells which have been grown anaerobically and aerobically with respect to retardation of division and survival after irradiation. The rate of linear growth of cells irradiated in oxygen and nitrogen will be determined. This will be done on individual cells so that changes of rate with time may be shown more clearly. The inhibitory effects of irradiated medium on division rate and linear growth rate will also be studied and compared with the effects of hydrogen peroxide.

Armstrong, Philip B. AT(30-1) 1343  
D1D488 STUDIES ON THE PHYSIOLOGY OF MARINE ORGANISMS USING RADIO ISOTOPES.

Marine Biological Lab., Woods Hole, Mass. April 1962–March 1963.

The Laboratory maintains a Hot-Lab on the top floor of its new research building for the general use of all investigators and students working at the Laboratory who have need for Radiobiological facilities. The Hot-Lab is well equipped for such work, and in addition has available a cesium 137 Irradiator. The facility is under the control of a radiation protection officer who not only polices Radio Isotopes, but also gives formal lectures on the use of Radio Isotopes and individual laboratory instruction to inexperienced users of isotopes so that proper precautions in their use may be observed. The Hot-Lab stocks isotopes in general demand by the various investigators and students and all needing the use of the facility have free and complete access to it at all times.

Chow, B. F. AT(30-1)-2992  
D1D518 ENDOCRINE GLANDS AND ABSORPTION  
OF Fe, Ca, AND Sr.  
Johns Hopkins Univ., Baltimore. School of Hygiene.

Schultz, Jack AT(30-1) 2356  
D1D562 STUDIES OF THE EFFECTS OF ULTRA-  
VIOLET RADIATION ON CELL STRUCTURE AND  
BEHAVIOR.  
Institute for Cancer Research, Philadelphia. March  
1962–February 1963. SP 6; MYr 3.3.

The vibrating mirror flying spot ultraviolet microscope will be employed in cytophotometry of nucleoprotein absorption in single, living cells. Serial estimations of integrated absorbancy will be made at various wavelengths during mitosis and interphase growth of cultured cells. These experiments will yield data on the kinetics of nucleic acid and protein synthesis in individual cells, and on their distribution during the mitotic process.

Studies of ultraviolet radiation effects on ascites cells and cells in culture will continue, using the vibrating mirror microscope to irradiate cells or parts of cells with monochromatized radiation at various wavelengths. The damage syndrome will be studied in terms of the morphological changes induced, and by cytophotometry to assess changes in nucleoprotein content and distribution. Radiation damage artifacts induced in living cells by ultraviolet microscopy will be demonstrable even if expressed only as inhibition of growth or synthesis.

Further development of the vibrating mirror flying spot microscope will provide an additional kinescope and automatic camera for time-lapse records, and an automatic stage movement system to facilitate background intensity readings in cytophotometric proce-

dures. To allow integration of irregularly shaped, or contiguous objects, an integrator control is to be provided allowing the photometric field to be defined by means of a template drawn on a kinescope display.

Klein, William H. AT(30-1)2373  
D1D563 A STUDY OF THE BIOCHEMICAL EF-  
FECTS OF IONIZING AND NONIONIZING RADIATION  
ON PLANT METABOLISM DURING DEVELOPMENT.  
Smithsonian Institution, Washington, D. C. May 15,  
1962–May 14, 1963. SP 10; MYr 4.5.

Studies in radiation botany concerning biochemical mechanisms and the kinetics of specific responses will be continued. The major areas to be investigated include: (1) the chemical changes of leaf tissue subjected to various light pretreatments, with particular emphasis on plastid development; (2) the changes in radiosensitivity of germinating seeds and seedlings and the relationship of these changes to physiological and metabolic states; (3) protein synthesis associated with the development of the chloroplast of higher plants; (4) measurement of changes in spectral distribution of total sky radiation.

Paoletti, Rodolfo AT(30-1)3091  
D1D602 EFFECT OF IONIZING RADIATIONS ON  
THE CONTROL MECHANISMS OF LIPID TRANS-  
PORT.  
Milan. Università. NYOO.

The effect of the acute and chronic treatment with ionizing radiations on lipid mobilization and transport will be investigated at different levels (mobilization of fatty acids from adipose tissue, synthesis and deposition of triglycerides in the liver, secretion of triglycerides from the liver to the plasma).

The investigation will be carried out with special reference to the interference of ionizing radiations with the physiological control mechanisms of lipid mobilization and transport, mainly peripheral sympathetic system, thyroid and adrenocortical hormones.

The effect of the radiations on lipids will be studied in presence of activated (cocaine treatment) or depressed sympathetic system (treatment with long lasting ganglionic blocking agents; depletion of catecholamines in the nerve endings with reserpine or guanethidine; use of antiadrenergic agents). A particularly interesting new experimental model is offered by rats without peripheral sympathetic ganglia ("Montalcini rats").

The possible role of ionizing radiations on fatty acids mobilization will be also investigated using a new *in situ* perfusion system of the dog omental fat, in which it is possible to measure on a quantitative basis the release of fatty acids after a direct stimulation.



The use of animals deprived of thyroid, adrenal, hypophysis and animals submitted to treatment with the corresponding hormones will help to identify the point of attack of the ionizing radiations on the factors regulating the lipids' transport.

## D1E Mineral Metabolism

See also A2B25, D1D22, D1D347, and K1B391.

Spencer, Herta AT(11-1)1231  
D1E68 "METABOLISM AND REMOVAL OF Sr-90 IN MAN."  
Loyola Univ., Chicago. Stritch School of Medicine. COO.

Low level counting techniques will be used in studies of the metabolism and removal of Sr<sup>90</sup> in man. Different agents which were shown to be effective in enhancing Sr<sup>85</sup> excretion in man will be administered to induce enhancement of Sr<sup>90</sup> excretion; for instance, intravenous calcium, orally administered ammonium chloride, corticosteroids and newer chelating agents as well as a combination of these agents. These investigations will be carried out during low and high calcium intake under strictly controlled dietary conditions on the Metabolic Research Ward without administering any radioisotope. The intake of Sr<sup>90</sup> in the diet and the output in urine and stool will be measured. Sr<sup>90</sup> and calcium balances will be determined in the base line period and during the enhancement studies. Also, balances of calcium, phosphorus, and nitrogen will be determined throughout both study phases.

Heaney, Robert P. AT(11-1)587  
D1E92 Ca-45 AND Sr-85 METABOLISM IN MAN.  
Creighton Univ., Omaha. School of Medicine. COO.  
SP 3.5; MYr 3.5.

The program of this laboratory is directed at an elucidation of the mechanisms for the control of bone metabolism in the normal adult, together with an understanding of the derangement thereof associated with metabolic bone disease. This work is involved primarily with the non-homeostatic factors which influence bone formation, including growth hormone, mechanical stress, and blood flow as well as the end-organ balance in the response to homeostatic factors, principally parathyroid hormone. Additional studies are being directed at the possible use of S-35 as an auxiliary bone tracer, in the hope of obtaining independent evaluation of Ca-45 bone uptake.

Aronoff, S. AT(11-1)1100  
D1E360 THE CHEMISTRY OF BORON IN PLANTS.

Iowa State Univ. of Science and Tech., Ames.  
Inst. for Atomic Research. COO.

With the knowledge that phenylboronic acid may serve as the sole source of boron in sunflower nutrition (although exerting a unique influence in addition), we have synthesized phenyl-C<sup>14</sup>-boronic acid as an adjunct tracer for boron. Autoradiography of plants fed this compound shows almost uniform distribution in the aerial portion. When leaves from plants fed C<sup>14</sup>-phenylboronic acid are extracted with 80% ethanol and the petroleum ether extracted 80% ethanol extract in chromatographed on paper, two C<sup>14</sup>-spots are obtained neither of which are phenylboronic acid. Their chemical properties indicate that they are not simple complexes. At present, experiments are under way to determine whether the two C<sup>14</sup>-containing materials are the result of the metabolism of phenylboronic acid in plants or artifacts of isolation. In addition, preliminary studies on the feasibility of methylboronic acid (and the corresponding synthesis of methyl-C<sup>14</sup>-boronic acid) have shown that this compound may prove to be considerably superior to phenylboronic acid as a tracer for boron.

As we initially showed, the symptomatic fluorescence of B-deficiency is the result of the accumulation primarily of caffeic and chlorogenic acids. Kinetic studies over an 8-day period now show that in B-leaves there is a rapid initial accumulation of caffeic acid, followed by a similar increase in chlorogenic acid, as might be expected from the homology of the compounds. The possibility of a correlation between the accumulation of phenolic acids and the necrosis of phloem tissue observed in boron deficient plants is being investigated.

Currently, a number of compounds are being tested as possible substitutes for boron in plant metabolism. Although results are as yet inconclusive, a few have shown promise and are being investigated further. In addition, studies are now in progress to ascertain the intracellular distribution of C<sup>14</sup>-labeled phenyl and methylboronic acids in sunflower. It is hoped that these avenues of research together with the feeding of the latter compounds to cultures of various plant tissues will enable us ultimately to determine the site and function of boron in the cell.

Joham, H. E. AT(40-1)2859  
D1E378 THE INFLUENCE OF MINERAL ABSORPTION, DISTRIBUTION AND UTILIZATION

## ON THE HOST PARASITE RELATIONSHIPS OF DISEASED COTTON.

Texas. Agricultural Experiment Station, College Station. OROO. MYr 2.

Cotton varieties varying in resistance to bacterial blight were grown in plastic pots containing complete nutrient solution. Three levels of calcium were supplied. The absorption and distribution of calcium were determined. Results from inoculation studies indicated that a variety x substrate calcium level interaction was significant. Thus increasing calcium level increased disease resistance in one variety and decreased resistance in the other two. A second experiment is now underway employing the same cotton varieties and levels of substrate calcium. At several dates, young, medium and old leaves will be inoculated with the bacterial blight organism. The calcium level of each inoculated leaf will be determined after the disease grade has been established. In another experiment, cotton plants will be grown in complete nutrient solutions. One series will receive calcium 45 during the initial 45-day period while a second series will be receiving the normal isotope. At the end of the initial 45-day period the isotope supply will be reversed. The plants will be mass inoculated with the bacterial blight organism and the influence of the disease on calcium absorption and distribution will be studied.

Ballentine, Robert AT(30-1)-1822  
D1E411 CELL MEMBRANE PERMEABILITY AND ACCUMULATION OF IONS.

Johns Hopkins Univ., Baltimore. MYr 0.35.

This research project is concerned with the problem of calcium and strontium metabolism. On a basic biochemical and cytochemical level we have sought for information to give us understanding of how cells and tissues accumulate an element such as one of the alkaline earths. We set up the hypothesis that in many organisms and many types of cells the driving energy for the accumulation of di- and multi-valent elements derives not from cell membrane processes but rather from the complexing activity within the intracellular soluble and particulate phases. This hypothesis has been substantiated by our experimental investigation in the case of the protozoan, *Tetrahymena*. The proposed investigation is to complete the detailed delineation of the sites and mechanisms whereby calcium and strontium are stably complexed by the subcellular structures. Supplemental to this phase of the research is the investigation of the interaction of nutritional status and these metabolic processes. Our former work has shown that significant alterations in the dis-

crimination ratio between calcium and strontium may be brought about by a variety of growth factor deficiencies or by certain metabolic inhibitors. In this, the terminal year of the contract, the results previously reported are being prepared for publication.

Cope, Oliver AT(30-1)2092  
D1E498 METABOLISM OF ALKALINE EARTH METALS.  
Harvard Univ., Cambridge, Mass. NYOO. SP 4; MYr 3.

The following six months will be devoted to the completion of the project already initiated. Bone analyses in ten patients will be completed to obtain the correlation of bone magnesium with the amount of exchangeable magnesium determined by isotope dilution methods. The isotope studies have been completed, but the bone analyses are in the process of completion at the present time.

Final calculations and details for publication are being completed on the studies on alcoholic patients relating the exchangeable magnesium to their state of alcoholism. Over 30 subjects are involved in this study and the laboratory work has been completed to permit final analysis of the data for tabulation and publication.

These two efforts will conclude our studies relating the determination of exchangeable magnesium by isotope dilution methods to the magnesium content of bone as obtained by direct chemical analysis and will complete our studies on magnesium metabolism in alcoholic patients.

## E ENVIRONMENTAL RADIATION STUDIES

### E1 TERRESTRIAL AND FRESH-WATER ECOLOGY

#### E1A Plant and Animal Systems

Platt, R. B. AT(40-1)2412  
E1A4 EFFECTS OF RADIATION ON PLANT AND ANIMAL COMMUNITIES IN NORTHERN GEORGIA.

Emory Univ., Atlanta. OROO. SP 9; MYr 8.7.

This program is designed to provide basic information on the effects of ionizing radiation on plant and animal populations and communities. The primary orientation is to consider ionizing radiation as an environmental factor along with

other factors such as temperature, moisture, and light.

Radiation levels in the environment have already increased and the possibility exists that they may continue to increase. Atomic explosions and peaceful uses of atomic energy may bring about drastic increases in certain areas. Scientists have a direct obligation to look into the short and long range effects of such potential radiation dosages on our environment, for we are dependent upon it for the space in which we live, the materials from which we build our homes and cities, and the lands on which we produce our food.

The procedures are based primarily on the exposure of plant and animal communities to gradients of radiation ranging from background levels to those well above lethality for most species. Both chronic and intermittent radiation sources are used. These include a 2500 curie  $CS^{137}$  source in the center of a fifty foot diameter field on the Emory Campus, a ten megawatt air shielded reactor on Air Force 67 Reservation in north Georgia and a proposed 40 acre natural gamma field for controlled irradiation studies. Appropriate controls are set up in comparable vegetated areas, so that radiation effects may be separated from those produced by other adverse environmental conditions and with which radiation effects may be easily confused.

Both descriptive and experimental approaches are utilized. Basic problems include the effects of radiation on succession, community structure and composition, primary and secondary growth, rates of humus decomposition, forest productivity, soil fertility, animal ecology, vegetation and terrain shielding, and dosimetry.

Carmon, James L. AT(40-1)2975  
E1A6 A STUDY OF GENETIC VARIANCES AND COVARIANCES IN A NATURAL BREEDING POPULATION OF PEROMYSCUS POLIONOTUS AND THE EFFECT OF RADIATION ON THESE GENETIC PARAMETERS.  
Georgia. Univ., Athens. OROO. May 16, 1962-April 1963.

The parent population will be trapped at the Savannah River Project, brought into the laboratory and expanded into a population of approximately 400 females and 100 males. The animals will be separated at random into three equal groups. Before breeding, the males will receive either 0, 100R, or 200R of gamma radiation.

Genetic variances, covariances, and correlations will be estimated for litter size, litter weight at birth, individual weight at weaning and maturity, body

length, spleen and adrenal weight. The analysis will be to determine if radiation changes these genetic parameters.

The effect of low level radiation as a stress factor will be determined by measuring spleen and adrenal weights and by histological characters.

The effectiveness of induced variability in providing flexibility in adapting to new environments will be tested by releasing mice from the study into field enclosures and comparing with wild mice in the enclosure.

Tinkle, Donald W. AT(40-1)2673  
E1A14 EFFECTS OF RADIATION ON A NATURAL POPULATION OF LIZARDS.  
Texas Technological Coll., Lubbock. March 1, 1963-February 29, 1964. SP 4; MYr 1.

The purpose of this study is to determine how high dosage radiation effects the biology of natural populations of organisms and what effects are evident in their offspring through at least two generations.

Two 2-acre areas have been established in a desert environment in western Texas. The lizards in both of these areas were studied in detail for at least one full year before experiments were begun. The growth rate, birth rate, death rate, distance of dispersal, size of home range and reproductive potential are a few of the characteristics studied in detail by mark and recapture and through mass sampling of lizards from adjacent areas. In addition 15 morphological characteristics were studied in at least 100 animals of each sex to determine their range of variation.

One of the two study areas, designated the experimental area, was chosen to carry out irradiation studies. All lizards in the area were irradiated with 450 r of X-ray in March, 1962. The  $F_1$  offspring from these irradiated adults was studied in the summer of 1962, the  $F_2$  generation will be studied in the summer and fall of 1963. At the same time data are being obtained from lizards on the second (control) area to compare with that obtained in experimental animals.

Finally, comparison will be made between data obtained in both areas before and after irradiation. In this way, changes in the experimental area that do not occur in the control can be assumed to have resulted from irradiation.

Odum, Eugene P. AT(38-1)310-I  
E1A17 ECOLOGICAL AND RADIOECOLOGICAL INVESTIGATIONS AT THE SAVANNAH RIVER PLANT.  
Georgia. Univ., Athens. Inst. of Radiation Ecology. SROO.

The University of Georgia, Institute of Radiation Ecology, Savannah River Research Program, has been, from the beginning of the Savannah River Production Site of the Atomic Energy Commission (1952), designed as a basic study of structure and function of ecosystems on the theory that experimental work in radiation ecology is best carried out in environmental systems which have been previously studied from the functional standpoint.

Work during the past years was divided into 17 subprojects which covered wide areas with special emphasis on succession, population dynamics and radioactive tracers applications. Most of these subprojects have been completed or condensed into three subprojects which form the nucleus of the on-site program.

Old-field Studies. Previous work has shown a definite oscillation in rates of production and in diversity of vegetation on denuded land. Hypotheses about successional processes will be tested by observing succession on experimentally denuded areas.

Loss Rate Studies. Emphasis is being placed upon an evaluation of the use of tracers to measure processes of free-living animals. Experiments are carried out in the laboratory and in ecosystems within field enclosures. Whole body loss rates are related to such factors as temperature, food consumption, energy flow, and reproduction.

Effects Studies. Enclosures are also being used to study radiation as a stress in seminatural populations of wild mammals. Previous studies concerned with determining ecological LD<sub>50</sub> of birds suggested that wild birds are more resistant to radiation than domestic species.

Breckenridge, W. J. AT(11-1)899  
E1A72 RADIATION AND OTHER FACTORS INFLUENCING THE DISTRIBUTION OF ANIMALS. Minnesota. Univ., Minneapolis. Museum of Natural History. COO. SP 3; MYr 0.8.

The objectives are to study the factors limiting the distribution of the toads, Bufo t. americanus, B. cognatus and B. hemiophrys which reach their range limits in a 20 mile zone in northwestern Minnesota, and to compare their natural behavior with that of artificially irradiated toads. Our studies of Bufo hemiophrys indicate that there are three crucial periods in this animal's life, any one or more of which may determine the habitat within which it can persist. These are the periods of metamorphosis, when pond water temperature and chemical contents are vital; of aestivation; and of hibernation, when soil temperature, structure, and the chemical composition of the soil moisture are important.

Field studies of animals marked with radioactive tantalum and located with scintillometers have shown that toads burrow on dry land for hibernation and that some activity occurs in midwinter. Local populations of B. hemiophrys winter in low earth mounds of unknown origin.

Studies of the tolerances of eggs and tadpoles in waters with varying temperatures and concentrations of sulphates, chlorides, carbonates, and hydrogen ions under laboratory conditions show that B. hemiophrys tadpoles are more resistant to extreme conditions than B. t. americanus and that certain metallic ions such as sodium and potassium are more detrimental to both species than are calcium or magnesium ions.

The behavior of both normal and irradiated toads is being studied under simulated winter conditions in the laboratory.

Tremaine, Marie AT(30-1)2797  
E1A73 ARCTIC BIBLIOGRAPHY.  
Arctic Inst. of North America, Washington, D. C.  
NYOO.

The purpose of the Arctic Bibliography since its inception in 1947 has been to provide a key to scientific publications relating to the Arctic and Subarctic that are available in the principal libraries of the United States and Canada and to systematize the material so that it may be readily available to scientists and others concerned with problems of northern research and development.

Ten volumes of the Bibliography have been published, Volume 11 was completed in May, 1962 and sent to the publisher in October. It will be published about June 1963. Volume 12 is to contain approximately 6,600 abstracts with index and is to be ready for printing in June 1963.

The Arctic Bibliography contains: (1) An author listing of books and papers on the Arctic and Subarctic, alphabetically arranged in standard library style, with translations of titles of non-English works, an informative summary of the contents of each book or paper and an indication of at least one major library in which a copy is located. (2) A sub-subject-geographic index and cross index in which books and papers are indexed by subject matter, general region, and by notable geographic features such as bays, rivers and lakes.

Everett, Keye R. AT(11-1)1157  
E1A76 SLOPE MOVEMENT AND MICRO-ENVIRONMENT AT CAPE THOMPSON, ALASKA. Ohio State Univ., Columbus. Inst. of Polar Studies. COO. MYr 1.

Results of slope movement investigations over the period 1960-1962 at Chariot Site, Alaska, indicate significant slope movements take place during the periods of freeze-up and thaw and vary in amount from year to year.

Individual measured movements ranged from 0.5 mm to 3.4 cm/year. The amount and rate of this movement is governed by soil texture, as it influences the type of ice formed, the presence or absence of vegetation, and changes in relative humidity. Changes in relative humidity, though not always separable from other causes of movement, are significant during the late spring and summer.

Movement is discontinuous in space and time. The measurement rate (exclusive of nonsorted circles) computed on a yearly basis for 100 years, is 22 meters. This is regarded as a maximum figure assuming a particular site moved each year by the same amount.

Gross movement data obtained from six large pits in various slope situations indicate that movement on the southeast-facing slope is continuing mainly by solifluction. The benched features on the opposing slope are regarded as stabilized forms which originated perhaps thousands of years ago during a climate warmer than at present. These features are regarded as having been formed by a process intermediate between earthflow and non-saturated creep.

Provost, Ernest E. AT(38-1)294  
E1A78 THE EFFECT OF WHOLE BODY AND GONADAL IRRADIATION ON REPRODUCTION AND SURVIVAL IN FERAL POPULATIONS OF SMALL MAMMALS.  
Georgia. Univ., Athens. School of Forestry, SROO.

In the most general terms, the objective of this study is to determine the effect of radiation on ecological survival levels in samples from natural populations of selected small mammals. Emphasis is being directed upon the reproductive capacity of treated females as compared to untreated controls. Initially it was hypothesized that feral populations would be less susceptible to radiation damage than would typical laboratory strains. The results of acute, whole body cobalt irradiation experiments, to date, have borne this out, indicating higher LD 50<sub>(30)</sub> levels in wild animals as opposed to comparable domesticated species.

Experiments in progress are designed to:  
(1) Quantitate the effects of low, medium, and high sublethal doses of whole body gamma irradiation on survival and reproduction in adult and immature

females, and fetuses in utero. (2) Determine the effect of gonad irradiation at various levels and during various seasons on subsequent reproduction in adult females.

Hamilton, J. R. AT(40-1)2905  
E1A79 AN EVALUATION OF THE EFFECTS OF HIGH LEVEL RADIATION ON THE ANATOMY OF LIVING TREES.  
Georgia. Univ., Athens. School of Forestry, OROO. SP 3; MYr 1 3/4.

Cell aberrations and gross morphological damage in the apical meristems of several tree species has been reported to be associated with exposure to ionizing radiation. Since a physiological relationship is thought to exist between the apical and lateral meristems in this type of material, a descriptive study of cell aberrations occurring in the secondary xylem was deemed to be of value.

Included in the study were several pole size individuals of angiospermous and gymnospermous tree species which had all above ground parts exposed to chronic or acute dosages of either gamma or mixed gamma-slow neutron radiation. Examination was restricted to samples obtained at 4.5 feet above the ground.

Acute but sub-lethal dosages of mixed gamma-slow neutron radiation caused the production of grossly aberrated secondary xylem cells and a reduction of secondary cell wall development in P. echinata during and immediately following the period of exposure. Less aberration was observed in Q. alba and L. styraciflua. A resumption of apparently normal cell production was observed, -in trees which remained alive several years after exposure.

Chronic exposure of P. rigida to gamma radiation over a period of several years resulted in similar cell abnormalities after a certain minimal dosage had been accumulated.

Current studies are concerned with cell multiplication, differentiation and enlargement in cambial and cambial derived cells of young pine stems exposed to controlled low-level gamma radiation.

Jenkins, James H. AT(38-1)293  
E1A80 RADIATION AND POPULATION STUDIES ON A LARGE PREDATOR (LYNX RUFUS) ON THE SAVANNAH RIVER PROJECT.  
Georgia. Univ., Athens. School of Forestry, SROO. SP 1/4 man year; MYr 1.5.

This project in wildlife management ecology seeks to appraise the radionuclide uptake of a large pred-

ator throughout its life span and to test a new approach to censusing of an elusive species through the use of isotope "spiked feces." Few, if any, studies have been made on the radio-biology of a large predator. The wildcat occurs in unusually large numbers on this outdoor laboratory. Techniques of trapping, handling, and care of these animals on this area have been worked out. Background levels of isotopes in this species will be determined for the coastal plain and the southern Appalachians using a whole body counter being built for this project. Results can be checked against a human whole body counter and by analysis of bones and flesh. Recapture of these animals is extremely difficult so radio tracking is being developed. Censusing, previously nearly impossible for many species, may be simplified with the "spiked feces" technique particularly in an animal with obvious feces depositories. This would open a whole new approach to field biology.

Heaslip, Margaret B. AT(40-1)2066  
E1A81 ECOLOGICAL EFFECTS OF FAST NEUTRONS AND GAMMA RADIATIONS ON DORMANT AND PHYSIOLOGICALLY ACTIVE SEED OF TREE SPECIES NATIVE TO THE EASTERN DECIDUOUS FOREST AREA.

Morehead State Coll., Ky. OROO. SP 2; MYr .95.

Acute doses of cobalt-60 gamma rays affect germination, seedling growth, and survival of 18 tree species native to the Eastern Deciduous Forest in an individual fashion. Various factors modify radiosensitivity by affecting water content and physiological activity of seed. Seed of native tree species that have dormant embryos are excellent materials to use to compare the relative effects of water and physiological activity on radiosensitivity. These investigations are now under way. Permanent plantings of seedlings grown from irradiated seed have been made to observe the effects of irradiation that continue throughout the vegetative and reproductive cycles. The possibility of seed radiosensitivity being used as an indirect test of seedling radiosensitivity is being investigated by comparing relative seed and seedling radiosensitivity of selected species. The radiosensitivity of Juglans nigra L. seed collected from 3 geographically distinct genetic populations in 1960 and 1961 did differ significantly from one population to another. The radiosensitivity of the 1960 and 1961 seed crops from a given population did not differ significantly. Exploratory investigations of the relative biological effectiveness of fast neutrons and gamma radiations on seed germination and seedling survival of 7 tree species are now being made.

Blair, W. Frank AT(40-1)1751  
E1A104 DIRECT AND INDIRECT EFFECTS OF IONIZING RADIATIONS ON THE GENETIC AND DEVELOPMENTAL SYSTEMS OF VERTEBRATES. Texas. Univ., Austin. OROO.

Indirect effects of x-irradiation, through genetic damage, on natural populations of the Mexican toad (Bufo valliceps) and feral house mice (Mus musculus) are being investigated. Measurement is in terms of population success and individual longevity of marked individuals. Males in a natural breeding population are irradiated (300-r) by gonadal dosage the first time they are recorded. The population is followed by capture, mark and release methods. Two control and three irradiated populations of house mice were established on spoil islands in the Laguna Madre, and these have been followed by mark and recapture methods. Reports on both projects are being prepared for publication.

Tryon, C. A., Jr. AT(30-1) 2579  
E1A112 RADIO-ECOLOGY OF SMALL VERTEBRATE SPECIES UNDER NATURAL ENVIRONMENTS.

Pittsburgh. Univ. NYOO. SP 2; MYr 8/10.

The effect of sub-lethal ionizing radiation on individuals has been investigated to some extent, but its effect on populations of animals under natural conditions is not known. Since the responses of a free-ranging population, subject to the effects of its normal environment, are quite different from those of a laboratory population, it is essential to make this step from the laboratory to the natural environment.

Two mammalian species, the pocket gopher (Thomomys talpoides) and the chipmunk (Tamias striatus) have been shown to be suitable for irradiation experiments under natural conditions and populations of the pocket gopher in Wyoming and of the chipmunk in Pennsylvania have been tagged and various physiological and morphological parameters determined. These populations show differences in morphometry, endocrine gland activity, metabolism, fat deposits, population density, growth and age classes with altitude and with season and thus provide the means for an experimental approach to the effects of gamma irradiation on population dynamics. Isotopes of iodine and zinc have been used in free-ranging mammals to estimate uptake and retention of these elements in relation to diet, altitude, season and population density. The latter of these seems to have the greatest effect on the metabolic utilization of these elements.

Peterle, T. J. AT(11-1) 967  
E1A116 NEW TRACER TECHNIQUES FOR  
EVALUATING THE EFFECTS OF AN INSECTI-  
CIDE ON THE ECOLOGY OF A FOREST FAUNA.  
Ohio State Univ. Research Foundation, Columbus.  
COO. MYr 3.

Need for knowledge of the basic ecology of forested areas combined with the need for additional reliable information concerning the effects of forest insecticides presents a unique opportunity for simultaneous intensive investigation of these two fields. The faunal ecology of two similar, adjoining watersheds of approximately 20 acres each was studied for one year prior to treatment of one with the organophosphate insecticide, malathion. Studies conducted for two years after treatment will seek to determine the effects of the pesticide on the fauna of the area and to measure insecticide movement, redistribution, and cycling as related to time.

Quantities of a standard two pound per acre application of malathion were labeled with Sulfur 35 to follow the insecticide throughout the ecosystem, to detect soil-water-fauna-insecticide relationships, and to develop methods for determining insecticidal effects on a hardwood forest ecosystem. The area was treated in May, 1962, and sampling will continue until September, 1963. The preliminary results suggest a reduction in insects for 2-3 weeks but little or no effect on vertebrate populations or soil microorganisms. Radioactive assays of faunal samples provided satisfactory estimates of residues.

Gilbert, Gareth E. AT(11-1)552  
E1A117 CONTINUING BIOCLIMATIC AND SOILS  
INVESTIGATIONS IN FOREST ENVIRONMENTS.  
Ohio. Agricultural Experiment Station, Wooster.  
SP 5; MYr 3.

This investigation is a continuation and elaboration of a bioclimatic research program which was established within the Department of Botany and Plant Pathology of The Ohio State University 20 years ago. Specifically, the climates of three major forest communities of the Appalachian Plateau will continue to be studied during all seasons of the year by a variety of constantly recording instruments for the express purpose of the establishment of new, as well as further elucidation of previously established, principles concerning forest climates. Weekly, frequently twice weekly, observations concerning plant growth, development, and behavior will continue to be made throughout the year of some 400 native plant species within the experimental forests, and will include such items as germination, seedling growth and death, bud formation, leaf development,

leaf coloration, leaf abscission, flowering, fruiting, initiation and length of dormancy, radial and longitudinal growth of woody stems, among many others.

Studies of forest soil environments will also be continued and will, as before, include researches concerning the annual march of soil moisture and temperature at various depths, root distribution, as well as soil profile and physical characteristics.

Preliminary studies concerning radioactive materials as important factors within forest environmental complexes will be continued, and will include radiological investigations of various native plant materials as well as amount, distribution, and migration of radioactive materials within forest soil environments.

Yeager, Lee E. AT(11-1)898  
E1A119 EFFECTS OF THE ENVIRONMENT ON  
A WILD DEER POPULATION.  
Colorado State Univ., Fort Collins. COO. SP 7;  
MYr 2.7.

The Cache la Poudre mule deer population in North-Central Colorado has been studied ecologically and nutritionally since June, 1960, in quantitative measurement of environmental conditions affecting behavior and physical condition. Measurement of deer response to these conditions was begun in 1961.

Project objectives are being sought by: (1) micro- and macro-climatic measurement at 4 environmental measurement stations operating continuously on representative winter range at 8,000 feet elevation; (2) vegetative measurements, calibrated by slope, exposure, and soil characteristics, and including composition, density, year-around phenology, forage production, forage utilization, and nutritive content and digestibility coefficients of key food species of mule deer; (3) movements and behavior, determined seasonally, as influenced by food availability, quantity, and quality; weather conditions, including temperature, precipitation, snow depth, wind, humidity, and thermal belts; and topography, including slope, exposure, rock formations, valleys, draws, vegetation (as determined by topography), and proximity of food and water to vegetative and other cover; and (4) approved statistical design and analysis of data for all major phases of the investigation. Selected radiological determinations were begun in 1961 and will be continued in the Section of Radiology, Colorado State University, through the next annual segment under Contract AT(11-1)-1156, for which the investigation summarized here will provide certain environmental calibrations. During the summer and fall of 1962, the prototype of an electronic device

for obtaining quantitative data on deer activities and behavior patterns, as influenced by environmental stimuli, was perfected and will be employed on an experimental basis in 1963.

Petty, Robert AT(11-1)-1006  
E1A160 RATES AND PATTERN OF MOVEMENT  
OF VARIOUS ISOTOPES IN A CENTRAL MESO-  
PHYTIC FOREST: ALLEE MEMORIAL WOODS,  
PARK COUNTY, INDIANA.  
Wabash Coll., Crawfordsville, Ind. COO.

With ever increasing amounts of long lived radioactive materials being added to our environment, both as fallout from weapons tests and through reactor waste disposal procedures, plus the looming possibility of tragic amounts being contributed by thermonuclear war devices, the rate of element movement and distribution in biogeochemical cycles is receiving renewed attention. A detailed characterization of biologic half-life for the prominent isotopes and their concentration factors in dominant organisms and soil types of many environments is needed if we are to have sound biologic answers to the many questions already arising out of a growing nuclear industry.

The initial purpose of this project is to study (1) the rate and pattern of release of various radioisotopes from decaying leaves and twigs of beech, maple, tulip poplar and white oak (2) the rate of secondary transfer of radioisotopes from inoculated saplings to surrounding vegetation and to herbivorous insects; and (3) the competitive uptake of various isotopes by forest tree seedlings. Isotopes which are being used in this study to date are Rubidium <sup>86</sup>, Phosphorus<sup>32</sup>, Cesium<sup>134</sup>, and Calcium<sup>45</sup>. We are inoculating 4 to 5" dbh saplings of the above mentioned species with 2 mc of the specific isotope in 1000 ml of full nutrient solution. Certain of the inoculated trees are then harvested in the fall of the year, sectioned and placed in nylon net bags and returned to the litter environment to study the leaching/decay process. Uptake by organisms of decay is followed in addition to transfer and cycling rates from the remaining "hot" trees. This research is carried on at the Allee Memorial Woods, a 180 acre wilderness tract owned by Wabash College. The tract is typical of the western extension of the central mesophytic forest region as developed on soils derived dually from Wisconsin glacial till and Pennsylvanian sandstone. The project is currently focused on 3 successional environments: (1) an abandoned field (25 yr.), (2) a second growth oak stand, (3) an area of virgin climax forest. Studies of initial uptake by

small mammal and box turtle populations are planned for the coming year.

Carlson, W. D. AT(11-1) 1156  
E1A166 A STUDY OF THE FOOD-CHAIN PAT-  
TERN OF STRONTIUM-90, CESIUM-137, AND  
IODINE-131 IN A WILD DEER POPULATION.  
Colorado State Univ., Fort Collins. COO. SP 1;  
MYr 3/4.

This study is in its early phase and is an attempt to measure fall-out radionuclides in a wild deer population such as strontium-90 in bones and antlers, cesium-137 in muscle, and iodine-131 in the thyroid gland. These same radionuclides are found in humans also but the concentration is greater in deer since the deer consumes plants and grasses which are contaminated with the fall-out. Therefore, the deer will be a sensitive measure of potential danger levels before the levels are hazardous for humans.

In addition to measurements on deer collected weekly, studies are made on radionuclide levels in grasses and plants which comprise the food for the deer and also on the levels in air, rain and snow, and in soils where the deer are collected. Attempts are being made to correlate radionuclide levels in the deer environment to that in the deer's body so that the relationship between environmental levels and levels in the deer can be established. The research should eventually lead to a better understanding of uptake, retention and excretion of these radionuclides in a deer.

Many of the necessary measurement techniques have been established and variations in iodine levels in the thyroid glands and in cesium levels in muscle have been observed. Correlation can be established with activity in nuclear weapons testing particularly with radiiodine levels. The average exposure to deer thyroids in 1962 was found to be approximately 18 rads or slightly more than one-half of the accepted maximum permissible level for humans employed as radiation workers.

Osburn, William S. AT(11-1) 1191  
E1A167 RADIOECOLOGY OF THE COLORADO  
FRONT RANGE.  
Colorado. Univ., Boulder. COO. June 1962-  
May 1963.

The research proposed for 1962-1963 will continue the following programs begun in previous years: measurements of regional environments in four mountain climax regions, measurement of altitudinal distribution of fallout (gross beta), study of the variations in growth and periodicity of plant ecotypes growing in different regional environments, search



for morphological variation of plants growing in areas of high background radioactivity, study of the distribution of fallout nuclides (gross beta) in an alpine tundra snow accumulation ecosystem.

No research proposed for 1962-1963 is designed to investigate the pattern and process of fallout (gross beta) distribution in different types of alpine landscape units, particularly those units which occur in the 11 square mile city of Boulder mountain watershed. From the accumulated data, overlay maps of the topography, winter snow cover, rainfall pattern, plant communities and gross beta distribution will be prepared to show interrelations. The significance of the relationships will be determined statistically from calculating correlation coefficients and subjecting appropriate data to an analysis of variance.

Allred, Donald M. AT(11-1)786  
E1A171 COMPARATIVE ECOLOGICAL STUDIES OF ANIMALS AT THE NEVADA TEST SITE WITH SPECIFIC REFERENCE TO THEIR REACTION TO EXPOSURE OF NUCLEAR EFFECTS.  
Brigham Young University, Provo, Utah. COO.

This is a continuation of work initiated in 1959. It is designed to determine the kinds, populations, ecological distribution, seasonal occurrence, migration, home range, and other habits of native animals living in areas exposed to nuclear detonations in comparison with animals in contiguous unexposed areas. The predominant kinds of arthropods and vertebrates, their relative abundance, ecological and seasonal occurrence have been determined. Further studies concerned with the ecology of these animals are being continued.

Tanner, Wilmer W. AT(11-1)819  
E1A443 COMPARATIVE POPULATION STUDIES OF VERTEBRATES IN THE URANIUM AREAS OF THE UPPER COLORADO RIVER BASIN, WITH SPECIFIC REFERENCE TO THE NATURAL RADIATION EFFECTS ON THE ANIMALS INHABITING THE AREAS OF HEAVY RADIATION.  
Brigham Young Univ., Provo, Utah. COO.

During the summer of 1962, essentially the same program was followed as in the summer of 1961 (see summary submitted 4-19-62). In these desert areas, where population densities are not high, considerable time has been needed to accumulate large enough series to provide statistically valid data.

The information dealing with home ranges has been confirmed and compared with data gathered at the Nevada Atomic Energy Test Site. Radiation tests have again been verified, and the statistical analysis of these populations is now in progress.

McCabe, Robert A. AT(11-1)954  
E1A447 A DIRECT EVALUATION OF PRODUCTIVITY IN ANIMAL POPULATIONS THROUGH RADIOACTIVE LABELING OF BREEDING FEMALES.  
Wisconsin. Univ., Madison.

We are attempting to identify progeny of wild animals after the adult female has been implanted with radioactive calcium ( $Ca^{45}$ ) or strontium ( $Sr^{85}$ ). The offspring of such females will or should have detectable amounts of the isotope in their bones. In birds the calcium has been administered in many forms and to date we can get the isotope to be released over a protracted period but have not been able to delay the initial release of the isotope once the material has been implanted. We have had complete success in picking up the radioactivity from egg shells from implanted hens (pheasants) but only partial success in detecting the carryover to the first winter from birds hatched in May and June.

In mammals (rabbits, hares and 13-lined ground squirrels) the problem of transfer is relatively simple. In multi-littered species like the cottontail rabbit or snowshoe hare it is possible that the early litters are easily detected but later litters may not. In a single-littered mammal like the ground squirrel the radioactivity could carry over for more than a single breeding season. Our problem here is one of dose level and release rate.

Williamson, F. S. L. AT(49-7)-2153  
E1A525 ECOLOGY OF TERRESTRIAL BIRDS.  
Public Health Service. Bureau of State Services, Washington, D. C.

Erdtman, O. G. E. AT(30-1)-3119  
E1A526 DESCRIPTION OF SPORES AND POLLEN GRAINS OF SIGNIFICANCE IN PALYNOLOGY.  
Sweden. Statens Naturvetenskapliga Forskningsråd, Solna.

Hartman, Richard T. AT(30-1)3018  
E1A601 STUDIES ON THE PRODUCTIVITY OF VASCULAR HYDROPHYTES AND THEIR ROLE IN MINERAL CYCLING IN AQUATIC ECOSYSTEMS.  
Pittsburgh. Univ. April 15, 1962-April 14, 1963.  
SP 3; MYr 1.25.

Compensation points, relative photosynthetic rates, and annual production values will be determined for species of vascular aquatic plants representing floating, submerged, and emergent forms. Changes in the composition of the internal atmosphere of aquatic species during photosynthesis will be determined by gas chromatographic procedures under a variety of light intensities and temperature values. The effect of the

presence of an internal atmosphere on traditional methods of measuring photosynthesis will be appraised.

Carbon-14 tracer techniques will be used to measure rates of carbon fixation by Wolffiella floridana and Lemna trisulea and to determine carbon sources by various other aquatic species.

Radioisotopes will be used to study mineral uptake by the root and shoot system of vascular hydrophytes. The loss of absorbed elements to the surrounding water will be investigated as will the rate of return of elements to the abiotic portion of the ecosystem through deciduous organs and seasonal dieback.

## E1B Soils, Plants and Soil-Plant Relations

Kramer, Paul J. AT(40-1) 1827

### E1B3 THE PATH OF RADIAL MOVEMENT OF MINERALS FROM SOIL TO XYLEM IN ROOTS.

Duke Univ., Durham, N. C. OROO.

The basic objective of the current research is to learn more about the pathways and mechanisms by which salt moves from the surface of roots into the xylem. We are attempting to do this by studying the relationship between volume and composition of xylem exudate and variations in root structure due to age of roots and species of plant. A survey of plant species has been made and a group has been found which regularly shows copious exudation. Another group of species has been found which shows little or no exudation. Studies of root structure are being made to learn if the amount of exudation can be related to the degree of development of the endodermis, or some other anatomical feature of the root. We also have started a study of exudation from dormant and growing root systems of woody species to learn more about the relationship between stage of root maturation and occurrence of exudation.

Eno, Charles F. AT(40-1) 2754

### E1B5 THE EFFECTS OF GAMMA RADIATION ON SOIL MICRO-ORGANISMS AND THEIR METABOLIC PROCESSES.

Florida. Agricultural Experiment Station, Gainesville. OROO. June 1962-May 1963.

This work is designed to determine the effects of gamma radiation on the metabolic processes of total soil populations and on certain groups of organisms which can be identified by either specific biochemical processes or physical characteristics.

Results obtained thus far have been on Arredondo fine sand which was exposed to gamma radiation

(cobalt<sup>60</sup>) at doses of 1, 4, 16, 32, 64, 256, 1024 and 2048 kiloroentgens (kr.). Survival of fungi and bacteria progressively decreased to <4% at 1024 kr.; algae were slightly more resistant. No nematodes were recoverable after 14 days, from soils receiving 256 kr. or more. Initially, carbon dioxide evolution was inversely related to radiation dose. Later, all irradiated soils, except those receiving doses >256 kr. essentially equaled or exceeded the controls in CO<sub>2</sub> production. Nitrate and sulfate production was progressively reduced by increasing doses of radiation. Nitrate production in 28 days at 1024 kr. was reduced to 4% of the control. Greatest reductions in organisms and biological processes occurred above a radiation dose of 256 kr. High levels of radiation on several other soils have increased the availability of soil nitrogen and phosphorus to plants.

Dieckert, Julius W. AT(40-1) 3015

### E1B13 THE MOBILIZATION OF THE METALS OF THE COTYLEDONS AND THEIR REDISTRIBUTION TO OTHER REGIONS OF THE GROWING DICOTYLEDON SEEDLING.

Texas. Agricultural and Mechanical Coll., College Station. Engineering Experiment Station. OROO.

A program is proposed to study the mobilization and redistribution of metals in the dicotyledon seedling as growth proceeds. Four nutritionally important metals will be investigated. These are potassium, manganese, copper and zinc. Evidence concerning four major points will be sought including (1) confirmation of the existence of reserves of the four metals in the cotyledons, (2) the existence of morphologically or chemically defined storage sites for the metals in the cotyledons of the mature desiccated embryo, (3) the redistribution pattern of the metals with respect to the epicotyl, hypocotyl, root and cotyledons under "normal" conditions of nutrition and growth, and (4) the influence of the inorganic nutrition and other variables on the extent and pattern of the redistribution of the metals during the growth of the seedling.

Mayberry, B. D. AT(40-1) 2749

### E1B15 SOME FACTORS INFLUENCING THE ABSORPTION AND TRANSLOCATION OF STRONTIUM BY PLANTS.

Tuskegee Inst., Ala. OROO.

The scope of this project is to study factors and the interrelationships of these factors on the absorption and translocation of strontium by plants. The variables under consideration are plant species, soil type, soil calcium level and placement (root, foliage and gynophore in the case of peanuts).

The tracer technique with radioactive strontium and calcium constitutes the principal experimental tool.

Peanut, bean and tomato plants will be grown in three different soil types having calcium added from zero (0) to three thousand (3,000) pounds per acre. Subsequently, they will be treated with tagged strontium. After the experimental period, samples will be assayed by counting, autoradiographic and flame photometric techniques.

It is envisioned that the results of this study may aid in arriving at more adequate means of reducing the amount of strontium 90, a product of nuclear fission, that may enter human food chains.

Jackson, W. A. AT(40-1)2410  
E1B16 THE EFFECTS OF FORM OF NITROGEN ON THE MECHANISMS OF ABSORPTION AND TRANSPORT OF MONO- AND DIVALENT CATIONS, WITH PARTICULAR EMPHASIS ON Cs AND Sr.  
North Carolina State Coll., Raleigh. OROO.  
SP 3; MYr 3.

The general objective of the present work is to determine the ways in which nitrogen metabolism of the plant affects the processes of inorganic cation uptake and transport in higher plants. Results to date indicate that  $\text{NH}_4$  inhibits Cs uptake from very dilute solutions by roots of young wheat seedlings in a manner which is not entirely competitive in nature. Experiments will be designed to test the postulate that much of the restriction in Cs uptake by  $\text{NH}_4$  results from utilization of reduced pyridine nucleotides and high energy phosphate compounds in synthesis of amides, amino acids and proteins when  $\text{NH}_4$  is present, thus reducing the amount of energy available for the accumulation of other cations. These experiments will involve measurements of the rates of incorporation of  $\text{N}^{15}\text{H}_4$  into various nitrogen fractions, turnover of the organic and inorganic polyphosphates,  $\text{CO}_2$  evolution,  $\text{O}_2$  uptake, and concurrent uptake of Cs.

Our work also has shown that addition of  $\text{NO}_3$  to low N wheat seedlings results in increased rates of uptake by roots and transport to shoots of Cs and Sr. Experiments will be designed to test the postulate that under these conditions the increased cation uptake results from the rapid, active uptake of  $\text{NO}_3$  with the cations being passively taken up to maintain electrical neutrality. It also is postulated that  $\text{NO}_3$  enhancement of cation uptake takes place not only in the cytoplasm of root cells but also in transport into the vascular stele as well.

Coleman, N. T. AT(11-1)34-92  
E1B27 ACCUMULATION OF CERIUM, YTTRIUM, AND CESIUM IN PLANTS AS AFFECTED BY THEIR SOIL CHEMISTRY AND THE AERATION OF THE SOIL.

California. Univ., Riverside. SAN. SP 3; MYr 1.50.

The project deals with two basic aspects of the soil-plant system, chemistry and aeration, as they influence the plant uptake and transport of the fission-product radio nuclides, Cs, Y, and Ce. The adsorption and desorption of trace amounts of the nuclides is being studied to establish sorption mechanisms and develop generalizations concerning "solubility" in soil systems as influenced by soil properties such as mineralogy, organic matter content, ion-saturation, and pH. Soil-plant experiments are being conducted to determine the extent to which the absorption of the nuclides by plants is correlated with their soil chemistry. The effect of soil oxygen on the uptake and translocation of the nuclides from solution and soil cultures also is being examined. Direct effects of substrate oxygen are measured in systems where gas of known composition is passed through nutrient solution or over soil surfaces. Indirect effects of soil aeration, i.e., as by limiting the root zone, are being studied by placing nuclides at various depths in soil columns and modifying oxygen concentrations in various parts of the root zone by varying water contents or the composition of gas streams.

Jenny, Hans AT(11-1)34-55  
E1B32 MODES OF ENTRY OF STRONTIUM AND OTHER POLYVALENT IONS INTO ROOTS AS REVEALED BY PHYSIOLOGICAL, CHEMICAL AND ELECTRONMICROSCOPE TECHNIQUES.  
California. Univ., Berkeley. SAN.

At the boundary of root and soil living and non-living matter meet. This zone is crucial for plant growth for it is here that water and nutrients enter the root and also leave it. Although this contact zone is the seat of important chemical and biological activities, no adequate theories could be formulated because it could not be explored with conventional tools.

Recent advances in thin section techniques and electronmicroscopy have made it possible to view the root-soil boundary and photograph it. The unexpected new feature is the existence of a relatively thick gel of mucilage, an organic slime, which connects the cell wall of the root surface with the mineral particles of the soil. Often bacterial colonies are imbedded in the mucilage. Soil particles and mucigel are intimately tied together, permitting

nutrient ions to be transferred to the living protoplasm of the plant by a great variety of paths.

Dean, L. A. AT(49-7)-1  
E1B50 ACCUMULATION AND MOVEMENT OF FISSION PRODUCTS IN SOILS AND PLANTS. Department of Agriculture. Agricultural Research Service. Soil and Water Conservation Research Div., Beltsville, Md. WASH. SP 4; MYr 2.5.

Major objectives include the study of principles and methods involved in minimizing the potential hazards of radioactive fallout in soils and plants. Particular consideration is given to the soil chemistry and plant uptake of strontium-90.

An evaluation has been undertaken of the effect of certain soil management practices in reducing strontium-90 uptake by crops. Field experiments with deep placement (simulated deep plowing), irrigation, liming and potassium fertilization were carried out with several crops at a selected location in each of four states. Placement of strontium-90 at 20 inches beneath the soil surface as compared with conventional plowing, reduced the uptake about 50 per cent with most crops at most locations. The other practices reduced uptake in certain instances, however, the effects from the different treatments were not additive.

The period of high fallout during the spring of 1962 offered an opportunity to further assess the direct accumulation of strontium-90 in field-grown crops. Direct contamination of the foliage by rainstorms was found, and the percentage of the strontium-90 retained from these storms increased with the weight and age of crop. Accumulation between rains was small, about equal to expected uptake from the soil.

Studies have continued on ion exchange and fixation reactions in soils. A fundamental theoretical description of ion exchange reactions has been developed and tested in resin systems. The tests are being extended to include clays and soils. Identification of the forms in which some strontium is rendered unavailable to plants in certain soils is proceeding.

Moore, David P. AT(45-1)1547  
E1B52 A STUDY OF THE MECHANISM OF DIVALENT CATION UPTAKE BY PLANTS. Oregon State Univ., Corvallis. RLOO.

Divalent cations are usually absorbed more slowly than monovalent cations, and therefore they have received less emphasis in plant nutrition studies. The objective of this study is to evaluate the effect of metabolic factors, concentration, pH, and

competitive ions on the absorption of divalent cations. Emphasis is on Ca, Sr, Mg, and Mn although Zn, Cu, and Fe are other cations of interest. Excised roots, intact plants and decapitated plants of various species are materials used in this study. Absorption by decapitated plants is evaluated by collection of successive increments of exudate and measuring the ion concentration. The use of this technique allows a continuous measurement of accumulation which is not possible using excised roots or intact plants. Collection of exudate is also made from individual excised roots. The results indicate that calcium and strontium are both metabolically accumulated in the exudate in substantial amounts in contrast to the absorption by excised roots. The rate of absorption by decapitated plants is equivalent to that for transpiring intact plants indicating an active mechanism for these ions.

Biddulph, Orlin AT(45-1)1380  
E1B53 FOLIAR UPTAKE OF FISSION PRODUCTS AND ION TRANSPORT IN PLANT STEMS. Washington State Univ., Pullman. RLOO. SP 1; MYr 1/2.

The research is to consist of a comparison of the mode of ascent of  $K^{42+}$ ,  $S^{35}O_4^-$ , and possibly  $HP^{32}O_4^-$  and other ions, with the mode of ascent of  $Ca^{45++}$  in the plant stem. In our previous work on the above contract, it was found that calcium ascended the stem by an exchange mechanism rather than by a mass flow, the mechanism previously postulated.

Procedures: (1a) Radioactive tracers are to be placed in the nutrient solution at the beginning of a particular photoperiod when the plants (bean) are approximately 3 weeks old. (b) At specific time intervals throughout the 12-hour photoperiod, plants are to be removed and stem sections (as well as other plant parts) are to be analyzed for the tracer. This will establish the normal uptake pattern for the particular tracer. Stem sections are to be divided into "bark" (tissue exterior to the cambium) and "wood" (tissue interior to the cambium). This establishes lateral transfer patterns.

(2a) Other plants, similarly grown, will be placed in the tracer solution for a short time interval (at the beginning of the photoperiod) and then removed to nontracer nutrient solution for varying periods prior to harvest in order to follow the efflux from sections as the tracer moves up the stem.

(3a) Plants which have been temporarily held in very dilute nutrient solutions in order to free the stems and roots of "pools" of mobile ions will be treated similarly to those under 2a (above) except that they are returned to very dilute nutrient solu-

tions after receiving the tracer. Lodging of tracer ions in the stem by adsorption on exchange sites will occur if ascent is by exchange. Other ions from various positions in the lyotropic series may then be introduced to free the adsorbed ions and move the tracer up the stem. This is the critical test for adsorption exchange. This procedure has been successful with calcium.

Gardner, Walter H. AT(45-1) 1543  
E1B54 UNSATURATED FLOW OF WATER IN  
POROUS MEDIA AS INFERRED FROM NEUTRON  
ABSORPTION.

Washington State Univ., Pullman. RLOO.

Potential and diffusion theory for description of water movement under unsaturated conditions as applied to both uniform and non-uniform porous media, particularly to soils, are under test with water content being inferred from neutron attenuation measurements. Studies include the effect of shrinking and swelling and temperature gradients in soil. Also, work is under way on improving methods for measuring the energy status of water during flow. A neutron-matter interaction technique has been developed for the measurement of the water content of small volume elements of soil accurately, rapidly and at frequent time intervals using high thermal neutron fluxes available only from nuclear reactors. Using 2 sec. counting with beam resolution of  $1 \times 10$  mm. for dry and wet water content regions (about 5% and 25%), precisions of  $\pm 0.2\%$  and  $\pm 0.8\%$  water have been achieved. Considerably greater precision is possible with longer counting time. Although the neutron beam is less sensitive to the mineral fraction of the soil, using long counting time (200 sec.) bulk densities have been measured with a precision of  $\pm 0.004$  gm./cm.<sup>3</sup>

Kittrick, J. A. AT(45-1)1756  
E1B55 THE MECHANISM OF ION FIXATION  
BY LAYER SILICATES.

Washington, State Univ., Pullman. RLOO.  
MYr 1/2.

The factors that determine the fixation and release of ions by layer silicates have been the subject of intensive study during the past two decades. During this time the fixation and release of  $K^+$  and  $NH_4^+$  has been shown to be of considerable importance in agriculture and geology, whereas the fixation and disposal of radiocesium and similar radionuclides has been of concern in the atomic energy field. Evidence now available indicates present theories of the mechanism involved to be superficial and inadequate. The objectives of this research project are to formu-

late new theories concerning the basic mechanism of ion fixation and release by expanding layer silicates, and to devise and execute definitive experimental tests of these theories.

To account for what is presently known about ion fixation, the following general hypothesis is proposed. The primary contracting force in layer silicates is the electrostatic attraction between negatively charged silicate layers and positive interlayer ions. The primary expanding force (prior to expansion to the point of double-layer formation) is hydration of interlayer ions. Initial experiments to test this hypothesis are concerned with the relative importance of ion size and hydration energy, the behavior of ions the size of  $Li^+$  and  $Mg^{2+}$  in fixation experiments, and release of fixable ions as a function of ion hydration energy.

Harward, M. E. AT(45-1)1063  
E1B56 RELATIONSHIP OF SOIL PROPERTIES  
TO CHEMICAL REACTIONS AND OTHER PHE-  
NOMENA INVOLVING SULFUR.

Oregon State Univ., Corvallis. RLOO.

The purpose of the present project was to study chemical reactions and other phenomena involving sulfate ions in soil and clay systems. The research conducted with the aid of  $S^{35}$  using both equilibration and chromatographic procedures, has given information on the movement of sulfate ions through soil columns in relation to soil characteristics, adsorption and desorption phenomena under equilibrium conditions, soil constituents affecting sulfate retention, the effects of various cations and anions on sulfate retention by soil systems, and possible mechanisms of sulfate adsorption by soils.

Work to be undertaken currently: (1) studies will be continued on effects of anions on sulfate adsorption by soils at various pH levels. Both inorganic and organic anions will be investigated in relation to iron and aluminum oxides of soils. (2) Studies will be initiated on adsorption characteristics of some competing anions in order to elucidate reciprocal action between anion pairs. (3) Studies will be conducted to obtain further evidence of exchange between hydroxyl and sulfate anions. The possibility of using tritium tagged hydroxyl compounds of iron or aluminum will be explored. (4) Studies will be continued on relationships between adsorption energy of sulfate ions and uptake by plants.

Overstreet, Roy AT(11-1)34-23  
E1B58 DECONTAMINATION OF SOILS CON-  
TAINING SALT AND RADIOACTIVE ELEMENTS.  
California. Univ., Berkeley. Coll. of Agriculture.  
SAN. SP 1; MYr 0.30.

Originally, this project was concerned with the decontamination of soils containing Sr 90, Cs 137, and I 131. However, the work was soon expanded to include studies of the soil chemistry of these elements in carrier-free form and the nature of their uptake by plant roots. Significant results of the research are as follows:

(1) A surface contamination of Sr 90 can be partly removed from a soil profile by treatment with amendments such as HCl and FeCl<sub>3</sub>, followed by intensive leaching. The cost of the procedure is prohibitive. A surface contamination of Cs 137 cannot be removed by this method.

(2) Initially, Sr 90 is adsorbed by soil particles in an exchangeable form. On long standing, however, a small fraction of the element is fixed in a non-exchangeable form.

(3) Carrier-free Cs 137 is fixed by soil particles in a form that is difficultly exchangeable, even by Cs isotopes.

(4) Carrier-free I 131 appears to be fixed largely by the organic fraction of soil.

(5) The uptake of carrier-free Cs 137 by barley roots from culture solutions is markedly depressed by the presence of either K, Rb, NH<sub>4</sub>, or Cs.

(6) The uptake of Sr 90 by barley and maize roots from culture solutions is probably non-metabolic.

Tukey, H. B., Jr. AT(30-1)2598  
E1B66 THE LOSS OF ORGANIC AND INORGANIC MATERIALS FROM ABOVE-GROUND PLANT PARTS WITH ESPECIAL REFERENCE TO DECONTAMINATION OF PARTS UTILIZED FOR FOOD. Cornell Univ., Ithaca, N. Y. NYOO.

Appreciable quantities of inorganic and organic metabolites are leached from above-ground plant parts by rain and mist. These losses affect yield, quality of crops, natural plant distribution and association and the pattern of growth and development.

Young plants, grown in radioactive nutrient solutions, are leached with water mist, the leachates collected on resins, and losses determined. Leaching is a wide-spread phenomenon; all plant inorganic nutrients, carbohydrates, amino acids, and organic acids are leached.

Important areas of investigation include (1) mechanisms and pathways of metabolite loss, (2) further study of the internal and external factors which influence leaching, and (3) further evaluation of the significance of leaching.

Leaching losses are influenced by species, metabolite being leached, leaf morphology and age, nutrition, environmental factors, and injury of any type. Nutrients recycle from soil to the leaves, are then

leached to the soil, to be reabsorbed by other plant species. Leaching is in part a diffusion phenomenon. It has many implications in plant science, not the least of which is the removal and redistribution of fallout materials from leaves and fruit.

Massey, H. F. AT(40-1)2629  
E1B89 EFFECT OF CALCIUM LEVEL AND PLACEMENT IN THE SOIL ON ITS UPTAKE BY PLANTS AND ON THE SOURCE OF THE CALCIUM TAKEN UP BY PLANTS. Kentucky. Univ., Lexington. Agricultural Experiment Station. OROO. SP 1; MYr 1.

Studies will be conducted to determine the location, with respect to soil depth, of the calcium taken up by plants and to determine the relationships between the "calcium feeding" pattern and levels of calcium in the soil. This information will be useful in devising operations that will decrease plant accumulation of strontium 90.

Frames, with a capacity for 12 in. profiles of soil, are to be filled with unlimed and variously limed Manitou silt loam soil. Bluegrass will be planted and allowed to grow for approximately one year in order to establish a dense sod. The sod-covered soil will be injected to various depths with Ca-45. After a growth period the bluegrass will be harvested and the specific activity of the calcium determined. From this, the relative plant uptake of calcium from the various soil depth will be calculated.

Because a knowledge of the movement of Ca-45 from its point of injection in the soil is important to interpreting the plant uptake patterns, the diffusion and mass movement of calcium will be studied.

Wallace, Arthur AT(11-1)34-51  
E1B122 BEHAVIOR OF CERTAIN SYNTHETIC CHELATING AGENTS IN BIOLOGICAL AND SOIL SYSTEMS. California. Univ., Los Angeles. SAN. SP 4; MYr 2 $\frac{1}{2}$ .

In the past several years considerable progress has been made in using chelating agents as a means of supplying micronutrients to plants. Many of the basic questions that relate to such use have been answered or partially answered by the use of radioactive isotopes. Radioactive isotopes are being used in evaluating these chelating agents and in learning their behavior in soils and in plants. The influence of chelating agents on the accumulation of other metals in the soil by plants is also being studied. Accumulation by plants of some fission products of nuclear testing can be altered either upwards or downwards by the use of synthetic

chelating agents and the ramifications are being explored.

The unanswered questions on the use of chelating agents in plants and soils are being considered in the project. The ability of synthetic chelating agents to penetrate plant cells will be studied with the effects of such penetration on cation accumulation mechanisms and on the growth behavior of the plants involved. There is considerable evidence that chelating agents can be absorbed by plants but problems remain as to how, how much, under what conditions, and the relationship of absorption of chelating agents to uptake and translocation of micronutrients. There is some evidence that some synthetic chelating agents can be metabolized in soils and in plants and this will be further explored.

This study of chelating agents is providing some insight as to possible mechanisms by which plants obtain micronutrients from the soil and why some species are susceptible to micronutrient deficiencies. Work will also continue on this aspect of the project.

McLaren, A. Douglas AT(11-1)34-50  
E1B123 AN INVESTIGATION INTO THE UTILITY OF RADIATION STERILIZED SOIL AS A MEDIUM FOR GROWTH OF PLANTS AND MICROORGANISMS. California. Univ., Berkeley. SAN.

We are studying the influence of radiation on the soil microbial population in order to obtain sterile soil suitable for the growth of sterile plants and for studies on plant-microbe interrelationships. We are also investigating the uptake of organic molecules by plant roots from sterile soil.

The survival curves for microorganisms in a soil irradiated with 6-8 Mev electrons, x-rays or gamma rays from  $\text{Co}^{60}$  are nearly identical. Results differ somewhat between soils of different kinds. About 5 million rep are required to completely sterilize soils. Fungi are more easily killed than aerobic bacteria in soil. Sterile soil contains active enzymes.

Techniques for the growth of plants with sterile roots have been developed for tomato and barley plants in sterile sand, soil, and solution culture.

By means of fluorescent-dye labeled proteins and fluorescence microscopy, it can be seen that large molecules such as lysozyme are capable of entering plant roots. By means of radioautographs of thin cross-sections of barley and other plant roots containing radioactive proteins, it was found that within a few minutes lysozyme, ribonuclease and hemoglobin entered the root to the stele, the root cells, and, with ribonuclease, even the nuclei of the cells (but not the vacuoles). By means of autoradiography of whole plants, we have observed translocation of macro-

molecules within tomato plants following a period of slight wilting or root injury.

We have just begun to utilize radiation sterilized soil as a medium for plant growth and to study the possible utilization of sterile peptides and proteins as nitrogen sources for sterile plants (tomato).

An effort will also be made to find exactly where enzymes are located in soil and to evaluate the importance of extracellular enzymes in soil fertility.

Jacobson, L. AT(11-1)34-5  
E1B124 THE MECHANISM AND KINETICS OF MINERAL ABSORPTION BY PLANTS. California. Univ., Berkeley. SAN. SP 1; MYr 0.50.

The transport of solutes across cellular membranes is a property of all living cells. This project is concerned with the mechanism whereby plant roots obtain inorganic nutrients by transferring salt ions from the external phase to the interior of the cell. The major emphasis is on the structural and biochemical properties of plant cells which enable them to take up ions against a concentration gradient.

We have correlated absorption and exchange with the degree of cell maturation. Normal absorption required vacuolated cells, exchange occurred most readily in non-vacuolated cells. Trace amounts of Ca were found to markedly affect the absorption of monovalent cations, ranging from almost complete suppression of Li uptake to stimulation of K uptake. It is presumed Ca acts by modifying the permeability of the cellular membrane.

A stimulation of  $\text{CO}_2$  fixation was shown to occur whenever excess cation uptake prevailed. In barley roots, the labeled carbon was ultimately incorporated as carboxyl groups of malate. The resulting increase in malate content served to balance the excess cations. Several systems which fix  $\text{CO}_2$  have been found in barley root cells.

Autoradiography at the cellular level is being used to localize absorbed ions within cells and tissues. The transport of  $\text{Fe}^{59}$  has been followed from nutrient solution to leaf cell. The movement and distribution of other ions is currently being investigated.

Emmert, Fred H. AT(30-1)2117  
E1B143 ION INTERACTIONS IN PLANT TISSUES. Connecticut. Univ., Storrs. NYOO.

Work over the past year dealt with the identification of forces responsible for Sr immobilization and movement in the stem following initial entrance into the plant. The function for Sr immobilization followed Freundlich adsorption kinetics, but was not reversible. It was proposed that binding of the ion was linked with the oxalate system. Movement of ion up the stem

reflected directly the degree with which the trapping mechanism was saturated with cation.

In other studies, the balance between passive and metabolic forces involved in initial ion penetration across the root was altered by adjusting water flow into the plant. This was accomplished by setting up different osmotic pressures in the ambient solution with polyethylene glycol. It was found that as water flow decreased, (allowing a greater relative penetration via the metabolic pathway) discrimination against Sr by the plant increased. As water flow decreased, all tissues exhibited a higher Ca/Sr ratio.

Work is planned for the future which will elaborate on these two findings discussed.

Sawhney, B. L. AT(30-1)2955  
E1B144 FIXATION OF CESIUM-137 BY SOIL  
CLAYS.

Connecticut. Agricultural Experiment Station, New Haven. NYOO.

The reactions of Cs with clay minerals are being studied to enable us to predict the availability and fixation of radioactive Cs-137 by soils of varying mineral content. Especially, we are studying the fixation of Cs from dilute solutions.

To this end, we have examined the uptake and release of Cs-137 from 10 ml of 10<sup>-5</sup> M CsCl solution by 0.1 gm samples of a number of clay minerals. Essentially, to prevent Cs sorption on exchange sites, an excess of several cations was left in the system, saturating the exchange site.

These large excesses did not prevent Cs sorption. Saturation of minerals with Ca, Sr, Ba, Al and H resulted in greater sorption of Cs than where the minerals were saturated with K, NH<sub>4</sub> and Cs. Montmorillonite and kaolinite are exceptions to this; sorption was slightly increased when these two minerals were saturated with K and NH<sub>4</sub>.

Once sorbed on micas Cs is exceedingly difficult to remove, especially from Ca-saturated muscovite.

There evidently are specific Cs sorption sites in micas, and micro-quantities of this cation are not only taken up by these minerals in the presence of other electrolytes but are also strongly held at these sites.

Holowaychuk, N. AT(11-1)414  
E1B145 MAPPING AND FIELD AND LABORATORY CHARACTERIZATION OF SOILS OF THE PROJECT CHARIOT AREA, ALASKA.  
Ohio. Agricultural Experiment Station, Wooster. COO. SP 2; MYr  $\frac{2}{5}$ .

The project area comprising a 43 square mile watershed is located about 100 miles north of the

Arctic Circle in western Alaska. As a part of an overall environmental study of the area the soils were classified and mapped and a number of their properties were determined in the laboratory. Parent materials, most of which are colluvial, are derived from calcareous or from acid shale and sandstone bedrocks. Tundra vegetation is prevalent throughout. The soils are shallow and weakly developed and many are appreciably affected by multi-gelation processes. Perennially frozen substrata occurs below about 54 inches in porous well drained soils and below about 16 inches where very poorly drained. Base saturation is very low except in well drained soils on calcareous materials or where they have been affected by seepage or runoff from calcareous rock. Leaching studies with Sr 90 solutions indicate that this isotope is retained by neutral or mildly alkaline soils but is relatively mobile in acid soils. Genesis and the physical, chemical and mineralogical properties of these soils will be further investigated.

Smith, R. L. AT(11-1)1055  
E1B161 USE OF RADIOISOTOPES IN STUDYING LIME-INDUCED CHLOROSIS.  
Utah State Univ., Logan. COO.

Objectives: (1) Study the interrelationships of elements, ions, and other factors, in soil and within the plant whereby various types of chlorosis—such as iron, zinc or manganese—might occur. (2) Study the movement and distribution of these micronutrient elements within the plant.

Attention has been focused at two major areas where trouble might arise, namely the root-soil environment and the internal environment of the plant.

It has been shown that increased phosphorus, bicarbonate, and pH will interfere at the surface or in the cortical tissues or endodermis of the root with uptake of iron and transfer to the shoot. These factors do not appear to interfere with upward movement from the root to shoot once the iron is in the xylem, although this is still under study.

Bicarbonate and phosphorus will interfere with movement from one leaf to another leaf or stem tip; the mechanism of this inactivation is under study, but may involve reduced transfer of iron to the phloem or inactivation in the phloem.

It has been noted that iron-deficient plants have low levels of protein material in the leaves. The possible effect of high bicarbonate, high phosphorus or low iron on protein synthesis is being investigated.

Graham, Ellis R. AT(11-1)1014  
E1B163 EFFECT OF SOIL COLLOID. TYPE AND



GROWTH RATE OF PLANTS ON THE UPTAKE OF RADIONUCLIDES BY PLANTS.

Missouri. Univ., Columbia. COO. SP 3; MYr 2.

It is the objective of this study to investigate inorganic colloids, montmorillonite, illite, kaolin and Putnam clay; and the organic colloids, peat moss, straw compost, oak leaf compost, in relation to the adsorption of radionuclides, physical-chemical measurements of distribution coefficients and distribution selectivity of specific nuclides over Ca.

The adsorption of radionuclides by the soil colloids will be studied by physical-chemical measurements, such as distribution coefficients determined for trace amounts of nuclides added to high Ca-saturated systems equilibrated in .01 M CaCl<sub>2</sub>. Selectivity numbers will also be determined for specific nuclides and different arrangements of Ca and other ion saturations.

The adsorption of isotopes by plants will be measured by growing plants on colloid mixtures in the presence of radioactive isotopes. The uptake will be determined by radioactive assay of the plants.

The growth rate of the plants will be modified by controlling nitrogen nutrition, water level, and temperature. The effect of rate of growth on uptake of radionuclides will be determined by assaying the plant material for the adsorption of nuclides for intervals of growth under controlled conditions.

Forages growing at different rates in the field, as a result of past soil management, will be contaminated with tracer amounts of important nuclides, and the radioactivity content of the harvested crop determined.

Results obtained reveal the soil colloid as an important factor in influencing the uptake of Cs-137 and Co-60 by plants. Sr-85 is influenced little by the type of colloid and is controlled by the concentration per kilogram.

Wittwer, S. H. AT(11-1)888

E1B164 MECHANISMS OF UPTAKE OF IONS BY ABOVE GROUND PLANT PARTS AND THEIR SUBSEQUENT TRANSPORT AND REDISTRIBUTION WITHIN THE PLANT.

Michigan State Univ., East Lansing. COO. SP 5; MYr 3.

Leaves and other aerial parts function as nutrient absorbing organs. Qualitative and quantitative measurements of uptake through leaves from nutritional sprays is possible through isotopic labeling. Emphasis will be given to transport (mobility) of labeled nutrients (Ca<sup>45</sup>, Cl<sup>36</sup>, Fe<sup>59</sup>, Mg<sup>28</sup>, Rb<sup>86</sup>, P<sup>32</sup>, S<sup>35</sup>) and constituents of fallout (Cs<sup>137</sup>, Sr<sup>89,90</sup>) subsequent to foliar absorption. Studies include effects of root temperature, chemical stimuli, movements from

apical to basal parts of leaves via graft unions, mobilization in seeds and fruit, and redistribution from seeds to seedlings. The physiological and anatomical changes in leaves induced by root temperatures that modify foliar absorption are receiving attention. A mathematical expression "specific absorption" has been coined. This defines the amount (micromoles) of substance absorbed per unit area (cm<sup>2</sup>) per unit time. By this measurement and an entirely new technique of immersing a leaf of known dimensions into a tracer solution maintained in a known and reproducible environment, mechanisms of ion uptake are being studied with precision. Penetration of ions through isolated leaf cuticles will receive attention, as well as absorption of ions by isolated cell wall masses. Field studies will include tolerances of aerial plant parts to nutrient sprays, the effects of phosphate sprays on yield and performance of specific crops. Studies relating to foliar absorption of nutrients as gases will be initiated.

Fuller, Wallace H. AT(11-1)947

E1B172 THE UPTAKE OF STRONTIUM BY VARIOUS TYPE CROPS AND FACTORS AFFECTING UPTAKE AND TRANSLOCATION OF STRONTIUM AND CALCIUM NATIVE TO SOIL.

Arizona. Univ., Tucson. COO.

The predominance of calcium as a constituent in soils in the Western United States and in most arid and semi-arid lands the world over has long been a matter of interest and curiosity for the soil scientist. A variety of calcium minerals, of which calcium carbonate predominates, are to be found in these soils. Since calcium and strontium are absorbed virtually nondiscriminately from soils by plants, factors affecting these two ions in soils and their uptake by plants have taken on a new interest due to the possibility of food-chain contamination with radioactive strontium from fallout. In this laboratory, factors affecting calcium and strontium mobility in calcareous soils are being studied. Certain soil amendments as well as crop residue added to several calcareous soils have been found to markedly increase the movement of both native soil calcium and applied carrier-free strontium. An extensive study involving several western soils is being conducted to investigate the movement of these ions in the soil, their exchange with native calcium minerals and their uptake by crop plants.

Kirkham, Don AT(11-1)1269

E1B436 MISCIBLE DISPLACEMENT OF TAGGED NITROGEN AND PHOSPHORUS IN SATURATED AND UNSATURATED POROUS MATERIAL.

Iowa State Univ. of Science and Tech., Ames.  
MYr. 5/8.

Nitrate and phosphorus movement in water-saturated and water-unsaturated soil columns, and in columns of other porous materials, will be studied by the process of miscible displacement. Nitrate movement will be studied first. To discriminate between nitrate already present in the soil and nitrate solution added, a known volume of  $N^{15}$ -tagged nitrate solution will be added to the input end of the soil or porous medium column. Each study will be conducted under steady-state flow conditions for both the saturated and unsaturated columns. Outflow concentrations of the tagged and untagged nitrates will be measured. Velocity of flow through the column will be a parameter. From the known input velocities and measured outflow concentrations, the influence of the following factors on the nitrate movement should be determinable: (a) bacterial action, (b) residual charge on the column material, (c) diffusion, and (d) possibly other items. Our results, in addition to providing information on the above effects, should show any limitations on the use of the  $N^{15}$ -tagged nitrate in this type of work. Phosphorus movement, using  $P^{32}$ , will be studied second and similarly.

Hulburt, W. C. AT(49-7)-1527  
E1B524 EQUIPMENT AND METHODS FOR DECONTAMINATION OF AGRICULTURAL LANDS CONTAMINATED BY RADIOACTIVE FALLOUT.  
Department of Agriculture. Agricultural Research Service, Beltsville, Md.

Tedrow, J. C. F. AT(30-1)2494  
E1B567 A STUDY OF STRONTIUM, BARIUM AND CALCIUM RELATIONSHIPS IN SOILS AND VEGETATION.  
Rutgers Univ., New Brunswick, N. J. NYOO. SP 6; MYr 1.22.

Representative leaf tissue samples have been gathered from the principal species comprising the subordinate, understory and overstory cover on three undisturbed soil sites of different parent materials. Sub samples of litter and soil sola have been collected within the site locations. Quantitative determination of K, Mg, Ca, Ba, Sr, Al, Mn, Fe, Cu, Zn, Pb, Cd, Ni, V, Mo, Cr, Ga, Sn, Co, and Ti will be made on both plant tissue and soil samples. Method of elemental analysis is to be optical emission spectroscopy. Plant tissue determinations involve use of a buffer procedure and concentration technique. Soil samples are examined directly using a d.c. arc in an argon-oxygen atmospheric chamber. Soil samples will also be texturally separated and examined by petrographic methods.

Preliminary data of 1960 showed wide variations between plant species sampled as a profile of the canopy cover. Toward providing a sounder basis for interpretation of the data, the 1961 sampling was collected according to a statistical pattern. An analysis of variance with decomposition of degrees of freedom for soils data and one degree of freedom, orthogonal contrasts among vegetative species, is planned.

## E1C Fresh-Water Systems

Ordal, E. J. AT(45-1)1727  
E1C51 AQUATIC MYXOBACTERIUM:  
CHONDROCOCCUS COLUMNARIS.  
Washington. Univ., Seattle. RLOO. Dec. 1, 1962-  
Nov. 30, 1963. SP 3; MYr 1 $\frac{4}{5}$ .

The over-all objective is to carry out the basic biological studies on the pathogenic myxobacterium Chondrococcus columnaris in order to make it possible to evaluate the roles of water temperature, radioactivity, and other environmental factors in the development and transmission of the virulent strains which have been found in the Columbia River in post-war years. It is planned to develop serological and other markers of specific strains so that definitive experiments can be carried out to learn the genetic mechanism by which strains of higher virulence arise. Efforts will be made, insofar as facilities permit, to define more clearly the grades of virulence; and it is planned to carry out studies on the effects of water temperature on disease due to strains of C. columnaris of different grades of virulence.

Yager, C. M. AT(40-1)2973  
E1C74 UPTAKE OF METALLIC IONS BY THE FRESHWATER SNAIL, AUSTRALORBIS GLABRATUS.  
North Georgia Coll., Dahlonega. OROO. SP 2; MYr 1.

Studies to date have been concerned with the uptake of several metallic ions, (copper, cadmium, iron, and zinc) by the snail Australorbis glabratus, a schistosoma intermediate host. Results compiled indicate a high concentration of copper, cadmium, and zinc in the liver of the snail when the concentration of these ions in the dosing solution is held below toxic levels. When the dosing solution becomes toxic due to higher concentration, a shift has been noted in the uptake of the ions by the body parts. To be determined is the reason for the shift.

Studies are to be made of the release of the metals after snails have been exposed in standard dosing solutions. It has been shown that release through the kidney is unlikely. Release through the external

epithelium and the digestive tract are possible routes yet to be investigated.

Uptake of the various tissues and organs of the snail are to be made when exposure to the metallic ions is made in the presence of a chelating agent. Parallel studies involving exposure to two ions simultaneously will provide information relative to the comparable magnitude of uptake of the ions under study.

Studies of the uptake of ions less toxic to the snails will be included.

Whitford, Larry A. AT(40-1)2100  
E1C106 STUDIES IN THE ECOLOGY OF FRESH-WATER ALGAE IN NORTH CAROLINA. North Carolina State Coll., Raleigh. OROO. Mar. 1, 1963-Feb. 29, 1964. SP 4; MYr 2.

Studies will be continued with emphasis on the communities inhabiting rapids. Data will be collected on production throughout the year and changes in communities as influenced by important habitat factors such as light, water temperature, water quality, and current speed. Laboratory studies on the effect of a current on mineral uptake and respiration in related lotic and lenitic species will be continued. The morphology of certain crustose species of Chlorophyceae will be studied. All species new to the state will be recorded.

A study of the distribution of species of Mesotaeniaceae and Desmidiaceae in North Carolina will be continued.

Krumholz, Louis A. AT(40-1)-2595  
E1C108 A RADIOLOGICAL STUDY OF THE BIOTA OF DOE RUN, MEADE COUNTY, KENTUCKY. Louisville, Ky. Univ. OROO. SP 4; MYr 2.0.

This study will continue to provide information on the seasonal accumulation of naturally occurring radionuclides and radionuclides from nuclear fallout by selected organisms in Doe Run. Work will continue on studies of various aspects of the life histories and ecology of selected organisms in that biota. Gross beta radioassays will be continued at biweekly intervals in an attempt to assess changes in accumulation of radioactive substances following the series of nuclear tests initiated by the U.S.S.R. and the U.S.A. since September 1, 1961.

Radiochemical analysis for strontium 90 and cesium 137 will continue to be made for selected samples of organisms to determine whether or not there is a seasonal pattern to such accumulation as may occur. At the same time, ratios will be set up between the naturally occurring radionuclides and those resulting from fallout. Of particular interest

will be the occurrence or lack of occurrence of a spring peak in the accumulation of such materials similar to that found in certain terrestrial organisms that serve as food for man.

A final report on the accumulation and composition of radioactive materials by the organisms in Doe Run will be prepared and submitted.

Lackey, James B. AT(40-1)2137  
E1C110 RATES, AMOUNTS, NUCLIDE ORIGIN AND EFFECTS OF RADIATION ACQUIRED BY FRESH-WATER AND SALT-WATER MICRO-ORGANISMS UNDER EXPERIMENTAL CONTROL. Florida., Univ., Gainesville. Jan. 1, 1963-Dec. 31, 1963. MYr 2.80.

The effects of radioactivity from whatever source, radioisotopes or reactor, upon freshwater and marine microscopic organisms, are being evaluated. The organisms include bacteria, filamentous fungi, blue-green algae, green, brown and red algae, also some which are macroscopic, but closely related to microscopic types. Animals include protozoa, rotifers, nematode worms and some oligochaete worms. Comparative uptake by several species of one genus, and pathways of metabolism by using C-14 are under study, also comparative uptake by species exposed to radiation for several years, and the same species not heretofore so exposed. Effects are: uptake, rate and maximum, loss, behavior with respect to various radioisotopes, factors interfering with uptake, genetic effects if any, and death. Experimental work should show whether the process follows an orderly path or is random. Conversely, we should learn how these microorganisms affect radioactivity in our environment.

Ball, R. C. AT(11-1)655  
E1C118 STUDY OF PRODUCTIVITY IN A STREAM ECOSYSTEM USING A RADIOACTIVE TRACER. Michigan State Univ., East Lansing. COO.

This project has been the study of the movement and exchange of phosphorus within a stream ecosystem by following its path through the trophic structure with P<sup>32</sup>. Estimates of uptake of isotopic phosphorus in relationship to the exposure of the stream to radiant energy and to the phosphorus pool within the several segments of the stream have been made.

Findings have shown rapid uptake by diatom flora (producers) of the stream and transfer to filter-feeding organisms, *Simulium*, the primary consumers. The isotope is repeatedly recycled, through the producer plants and utilized by primary consumer groups in less time than it takes to reach the

detritus feeders. Secondary consumers continue to increase in activity for at least 60 days in spite of the rapid physical transport within the stream.

Incorporation of the isotope into a bacterial culture and application to the stream in particulate form resulted in much less being retained in the test section than when applied as inorganic phosphorus. A different path through the trophic structure was also followed.

An upstream movement of isotope was brought about by the upstream migration of larval aquatic insects.

The forthcoming project will make use of As-74 incorporated in sodium arsenite (herbicide) to follow the pathways of arsenic through a pond ecosystem and establish its relationships to the several trophic levels within the pond and evaluate its potential hazard to man.

Sigler, William F. AT(11-1)1023  
E1C162 LABORATORY STUDIES ON THE EFFECT OF RADIUM ON AQUATIC ORGANISMS.  
Utah State Univ., Logan. COO.

A study being conducted by Utah State University will determine the physiological effects of certain radioactive materials on algae and fish.

In the laboratory, local algae communities already attached to rocks will be used as experimental units since almost pure cultures of a given species can be collected in this manner. Water from Logan River, Utah, where the algae are gathered, will be used as the culture medium. Since light affects both rate of uptake and amount of radiomaterial accumulated, a quantitative record will be taken of the relative amounts of light received over the length of the experiment. A correlated record will be made of the water temperature.

In a study of fishes, attempts were made to (a) establish control-level (without radium) of red and white blood cell counts for goldfish and rainbow trout at various water temperatures; (b) determine changes in the blood cell counts when fish are exposed to radium at concentrations of 0, 0.1, 0.2, 0.3, and 0.4 microcuries per liter of water for periods of 5, 10, and 15 days; (c) correlate changes in blood cell counts to water temperature, radium concentration, exposure time, and exposure rate. This section of the study has now been terminated and publications are being prepared.

Marshall, Jack AT(11-1)1005  
E1C165 FATES AND EFFECTS OF RADIOISOTOPES IN AQUATIC FOOD CHAINS.  
Michigan. Univ., Ann Arbor. Mar. 15, 1963-  
Mar. 14, 1964.

Subproject (1), "Role of organisms in the freshwater strontium cycle and influence of dissolved salts," involves laboratory experiments with Chlamydomonas reinhardi, Daphnia magna, or Lebistis reticulatus allowed to reach activity equilibrium in samples of natural waters which have been doubly labeled with Ca<sup>45</sup> and Sr<sup>85</sup>. The waters are collected from a variety of streams and lakes in and around Michigan (including some of the Great Lakes), and chemical determinations are made for Ca<sup>+2</sup>, Mg<sup>+2</sup>, Na<sup>+</sup>, K<sup>+</sup>, SO<sub>4</sub><sup>-</sup>, Cl<sup>-</sup>, SiO<sub>2</sub>, pH, total alkalinity, and specific conductance.

Subproject (2), "Dynamics of irradiated Daphnia populations," deals with the long term effects of chronic exposure of 25 Daphnia pulex populations to different levels of external gamma radiation from a Co-60 source. The dose rates employed in this study range all the way from near-background levels to levels causing extinction within a very few generations. Irradiation will be continued until the populations have established phenotypic equilibria or definite long term trends in population size, birth rate, death rate, individual fertility, and pre-natal mortality. The mode and extent of post-irradiation recovery will then be determined. From this we hope to estimate the relative importance of genetic and somatic changes underlying the long-term population consequences of increased radiation exposure in this species.

O'Connor, John T. AT(11-1)1264  
E1C398 THE FATE OF IRON AND ZINC IN NATURAL SURFACE WATERS.  
Illinois. Univ., Urbana. SP 4; MYr 3.

The project is primarily a study of fresh and salt waters which receive low concentrations of radioactive iron and zinc from fallout and nuclear operations. The more significant physical, chemical, and biological phenomena which influence the distribution of these metals in a natural water system are to be evaluated in a roughly quantitative manner. In addition, measurements are to be made of the quantities of the radioisotopes of iron and zinc in environmental samples. Finally, an attempt is to be made to determine a means for monitoring natural waters for radioactive iron and zinc.

Iron is readily precipitated in aerated surface waters, while zinc is absorbed on river sediments in an easily and rapidly reversible equilibria. Both metals may be returned to solution when reducing conditions prevail. Accumulations of these metals, formed under conditions favoring adsorption or oxidation, may be released as transient pulses if reducing conditions occur. Therefore, it is difficult to

determine the dilution or receiving capacity of a stream, if the time, location, and magnitude of a transient release is not known.

Kaufman, Warren J. AT(11-1)34-100  
E1C405 NUCLIDE UPTAKE BY ALGAE AND  
ZOOPLANKTON.

California, Univ., Berkeley. SP 0.5.

The basic objectives of the study are:

1. To develop a continuous flow system in which flow rate, temperature, ionic concentration and pH of medium, biomass, etc., may be held constant in order to determine the environmental factors affecting the assimilation of radioactive waste products such as strontium and iron by phytoplankton and zooplankton.

2. To develop analytical techniques to measure the exchange capacity of algae and to study the effect of the ionic composition of the substrate on this exchange capacity.

3. To determine the importance of the mechanism of entry of strontium and iron on the extent of assimilation of these nuclides by zooplankton.

Pahl, L. George AT(11-1)1178  
E1C428 RADIONUCLIDES AND FRESHWATER  
CLAMS.

Saint Mary's Coll., Winona, Minn. SP 5; MYr 2.3.

The upper Mississippi River has an abundance of freshwater clams whose almost pure calcium carbonate shells can act as an important center for the concentration of strontium-90 from fallout. By means of the analysis of clams raised under variable conditions in the laboratory, it will be possible to determine the discrimination for-or-against strontium. To facilitate this work, use will be made of the radioactive tracers, Sr-85 and Ca-45. The central aspect of this study will be a determination of Sr/Ca ratios of:

1. The simulated river waters employed as the living medium for the clams.

2. The planktonic food used by the clams.

3. Clam viscera and shells.

Individual samples will be counted for Ca-45 with a gas flow beta Counter and for Sr-85 with a sodium iodide scintillation detector. In order to determine more precisely the mechanism of shell formation, use will be made of the excised clam mantle in a specialized plastic chamber. The solution on each side of the mantle will be regulated so as to elucidate its role in  $\text{CaCO}_3$  formation in particular as well as to gain insight into the active transport process of living membranes.

Patrick, Ruth AT(30-1)-2991  
E1C523 THE ECOLOGY AND TAXONOMY OF  
THE ORGANISMS COLLECTED ON THE SAVANNAH  
RIVER SURVEYS, 1951-1960.  
Academy of Natural Sciences of Philadelphia.

Renn, Charles E. AT(30-1)2536  
E1C546 SILT ADSORPTION OF RADIOACTIVE  
ZINC AND IRON.

Johns Hopkins Univ., Baltimore. School of Engineering. April 1962-March 1963.

This project is a continuation of work begun in 1960. It is designed to determine the conditions that determine the practical concentrations of zinc and iron that occur in streams that receive additions of zinc and iron from mine drainage and industrial wastes. These factors were explored in the early work. In the current program these explorations will be analyzed more critically.

The current program will study the processes by which zinc and iron adsorbed on silts and carried to the bottom in silt deposits and sludge beds are assimilated or regenerated by biological processes, including anaerobic fermentation and feeding by aquatic earthworms, snails, clams, and other debris feeding invertebrates.

## E2 MARINE SCIENCES

Ketchum, B. H. AT(30-1)3140  
E2-136 BIOLOGICAL, CHEMICAL AND RADIO-  
CHEMICAL STUDIES OF MARINE PLANKTON  
POPULATIONS.

Woods Hole Oceanographic Institution, Mass. NYOO.  
SP 15; MYr 7.5.

The program in plankton ecology at the Woods Hole Oceanographic Institution has concentrated on efforts to understand the environmental factors which determine the distribution of species of both phytoplankton and zooplankton. The physical and chemical characteristics of the environment which control the size and rate of growth of the population and the chemical composition of the organisms are studied in order to evaluate the way in which the populations may interact with individual elements in the environment. This program is designed to provide the basic knowledge which will permit the evaluation of the fate of radioisotopes which may be added to the sea.

The project is a combination of direct field observations of the populations at sea and laboratory experiments to evaluate the effects of environmental conditions on these populations. At sea contrasting environments are selected for study which include the

coastal waters of the continental shelf, the slope waters which represent a mixture of oceanic and coastal waters, the Gulf Stream which transports tropical waters to a location within 150 mi. of Woods Hole, and the Sargasso Sea, one of the "marine deserts" where the biological processes have so depleted the sea water of the essential plant nutrients that both plant and animal populations are extremely sparse. The laboratory studies include evaluations of the effects of light and nutrients on the rate of photosynthesis of pure cultures of phytoplankton algae using C-14 and other methods for the determination. The accumulation of elements from the medium by these algae is evaluated both by direct chemical analysis and by radiotracer techniques. The feeding mechanisms of zooplankton, the efficiency of assimilation and growth are studied both in the laboratory and in the field. The bacterial processes which complete the nutrient cycle, particularly nitrification by the newly isolated species Nitrosocystis oceanus is studied in the laboratory, and the distribution of this species is being studied in the sea.

## E2A Biological Uptake, Concentration, Distribution and Effects of Radioactive Elements

*See also E2-136.*

Isaacs, John D. AT(11-1)34-97  
E2A31 RESEARCH INTO THE DEEP WATER OF THE EASTERN NORTH PACIFIC.  
Scripps Institution of Oceanography, La Jolla, Calif.  
SAN. SP 5; MYr 5.

The program is an enlargement of the present Marine Life Research (MLR) Program of the University of California, which is concerned with the oceanography, biology and pelagic ecology of the eastern North Pacific Ocean. The MLR Program conducts research into the upper 1000 meters of these waters. The enlarged program will stimulate research into the deeper layers of the California Current region. Hydrographic casts and water samples (for determination of salinity, oxygen, silicate, phosphate, etc.) from the surface to the bottom (as much as 6000 meters deep) over the area from San Francisco (38°N) out to between 300 and 600 miles off shore through to southern Baja California (24°N) are being taken. Also deep net, dredge and midwater trawl hauls, and sonic records and photographs of the bottom at selected locations

will be carried out. These extended data and studies should give a much better understanding of the very deep sea environment throughout a large area. Further knowledge of the deep ocean is needed to better understand the processes affecting radioactive material in the deep sea, and the fate of radioactive materials that may be introduced there in the future.

Hsiao, Sidney C. AT(04-3)330  
E2A35 A STUDY OF THE EFFECTS OF IONIZING RADIATION UPON DEVELOPING SEA URCHINS.

Hawaii. Univ., Honolulu. SAN. SP 4; MYr 1<sup>11</sup>/<sub>24</sub>.

Summary of the work performed under the project. The effects of ionizing radiations, in the form of graded doses of X-rays, have been studied on the development of two species of Hawaiian sea urchins, Tripneustes gratilla and Colobocentrotus atratus. Different stages of the developing sea urchin eggs were subjected to irradiation and observed for 5-8 days post-irradiation for: (1) immediate reactions to graded doses of X-rays, (2) patterns of morbidity and mortality with reference to dose and post-irradiation time, (3) changes in the uptake of mineral ions after irradiation, and (4) the relative sensitivity of different stages of developing sea urchins to ionizing radiations. It was found that there is a species difference in sensitivity to radiation, T. gratilla being more sensitive than C. atratus. The immediate response to irradiation was an increase in viscosity in the case of eggs and unhatched embryos, whereas the free-swimming stages were either slowed down or immobilized right after irradiation. Graded morphological abnormalities were produced by graded doses above 2,000 r. A corresponding decrease occurred in the uptake of Calcium 45 with increased irradiation. Different developmental stages showed different sensitivity toward ionizing radiations. The effect of very low doses (5-20r) of X-irradiation was variable, with significant acceleration or slight retardation of cleavage depending upon the sensitivity of the batch of eggs used. Lowering the embryo's metabolism by cooling from 27 to 10 degrees C. did not, in contrast to results reported for the other species in the literature, block the onset of the damaging effect of ionizing radiation.

Carey, Andrew G., Jr. AT(45-1)1758  
E2A60 ECOLOGICAL AND RADIOLOGICAL STUDY OF THE BENTHOS IN THE PACIFIC OCEAN OFF OREGON.

Oregon State Univ., Corvallis. RLOO. SP 3; MYr 1.5.

A study of the benthic fauna is being undertaken to determine (1) the radioactivity of the organisms and

their environment, and (2) the abundance and distribution of the benthos as correlated with sediment composition. A series of 9 stations has been established westward off Newport, Oregon, on the continental shelf, slope, and the abyssal plain to a depth of 3000 meters and a distance of 165 miles offshore. These stations will be routinely occupied every other month throughout the year. A deep-sea anchor dredge is used to collect duplicate samples of the infauna. The large epifauna are collected with an Agassiz-type biological dredge and a 22-foot Gulf-type otter trawl. Samples of the sediment surface for radioanalysis will be collected with a Smith-McIntyre 0.1 m<sup>2</sup> bottom grab.

A multi-channel gamma-ray spectrometer is used to analyze the activity of the invertebrate fauna and their environment. Zinc-65 and chromium-51 from the Columbia River are traced through the benthic food chains. Fallout nuclide activity in the organisms is also measured. The most important concentrators of radioisotopes in the benthos will be determined.

Changes in the faunal assemblages and abundance associated with sediment composition are being studied. Sediments are biologically important and are being analyzed for particle size as well as organic content.

Curl, Herbert C., Jr. AT(45-1)1751  
E2A61 BASIC FOOD WEB RELATIONSHIPS  
AND ENERGY CONVERSION IN LOWER TROPHIC  
LEVELS IN THE MARINE ENVIRONMENT.  
Oregon State Univ., Corvallis. RLOO. SP 2; MYr 2.

Ingestion and assimilation processes of marine microcrustacean species grazing on phytoplankton are studied, using the phytoplankton species which are abundant off the Oregon coast and which can be cultured. Algal concentrations, zooplankton concentrations, and light and temperature conditions are adjusted in experiments to resemble those naturally occurring off the Oregon coast at various seasons.

Radioactive tracers are incorporated into the phytoplankton cells to obtain data on assimilation, storage and excretion of particular radionuclides by zooplankton grazing on phytoplankton. Experiments are conducted in flasks placed in an "aquastat" to provide gradients of light and temperature.

The data obtained are interpreted in terms of energy and element transfer between trophic levels on a species and on a community basis.

Osterberg, Charles L. AT(45-1)1750  
E2A62 RADIOANALYSIS OF OCEANIC ORGANISMS  
IN THE PACIFIC OCEAN OFF OREGON.

Oregon State Univ., Corvallis. RLOO. SP 4;  
MYr 2.6.

A multichannel gamma-ray spectrometer with 5 × 5 inch NaI(Tl) well crystal and 3 × 3 inch NaI(Tl) solid crystal detectors is being used to analyze samples from midwater trawl stations off the Oregon coast. Benthic organisms and environmental samples are also being studied. Special emphasis is being placed on *Euphausia pacifica* because of its abundance and role in the marine food chain. It has been found to concentrate both fission products from fallout and neutron-induced Zn<sup>65</sup> and Cr<sup>51</sup> from the Columbia River. *E. pacifica* migrates vertically diurnally, making it an important vehicle in the vertical transport of radionuclides in the ocean. Special closing nets are being developed to study vertical transport by biological means.

The radioactivity of gamma-emitters in the particulate and non-particulate fractions of sea water will be determined to correlate with gamma emitters in the macroplankton. Various ion exchange resins are being used as concentrators of ionic radionuclides.

Some effort is being devoted to learning the amount of stable isotopes in the macroplankton so that the specific activities can be determined.

Pearcy, William G. AT(45-1)1726  
E2A63 SPECIES COMPOSITION AND DISTRIBUTION  
OF MARINE NEKTON IN THE PACIFIC OCEAN  
OFF OREGON.  
Oregon State Univ., Corvallis. RLOO. SP 5; MYr  
3.16.

Midwater trawl collections are made throughout the year to various depths down to 1000 meters and along three latitudes off Oregon, providing information on the seasonal, vertical, and geographic distribution of small nekton, such as mesopelagic fishes, squid, and prawns. Species composition is also being assessed.

Since these oceanic animals have been found to accumulate radioisotopes introduced into the ocean from the Columbia River, e.g. Zn-65, their distribution and movements are being studied. Vertical migrations into near-surface waters at night and possible horizontal migrations across the continental slope during different seasons are being investigated using data on variations of relative abundance.

Brehmer, M. L., Sr. AT(40-1)2789  
E2A75 CONCENTRATION OF SUSPENDED RADIOACTIVE  
WASTES INTO BOTTOM DEPOSITS.  
Virginia Inst. of Marine Science, Gloucester Point.  
OROO. Jan. 1, 1963-Dec. 31, 1963. SP 12; MYr 1.

Previous research on this project has indicated that bio- and abioseston in the marine environment effectively concentrates radionuclides by the processes of biological assimilation or physical or chemical adsorption. The data also indicated that marine filter-feeding organisms are very efficient in removing seston from the water mass and incorporating it into bottom deposits. Theoretically, the oysters on an acre of estuarine bottom may remove more than a ton (dry weight) of material from suspension per week.

The proposed research will involve studies on the biodeposition rates of other marine filter-feeders. Clams, barnacles, mussels, and tunicates will be used in the experiments. The effects of water temperature, turbidity, salinity, and particle sizes on filtering rates will be investigated.

The rates at which bottom deposits accumulate in natural bottoms will be investigated using particles coated with a fluorescent dye. The stability of the deposits will be determined by chemical and radio-chemical techniques.

The permanence of radionuclides incorporated into or absorbed on biodepositions of oysters, clams, mussels, barnacles, and tunicates will be investigated in a flowing sea water system. Previous experiments utilizing static systems indicate radionuclides are resistant to desorption when incorporated into biodepositions.

Bonnet, Juan A. AT(401)1546  
E2A91 RADIOACTIVE IRON STUDIES WITH  
SOILS AND CROPS OF PUERTO RICO.  
Puerto Rico. Univ., Rfo Piedras. Agricultural Ex-  
periment Station. OROO.

Studies in which radioactive iron and iron chelates are used to obtain a better understanding of iron chlorosis and possibility of correction of the same are under way, under greenhouse conditions. Sugarcane, ornamentals and other crops will be tested on different soils.

The causative factors of chlorosis in the soils will be studied by characterizing them as to their available supply of calcium, phosphorus, manganese, copper and iron.

Meyers, Samuel P. AT(401)2855  
E2A94 UPTAKE OF RADIONUCLIDES BY MA-  
RINE FUNGI.  
Miami, Fla., Univ. Inst. of Marine Science. OROO.

Investigations are in progress on the ability of various indigenous species of marine fungi, particularly Ascomycetes and Deuteromycetes, to concentrate specific radionuclides such as cesium-137,

cobalt-60, iron-59, and strontium-90. Other radioisotopes including Ca-45 and P-32 will be used to examine the metabolism of certain fungi, especially those found in close nutritional association with parasitic marine nematodes. These laboratory data will be evaluated in relation to the abundance and ecological role of these heterotrophs. Phenomena such as age and growth processes of the particular fungus are being considered in analyses of the patterns of radioisotope uptake and retention. Comparative studies with non-marine species are being made to evaluate the biological activity of the marine isolates compared to that of fungi from other ecological habitats.

Correlated work with certain widely abundant chromogenic marine bacteria using radiocalcium, have shown the significance of these organisms in natural processes of calcium carbonate deposition. Rates and mechanisms of concentration of CaCo-3, and associated calcium metabolism, have been studied. Methodology developed will be extended to other marine nitrifying bacteria as well as to species of filamentous fungi and yeasts present in the sea. Tests are planned whereby radiosodium will be used to evaluate the marine affinity of heterotrophic species found in the littoral and sublittoral zones.

Hiatt, Robert W. AT(04-3)226  
E2A120 ENIWETOK MARINE BIOLOGICAL LAB-  
ORATORY,  
Hawaii. Univ., Honolulu. NS. August 1961-July  
1962.

The Eniwetok Marine Biological Laboratory was established by the AEC to encourage biologists interested in fundamental studies on tropical marine and terrestrial fauna and flora to make use of the unusually good facilities developed in this area, some 2500 miles southwest of Hawaii. The atoll has a typical Indo-Pacific fauna and flora. Many of these organisms exhibit unusual adaptations in mutualism, in the process of evolution of marine organisms toward a terrestrial mode of life, lengthy breeding seasons and rapid embryological and post-embryological development, and remarkable assemblages on the reefs which approach "steady state" conditions.

Most standard types of laboratory supplies and equipment are available at the laboratory. Investigators interested in making application to go to Eniwetok may request an inventory list to ascertain the adequacy of the laboratory stocks for their purposes. Running sea water is available, as are



aquaria ranging from small ones to concrete tanks up to 50 feet in length.

Research proposals need not be detailed, but should be submitted in a well-organized fashion. Greater consideration will be given to those which relate to this tropical area, and which cannot be carried out advantageously at a continental laboratory.

Research proposals as well as requests for information about the laboratory should be submitted to the Division of Biology and Medicine, AEC, Washington 25, D. C.

Banner, A. H. AT(04-3)235

E2A121 AN INVESTIGATION OF THE POSSIBLE EFFECTS OF INGESTION OF RADIOACTIVE FISH AND THE NATURE AND BIOLOGY OF TOXINS FOUND IN CERTAIN FISHES.

Hawaii, Univ., Honolulu, Hawaii Marine Lab. NS. November 1961–October 1962.

The purpose of this investigation is to explore the cause of the Ciguatera type of toxicity found in fishes of the central Pacific. In this toxicity, fish from restricted areas are found to be highly toxic when eaten, yet the same species are innocuous in other areas. The fish that is the basis of the present study is a red snapper, Lutjanus bohar.

Because of the marked increase in number of fish poisonings in the southern Marshalls during the period of atomic weapon testing at Eniwetok, the toxicity has been attributed by the natives to the testing program. The first aim of the investigation was to find if there was a correlation between the fish toxicity and radioactivity; results now at hand, based on fish from Eniwetok and Majuro in the Marshall Islands, and Christmas and Palmyra in the Line Islands, indicate that there is no such relationship. The second aim of the research is to attempt to ascertain the true cause of the toxicity. The most widely accepted hypothesis on the cause of toxicity is that the toxin comes to the fish through the food chain; that hypothesis is at present being investigated through 1) feeding experiments which attempt to induce toxicity in normally non-toxic fish; 2) studies on the food habits of toxic and non-toxic L. bohar; 3) field studies of the food of the fish, to be undertaken extensively after the perfection of a field test for toxicity, at present under development.

Holmes, W. N. AT(45-1)1381

E2A126 RADIOISOTOPE STUDIES OF ELECTROLYTE METABOLISM OF EURYHALINE TELEOST FISHES.

British Columbia, Univ., Vancouver. RLOO. May 1962–April 1963.

Euryhaline teleosts such as the Salmonidae are able to withstand wide variations in the toxicity of their environment without undergoing commensurate changes in their tissue electrolyte and water composition. The purpose of this investigation is to determine whether the excretory mechanisms associated with the transfer of trout from fresh to sea water are under endocrine control. The investigation is primarily directed towards an examination of the pituitary-adrenal axis during the environmental change. Techniques involving the renal and extra-renal excretory patterns after hypophysectomy and hypothalamic lesions are being used. Also in order to effect physiological hormone substitution therapy in such surgically treated fish an examination is being made of the body turnover rates of exogenous cortical steroids after administration by various routes and in various vehicles.

Skauen, Donald M. AT(30-1)2487

E2A128 RADIOACTIVE ZINC-65 IN MARINE ORGANISMS IN FISHERS ISLAND SOUND AND ITS ESTUARIES.

Connecticut, Univ., Storrs. NYOO. SP 3.

The zinc-65 content of oysters from selected points in the Thames River (Conn.), the Quinnipiack River (Conn.), the Pawcatuck River (R. I.) and Fishers Island Sound has been determined at regular intervals. Concurrent total zinc estimations have been conducted on these oysters by a modified dithizone mixed-colorimetric procedure.

Radioactive zinc concentrations have remained between 50 and 250 micro microcuries per kilogram of wet tissue during the period of this investigation except in July 1961 and again in September of 1961 when peak levels of 11,000 and 5,800 micro microcuries per kilogram of wet tissue, respectively, were observed.

Preliminary studies designed to follow uptake and distribution of zinc-65 in oysters and several small molluscs are being conducted.

Ketchum, Bostwick H. AT(301)1918

E2A135 OCEANOGRAPHIC STUDIES IN CONNECTION WITH THE OPERATIONAL SEGMENT OF PROJECT SWORDFISH.

Woods Hole Oceanographic Institution, Mass. NYOO. SP 4; MYr  $\frac{7}{12}$ .

During the spring of 1962 physical and chemical oceanographic observations were made in the Pacific Ocean in connection with Operation Swordfish. The present project provides for the completion of

the analyses and evaluation of the data obtained and the preparation of a final report. During the observational phase five instrumented, anchored buoys were installed with the cooperation of the USCGS Ship PIONEER to record temperature and current velocity and direction at various depths. Records were recovered from seven current meters and from 30 temperature recorders. The current meter records 3 one-minute periods each hour, from which north-south and east-west components will be derived as a function of time. The analysis of these results will be done on a computer, and current roses, trajectories and power spectra will be derived.

Also during the operational stage 31 hydrographic stations were occupied at which samples for salinity, temperature and various chemical analyses were taken. The concentrations of dissolved oxygen, inorganic phosphates and silicates were determined on board the PIONEER and samples were stored or frozen for later analysis of total phosphorus, nitrite and nitrate. The analysis of these observations will include the derivation of current velocity and direction from the distribution of the pressure field and a description of the distribution of the other characteristics measured.

During the operational phase of this project samples of plankton and of water were collected for radiochemical analysis. The evaluation of these collections is being made under a separate contract.

Skauen, Donald M. AT(30-1)3039  
E2A138 THE EFFECTS OF TRITIUM OXIDE ON  
AQUATIC ORGANISMS.  
Connecticut. Univ., Storrs. NYOO.

The objective of this study is to determine whether any toxic manifestations can be observed in the common guppy, Lebistes melanogaster, living in tritiated water.

A strain of Lebistes has been raised in our laboratories and is in sufficient supply to allow continuous experiments to be conducted. Preliminary experiments designed to perfect technics have been completed. More extensive tests are under way.

Johnson, Ralph G. AT(11-1)1019  
E2A170 RESEARCH ON THE MARINE GEOLOGY  
AND BIOLOGY OF TOMALES BAY, CALIFORNIA.  
The University of Chicago, Chicago, Ill. COO.

The studies are concerned with the chronological variation in the structure of marine communities with special emphasis upon the environmental factors influencing the distribution and abundance of benthic marine communities. The principal objec-

tive of the project is to determine to what extent the sum of species and individuals of a marine community are mutually limited. This aspect of communities is of paramount importance in assessing the influence of man on the marine environment. The proposed program involves the analysis of data collected during 1962 and 1963 at the first permanent time study station in Tomales Bay, California. The fauna and physical environment at the two existing time study stations will be monitored during 1963-64. Preliminary studies will be carried out for the purpose of establishing the third permanent study station at Tomales Point. Further studies will be made of the physical features of the infaunal environment, both intertidal and subtidal. These include the analyses of the salinity, oxygen content, pH, and circulation of interstitial waters. In addition, a variety of statistical experiments will be performed for the purpose of assessing the amount of population fluctuation that can be detected by standard sampling procedures.

Alverson, Dayton L. AT(49-7)1971  
E2A332 DEEP-WATER MARINE INVESTIGATIONS.  
BUREAU-A.E.C. COOPERATIVE STUDY OF THE  
MARINE FISH FAUNA OFF THE MOUTH OF THE  
COLUMBIA RIVER.  
Fish and Wildlife Service. Exploratory Fishing and  
Gear Research Base, Seattle. WASH. SP 3; MYR  
3.2.

The waters adjacent to the Columbia River mouth are heavily fished for a variety of demersal fishes. A continuing investigation has been designed to (1) determine the biological transport and uptake of radionuclides which have their origin in Columbia River waters by marine invertebrates and demersal fishes inhabiting these waters, and (2) investigate on a temporal basis the composition, distribution, and relative abundance of marine resources inhabiting these waters at depths from 50 to 1000 fathoms.

Sampling along a track line is conducted using a commercial otter trawl and dredge at several seasons of the year. Radiological analysis of samples collected is carried out by the Laboratory of Radiation Biology at the University of Washington.

Investigation to date has indicated that commercially utilized forms of fishes inhabit depths at least to 600 fathoms, and that seasonal bathymetric movements are carried out by several forms. Continued seasonal study of the fauna on the track line, along with the tagging program being conducted by the Oregon Fish Commission, is designed to determine the extent and pattern of bathymetric movements of the marine resources of the region. Study in the

next several years of the infauna, and stomach analyses of several commercially important benthic forms is designed to establish food-chain relationships within the benthic community.

Rice, T. R. AT(49-7) 5  
E2A333 CYCLING OF RADIONUCLIDES AND THEIR EFFECTS UPON ORGANISMS IN THE MARINE ENVIRONMENT.

Fish and Wildlife Service, Radiobiological Lab., Beaufort, N. C. WASH. SP 7; MYr 17.

Research of the Radiobiological Laboratory was initiated because the need was foreseen for accurate predictions and recommendations concerning potential radioactive contamination of estuaries and other marine environments. In addition it was realized that radioisotopes are valuable for studying problems in fishery biology such as mineral cycling in the environment, mineral metabolism in organisms, and filtering rates of organisms.

The research program emphasizes the experimental approach and includes three areas of field and laboratory studies: (1) Experimental Environments. The cycling of elements through the components of marine communities is being observed in large tanks and ponds. This yields more realistic accumulation rates, levels of concentration, and retention times for algae, crabs, oysters, fish, and sediments than conventional laboratory methods. By using gamma emitting radionuclides and a detector with a large chamber, live animals and other samples are removed from the tanks or ponds, measured for radioactivity, and then returned to the experiment for further observation. Some isotopes used include Zn<sup>65</sup>, Fe<sup>59</sup>, and Au<sup>198</sup>. (2) Estuarine Radioecology. The productivity and food relationships of estuarine organisms are being studied. Environmental radioactivity in marine organisms is being measured to establish base lines for existing levels and to determine ecological relationships. Also, in cooperation with the Corps of Engineers on a study of sediment movements, the accumulation of Au<sup>198</sup> by organisms was determined after the release of Au<sup>198</sup>-labeled sediments. Levels of accumulation were much less than MPC levels. (3) Radiation Effects. The effects of irradiation on marine organisms are being studied with both external and internal sources. Quantities of radiation required to kill one-half of the animals irradiated (LD<sub>50</sub>) have been determined for clams, oysters, and postlarval flounders. The effects of radiation on the physiology of blood, egg hatching, larval development, growth, and meristic characteristics have been studied for several species of fish.

Data on these three areas are being integrated so that assessments can be made concerning the potential hazards of radioactivity in marine ecosystems to marine organisms and to man.

Marshall, Nelson AT(30-1)2678  
E2A429 CONCENTRATION PROCESSES IN THE NIAN TIC ESTUARY.  
Rhode Island. Univ., Kingston. Graduate School of Oceanography.

The present phase of this program is centered on a study of the vertical exchange processes between tidal currents and the water adjacent to the bottom in the Niantic River, a typical shallow estuary. Sampling is carried out to determine the microflora, the chlorophyll a and the quantity, by weight, of particulate matter transported in the currents and transferred to relatively slack water adjacent to the bottom. Since the exchange through the water column is related to the boundary effects between the tidal currents and the substrate, observations will be carried out to determine empirically the characteristic current profiles from the substrate into the overlying free-flowing waters.

A supplementary study is being conducted to identify the source of high gross beta radiation that has been discovered in certain marine organisms, particularly the rockweed Fucus, of the Niantic estuary.

Dawson, William A. AT(45-1)1734  
E2A479 A STUDY OF THE PHYTOPLANKTON OF THE CHUKCHI SEA.  
Washington. Univ., Seattle. RLOO. MYr 1-18/24.

Phytoplankton samples from the Chukchi Sea, related plant pigment measurements, and related primary productivity determinations have been obtained by the principal investigator and others connected with the Department on five trips to the Chukchi. The trips were scheduled to span the growing season. The phytoplankton samples will be examined for a determination of the species composition, community structure and biomass. These data will then be related to the plant pigment determinations and to the productivity determinations and an estimate of the total annual plant production for the region will be derived.

Gorbman, Aubrey AT(30-1)-3037  
E2A527 PATHOLOGIC EFFECTS IN FISHES EXPOSED TO RADIOACTIVE IODINE FROM FALLOUT.  
Columbia Univ., New York.

Rochene, Jean AT(30-1) 2507  
E2A568 IODINE METABOLISM AND EVOLUTION

OF THYROID FUNCTION IN LOWER VERTEBRATES AND INVERTEBRATES.

Antonio and Rinaldo Dohrn Foundation, Naples. March 1962–February 1963.

Researches on iodine metabolism in lower Vertebrates and Invertebrates are in progress and some publications describing the results are under press in "Journal of General Endocrinology," "Comparative Biochemistry and Physiology," "Rendiconti dell'Accademia Nazionale dei Lincei," e "Comptes rendus de la Societe de Biologie." We have established that the endostyle of the larves of Lampreys (*Ammocoetes*) contains a primitive thyroid gland and the fate of its endocrine secretion have been studied. The most important result has been the demonstration of the biosynthesis of thyroid hormones in *Protochordata*; a *Cephalochordata*, the *Amphioxus*, and two *Urochordata* (Tunicata: *Ciona intestinalis* and *Clavelina lepadiformis*) produce thyroxine and 3:5:3'-triiodothyronine, characterized by chromatography and electrophoresis of  $^{131}\text{I}$ -labeled products after fixation of radioactive iodides by living organisms. Work on the possible biosynthesis of the same hormones by *Balanoglossus* (Hemichordata) is actually in progress. Further research results show that various species of Mollusks and of Anthozoa bind big amounts of labeled iodides but are unable to synthesize thyroid hormones. They synthesize iodinated soleroproteine including 3-monoiodotyrosine and 3:5-diiodotyrosine. The fate of iodine is fundamentally different: a) in all Chordata (Vertebrata and Protochordata) and b) in Invertebrates lower than Protochordata.

Schreiber, Bruno AT(30-1)2607  
E2A572 ECOLOGY OF ACANTHARIA (RADIOLARIA) IN RELATION TO THE CIRCULATION OF Sr IN THE SEA.

Italy. Università. March 1962–February 1963.

Investigations are planned for the study of the role of Acantharia in the capture and circulation of Sr radioactive isotopes due to fallout or waste disposal.

Previous researches (Schreiber, Cavalon) on the chemical nature of acantharian skeleton by means of X-rays structural analysis confirmed that "celestite" is the constituent of the spiculae of these animals and that a specific accumulation capacity for Sr ions is present.

Systematic and ecological researches of thyrrenian species of Acantharia and chemical analysis of plankton samples are conducted in order to ascertain the Sr content in correlation to zoological plankton composition.

Radiochemical analysis of whole plankton, autoradiogrammes of single specimens of Acantharia and

turnover assays of Sr *in vitro* are planned.

A part of this program is still in operation.

## E2B Sedimentation

See also E2C84.

Arrhenius, G. O. S. AT(11-1)34-83  
E2B26 RESEARCH IN MARINE MINERALOGY. Scripps Institution of Oceanography, La Jolla, Calif. SAN. SP 5; MYr  $2\frac{1}{2}$ .

The purpose of this research is to study the transfer of dissolved and suspended material through the ocean and to establish the distribution, particularly of the natural radioactive elements, between the solids which crystallize or precipitate on the ocean floor. For these purposes the novel field of electron microprobe x-ray microanalysis is being developed and existing methods in x-ray diffraction analysis are being modified. The sediment sequences, used as objects for these studies, are distributed over the Indo-Pacific area, and span in time the last few million years. Barium is found to be concentrated from the surface sea-water by certain planktonic microorganisms, together with strontium, including Sr-90. These organisms settle to the ocean floor, particularly below the equatorial production zone, and the barium crystallizes into barium sulfate, together with associated trace elements. Work has been initiated to synthesize in the laboratory solid solutions of barite and to establish their thermodynamic properties. The transfer of trace element ions in solution in sea water to the sediments by silicates, crystallizing on the ocean floor has been found to be of great quantitative significance. Particularly important in this respect are the ubiquitous particles of volcanic glass, which decompose into nontronite and harmotomephillipsite, the former an expanding sheet structure silicate, the latter a zeolite with molecular tunnels. Both are highly absorptive and incorporate in their structure particularly thorium among the radionuclides. The accurate composition and mode of formation of these phases is now being studied, together with the rare earth phosphates, which together with uranium, thorium and a number of heavy elements grow on the surface of skeletal apatite, mainly from fish, which is an omnipresent component of deep sea sediments.

We are further developing methods for separation and concentration by ion exchange methods of uranium, thorium, the rare earth elements, and other metals of geochemical interest, for their concen-

tration into a microdroplet, and for subsequent analysis by electron microprobe x-ray analysis. Water samples are being collected in vertical profiles through the Indian Ocean for analysis by this method, aiming in this case at the dynamics of turnover of these elements, their rate of introduction through rivers, their lifetime in solution in the ocean, and their removal into different scavenging minerals on the ocean floor.

Goldberg, Edward D. AT(11-1)34-84  
E2B29 MARINE GEOCHEMISTRY RESEARCH.  
Scripps Institution of Oceanography, La Jolla, Calif.  
SAN. SP 1; MYr 1.0.

The investigations concern the transfer processes of elements introduced into the oceans and subsequently incorporated into the sedimentary deposits and the time relationships in such processes. Three general lines of work are being prosecuted: (1) Rates of sedimentation and the determination of geological ages by the ionium/thorium, uranium/ionium and U-234/U-238 methods. Analyses of the natural radioactive nuclides are made either by alpha spectroscopy using solid state detectors or low-level beta counting. Previously, work has been restricted to the Pacific and Indian Oceans but this year we are emphasizing the determination of sedimentation rates in a profile of stations in the Atlantic between Martinique and Gibraltar; (2) Construction of an omegatron, a mass spectrometer capable of analyzing  $10^{-11}$  cc of gas sample in the mass range between helium and xenon. The initial problems to which the apparatus will be applied include the analyses of rare gases in sea water and the potassium-argon age determinations of milligram amounts of mineral and rock samples; and (3) the analyses of the rare earths in sea water and marine sediments by slow neutron activation analysis. The chemical behavior of the rare earth elements during the major weathering cycles at the earth's surface are poorly understood. Such analyses may delimit the physico-chemical conditions within chemical systems in the oceans where a fractionation of individual rare earths may occur through redox or differential solubility reactions.

Creager, Joe S. AT(45-1)1752  
E2B59 BOTTOM CURRENTS AND THE MOVE-  
MENT OF SEDIMENT ACROSS THE CONTINENTAL  
SHELF, AT(45-1)-1752.

Washington. Univ., Seattle. RLOO. SP 6; MYr 1 $\frac{1}{6}$ .

Two purposes underlie this study:

1. Such work will aid in our understanding the mechanism of sediment transport across the conti-

mental shelves. We know that such transport across the continental shelf in a seaward direction is probably the case but how this is accomplished is of considerable concern. Seaward of the continental shelf, sediment is transported and distributed by turbulent mud, flows running down the relatively steep continental slopes. The continental shelves are almost flat. Landward, near the beach, bottom currents generated by shoaling waves transport sediment primarily toward the beach. We must determine what the transport mechanism is on the relatively flat continental shelf beyond the wave produced bottom currents. But we must first describe the sediments which are being transported and the magnitude of the currents effecting this transportation before we can determine the causative agent or agents.

2. It is expected that the study will provide insight into the relationships between fluid flow and sediment movement. Previously described relationships have been based almost exclusively upon controlled laboratory experiments and have not been successfully verified in nature. This work will also further explore which of the possible variables are important in determining the hydrodynamic interactions of the sediment and the fluid flow.

The first year of the program has been spent in the development of a method of measuring in detail the bottom current profile over the continental shelf and the amounts and characteristics of the sediment that is moved as a result of such currents. The method must be capable of defining, in vertical range from 2 meters above the bottom to 20 cm below the bottom (a) the velocity distribution, (b) the sediment distribution, (c) the textural character of the sediment and (d) the geometry of the sediment-water interface (i.e., bottom). Preliminary considerations call for designing the method of measurement using closed-circuit underwater television as the principle device.

Johnson, Noye M. AT(30-1)2982  
E2B71 RADIATION DOSIMETRY OF GEOLOGIC  
ENVIRONMENTS.  
Dartmouth Coll., Hanover, N. H. NYOO.

The existence of natural thermoluminescence in calcitic carbonates has been demonstrated. Since high temperature thermoluminescence has potential use as a radiation dosimeter, the radiation history of carbonate rocks is open to analysis. The determination of ionizing dose rates received by selected geologic environments will be evaluated. Pleistocene and Recent calcitic shell material will be one object of study; limestones associated with recent volcanism will be another. Any natural thermolumines-

cence observed will be calibrated in terms of alpha or gamma radiation. Shell material from carbon-14 dated localities will be used whenever possible to provide elapsed time information.

A method of determining absolute age involving thermoluminescent dosimetry and radioactive decay will also be tested. Natural thermoluminescence will be calibrated in terms of total dose absorbed (rads) while radioactivity will be used for the intrinsic dose rate delivered (rads/year).

Koczy, F. F. AT(40-1)2411

E2B107 THE GEOCHEMISTRY OF RADIOACTIVE ELEMENTS IN THE MARINE ENVIRONMENT. Miami, Fla. Univ. Marine Lab. OROO.

The distribution of naturally occurring radionuclides is used to study oceanographic and geological phenomena.

The  $\text{Pa}^{231}/\text{Th}^{230}$  ratio is utilized for the determination of the time period passed since the sediments have settled. Solid-state alpha counters are employed. During the study of rates of sedimentation and age determination, special attention will be given to the problem of obtaining an efficient routine method.

The fractionation of sediment samples by chemical and physical means will facilitate studies of the origin of the various components of the sediment as well as the chemical processes active in the sediment. Emphasis will be on U, Th, Pa and their daughter products, but Zn, V, Mo, and Co will also be studied. We hope to be able to determine diffusion and reaction rates in deep-sea sediments.

Investigations will be initiated to determine the chemical state of the elements in the sediments, the equilibrium constants of their compounds, and their reaction rates. These investigations are necessary to understand and predict the behavior of the elements in the aquatic environment. Of specific interest are the processes of crystallization and recrystallization of clay minerals and the incorporation of trace elements.

Wangersky, Peter J. AT(301)2882

E2B134 THE SEDIMENTATION OF MANGANESE IN THE OPEN OCEAN.

Yale Univ., New Haven. NYOO.

Research on this project in the next year will be developed along two separate lines. In the laboratory, we will partition Caribbean core CP-28 into five fractions; interstitial water, coarse carbonates, fine carbonates, oxidized substances on the clays, and clays and residual minerals. With the aid of radio-carbon and protactinium-ionium dates we hope to be

able to calibrate the rate of transfer of manganese from the residual fraction to the carbonate fraction, and thus determine whether this shift is sufficiently linear to be used as a rough dating method. We hope also to be able to calculate the manganese content of both residual and carbonate phases at the time of sedimentation, and thus determine the average amounts of manganese incorporated into these fractions when they are still in the water column.

At sea, aboard the Bureau of Commercial Fisheries vessel R. V. Geronimo, we hope to sample the water column directly, to determine the distribution with depth of manganese in the particulate matter. Particulate matter will be partitioned into several phases by methods used in the core analyses, and manganese determined in each phase.

Since manganese is involved in photosynthesis, we must allow for the re-cycling of manganese in the euphotic zone of the ocean. We will attempt to estimate both the standing crop and the rate of turnover of manganese in the planktonic organisms.

Turekian, Karl K. AT(30-1)2912

E2B493 SIMULTANEOUS DETERMINATION OF SEVERAL TRACE-ELEMENTS IN SEA WATER BY NEUTRON ACTIVATION.

Yale Univ., New Haven. December 1961–November 1962. SP 3; MYr 2.

A method has been devised for the determination of 21 trace elements in seawater by neutron activation analysis. The method is based on irradiation of sea salt extracted from 100 ml samples of seawater by freeze-drying under vacuum. The irradiated salt is then fused with carriers for the 21 elements: Ag, Au, Ba, Br, Co, Cr, Cs, Fe, Hf, Hg, Ni, Rb, Sb, Sc, Se, Sr, Ta, Te, U, Zn and Zr.

Chemical separations are then performed and yield determinations are made by standard gravimetric and colorimetric methods. Radiochemical purity is ascertained on a 400 channel gamma-ray pulse height analyzer and quantitative determinations are made by integrating the areas of characteristic gamma-ray peaks. The constant strontium content in seawater demonstrated by this work and that of others makes possible the use of strontium as an internal flux monitor. Results obtained so far on selected seawater samples from the Atlantic and Pacific Oceans are shown in Table I.

TABLE I

Element	No. of Analyses	Avg. $\mu\text{g}/\text{l}$
Ag	35	.26
Au	4	.006

TABLE I—Continued

Element	No. of Analyses	Avg. $\mu\text{g}/\text{l}$
Co	30	.16
Cr	20	1.3
Cs	20	.28
Ni	11	3.5
Rb	20	98
Sb	7	.3
Se	2	.09

Ta, Zr, Hf, Sc are below the present levels of sensitivity; U and Br have been detected but not determined in actual seawater samples and the results for Hg and Zn indicate contamination of samples during collection or sample preparation. Coefficients of variation calculated from duplicate pairs of Ag and Co are 22 percent and 16 percent respectively.

## E2C Circulation and Mixing

Folsom, Theodore R. AT(11-1)34-71  
E2C28 MAGNITUDE AND DISTRIBUTION OF  
RADIONUCLIDES IN THE OCEAN.  
Scripps Institution of Oceanography, La Jolla, Calif.  
SAN. SP 6; MYr 3.6.

Overall objective is the distribution and behavior in the marine environment of certain radionuclides, particularly certain gamma emitters, throwing light on oceanographic and biological phenomena. Special experience has been gained in surveying for and analyzing samples of fallout cesium, but coverage of the ocean is still limited. Faster and more precise techniques are being developed. A review of marine radiochemical procedures was made and is being reported, including six months of direct collaboration with the Meteorological Research Institute of Tokyo.

Surface radiocesium in the Pacific has been mapped almost synoptically, and brief sampling made of the surface profile. Lateral distribution measured agreed with predictions of meteorologists and terrestrial collectors, but absolute concentrations did not. The reasons for discrepancy are being sought. Recent success with direct concentration of traces of cesium in sea water with zeolites is being followed up by design of new field and laboratory gear to improve and extend field measurements especially to very deep waters.

Success in trapping two distinct and widely distributed bottom-inhabitants, a hagfish and an amphipod, is being followed up in developing effective methods for assaying them for  $\text{Zn}^{65}$ ,  $\text{Cs}^{137}$ ,  $\text{Sr}^{90}$ , and

$\text{Ce}^{144}$ , preparatory for wide field collections and study of concentrating ability of such organisms.

Water samples from the Arctic and Indian Oceans will be studied, and others collected.

Rakestraw, Norris W. AT(11-1)34-74  
E2C34 RADIOCARBON MEASUREMENTS IN  
THE SUBSURFACE AND DEEP WATERS OF THE  
PACIFIC OCEAN.  
Scripps Institution of Oceanography, La Jolla, Calif.  
SAN.

The objective of this project is to determine the C-14 content of deep-sea water, in the hope that a comparison of the apparent age at different places may give a clue to the velocity of its movement. The first determinations, from a longitudinal line in the Southern Pacific, resulted in a progressive series of apparent ages from south to north suggesting a water velocity of about 0.3-0.4 mm per second. Later determinations from the Indian Ocean yielded velocities of about one-half that magnitude. In all, over one hundred measurements have been made, some 40% of them in surface waters, however. More than one hundred additional samples taken in the Indian Ocean during 1962 still await analysis.

The calculation of velocity can only yield a component which, in the absence of other definite information, is assumed to be in the direction of increasing age. The velocities thus far determined in this way are considerably smaller than those obtained by other methods. Reconciliation of this method with others is under study. Useful by-products of the project have also appeared, such as better information about surface values of C-14 and their relation to the atmosphere, and a knowledge of the vertical distribution of C-14 in the water column at many places. Such results as these can also increase our knowledge about mixing processes in the ocean.

Salo, Ernest O. AT(04-3)395  
E2C84 THE CIRCULATION, WATER QUALITY,  
AND SEDIMENTATION OF HUMBOLDT BAY,  
CALIFORNIA.  
Humboldt State Coll., Arcata, Calif. SAN.

The objectives of this project are to study the circulation and sedimentation within Humboldt Bay and to examine the exchange of water between Humboldt Bay and the Pacific Ocean.

Circulation is being delineated with current meter measurements, by tracing the movements of Rhodamine B dye, and by following and tracking drift poles. Standard hydrographic stations monitor the water temperature, salinity, and chemistry of the water in the bay and ocean. Grab samples from the bottom

will be subjected to mechanical and pipet analyses to give the distribution of particle size.

The results thus far show that the bay is an area of active tidal mixing. There appears that there is little if any modification of the water characteristics in the bay from that of the ocean. Preliminary results indicate that the correlation of sediment distribution with bottom currents is quite good.

Andersen, N. R. AT(30-1)2174  
E2C111 RADIOELEMENT STUDIES IN THE OCEANS.

Woods Hole Oceanographic Institution, Mass. NYOO. SP 3 $\frac{1}{2}$ ; MYr 3 $\frac{1}{2}$ .

The program is aimed to increase understanding of the relative geochemical importance and of the time constants of the hydrodynamic, chemical and biological processes moving elements through the hydrosphere. Special attention is placed on the tracer experiment resulting from bomb-test fallout in the Atlantic Ocean. Sea-water samples from various places and depths have for some years been analysed for Sr<sup>90</sup>, Ce<sup>144</sup>, and Pm<sup>147</sup>. Currently also are analysed Y<sup>91</sup>, Sb<sup>125</sup>, Cs<sup>137</sup> and occasionally Eu<sup>155</sup> and Sm<sup>151</sup>.

Sr<sup>90</sup> (and Cs<sup>137</sup>) move as solutes; at stations from 0° to 11°N, in early 1961, concentrations at 2500 m are about 25% of surface values. The lanthanides move largely as particulates, Pm being concentrated over Ce in more rapidly sedimenting fractions. Integrated deliveries of fallout are always higher at sea than the average of the same latitude band on land.

Chemical and radiochemical analyses of plankton and benthon are being made concurrently. Experimental studies have begun on the histology and excretion of radionuclides infested by plankton.

Ac<sup>227</sup> in marine sediments is found to be well below the value in equilibrium with U<sup>235</sup>. In some water samples Ac<sup>227</sup> is, however, barely detectable.

Schell, I. I. AT(301)2929  
E2C137 VERTICAL AND LATERAL MOVEMENTS OF WATERS IN THE OCEANS AND THEIR PREDICTION.

Tufts Univ., Medford, Mass. Jan. 1, 1963–Dec. 31, 1963.

It is planned to continue with the work on vertical and lateral movements of waters in the oceans effected by stirring by wind, sinking of surface water by contact with air of varying coldness in the high latitudes in winter, up-welling off coasts due to offshore winds and in the free ocean by divergent air flows, and to continue also with work on horizontal movements of water or wind driven ocean currents.

Continued use in the investigation is to be made of historical, or time series data consisting on the one hand, of mean monthly and longer-period values of atmospheric circulation indices obtained from mean monthly pressure charts and wind measurements at coastal and island stations, and, on the other, of surface and sub-surface temperatures, salinities, and oxygen content values reflecting shorter- and longer-period vertical and horizontal movements of water in the oceans.

The promising findings obtained from the work during 1962 in regard to the nature of the Peru Current and the upwelling off Peru and, indirectly, El Niño as reflected in the sea surface temperature anomalies off the west coast of South America, are to be tested with additional data, using mean monthly sea level pressures from the eastern South Pacific ocean and adjacent South America.

Finally, it is planned to investigate the movements of water in the oceans in terms of the preceding state of the atmospheric circulation and air temperatures as a means of predicting these movements in the future.

Aron, William AT(11-1)1145  
E2C173 A SURVEY OF THE OCEANOGRAPHIC LITERATURE OF THE SANTA BARBARA CHANNEL AREA.

General Motors Corp. Defense Research Labs., Santa Barbara, Calif. COO. MYr 1.3.

Approximately 1,000 references concerning the oceanographic literature of the Santa Barbara Channel area are listed and annotated. The present state of oceanographic knowledge for the region is reviewed and the significant gaps in our knowledge, particularly those which apply to the disposal of radioactive isotopes, are indicated.

Bowen, V. T. AT(30-1)3010  
E2C427 CURRENT SYSTEM STUDIES IN THE EQUATORIAL REGION OF THE WESTERN ATLANTIC OCEAN.

Woods Hole Oceanographic Institution, Mass. SP 20; MYr 15.

Physical oceanographic data in the area from 5°N to 5°S and from 25°W to 35°W, have been collected by two ships: included are hydrographic station, bathythermograms, continuous profiles of salinity, temperature and pH, geoelectro-kinetograph studies, buoy measurements of current speed and direction at various depths. This data will be reduced, collated and interpreted. Biological and Geological samples in the area above, plus the line from St. Thomas to 0°, 25°W and along the N. E. coast of S. America,



have been collected in great numbers. These will be studied taxonomically, chemically, radiochemically, and both chemical and mineralogical studies are planned on rock and sediment samples. Extensive bathymetric studies have been made.

Day, C. Godfrey AT(30-1) 2998  
E2C494 CONTINUOUS CURRENT MEASUREMENTS IN THE WESTERN NORTH ATLANTIC.  
Woods Hole Oceanographic Institution, Mass. May 1962–April 1963.

Six deep-sea current measurement stations are to be moored along the 65th meridian at the following latitudes: 30°00'N; 28°10'N; 26°20'N; 24°30'N; 22°40'N; 20°50'N. At each station, near-surface wind force and direction will be recorded at 20-minute intervals while similar current measurements will be made at depths of 50, 100, 500, 1000, 2000, 3000 etc., to a maximum depth of 6000 meters. The current meters, designed by Dr. W. S. Richardson of the Woods Hole Oceanographic Institution, and manufactured by Geodyne Corporation, record current speed and direction for extended periods. The stations will be checked at three month intervals, records removed and instruments re-activated. It is planned to acquire a minimum of 3 years of continuous readings.

Data will be studied to determine: (1) the reaction of the near-surface currents to different weather patterns; (2) the extent of tidal action; (3) the net movement at the depths measured; (4) seasonal and secular variations in currents.

Broecker, Wallace S. AT(30-1)2493  
E2C566 CO<sub>2</sub> EXCHANGE BETWEEN THE ATMOSPHERE AND OCEANS.  
Columbia Univ., Palisades, N. Y. Lamont Geological Observatory. December 1961–November 1962.

Estimates of water residence times in the deep sea based on radiocarbon data require a detailed knowledge of the rate of CO<sub>2</sub> exchange between the atmosphere and surface ocean. Because of the complexity of the exchange mechanism and the impracticability of making direct observations, the problem has proven to be a formidable one. Several approaches are currently being studied as part of this program: 1) laboratory measurement of the exchange rate for low turbulence rates, 2) determination of the ratio between exchange rate and mean wind velocity over inland lakes based on the concentrations of natural and of bomb produced radiocarbon, 3) the determination of the ratio of average oceanic exchange rate to the mean oceanic wind velocity from the steady-state distribution of C<sup>14</sup> in the ocean atmosphere system, 4) use of the fossil CO<sub>2</sub> and bomb C<sup>14</sup> distributions as indices

of the rate of mixing in the ocean-atmosphere system. To date the results of these investigations indicate that the exchange rate for the inland lakes is similar to that for non-turbulent solutions in the laboratory and that the mean oceanic rate is a factor of four higher. The distribution of fossil CO<sub>2</sub> is consistent with the average exchange rate computed for the ocean.

Ewing, Maurice AT(30-1)2663  
E2C577 MIXING, DIFFUSION AND CIRCULATION RATES IN OCEAN WATERS.  
Columbia Univ., Palisades, N. Y. Lamont Geological Observatory. November 1961–October 1962.

During the following year it is proposed that measurements of mixing, diffusion, and circulation be made in the open ocean to depths of 200 meters. These measurements will employ the use of Rhodamine-B dye as a tracer, together with a fluorometer detector for in situ measurements.

In addition to the dye tracer measurements other hydrographic observations will be made to supplement the program. These will consist of direct current measurements, standard hydrographic stations and continuous thermal gradient profiles.

Ships owned by Columbia University will be employed in the program and will be outfitted for hove-to measurements and under-way measurements using the in situ measuring fluorometer.

## E2D Other Oceanographic Studies

Hand, Cadet AT(11-1)34-96  
E2D30 A MARINE ECOLOGICAL SURVEY OF THE BODEGA HEAD REGION.  
California. Univ., Berkeley. SAN. SP 3; MYR 3/4.

One of our primary objectives is an attempt to predict and assess the effect of warm salt water from a proposed nuclear fueled power plant on the local marine habitat. In order to do this, however, much background information is needed about the subtidal and intertidal flora and fauna of this region both before and after the plant starts to operate. This information, accumulated over a period of ten years, will consist of statistical comparisons of quantitative biological samples from the various marine habitats available on Bodega Head, classification and maps of these habitats, and measurements of pertinent physical parameters of the environment.

During this first year emphasis will be placed on evaluation of methods, including field experiments and manipulations of the environment designed to

produce measurable changes in some summarizing characteristics of the entire community; examples of these are species diversity, total biomass, and oxygen consumption.

Johnson, J. W. AT(11-1)34-78  
E2D33 BEACH RADIOACTIVITY.

California. Univ., Berkeley. SAN. SP 2; MYr 3.

This project has been concerned with the use of naturally radioactive minerals as a tracer in studying the movement of sediment both in streams and along the shoreline by wave action. In the studies of the littoral movement of sediment, it has been found that certain streams and some rocky headlands act as a source of thorium-rich rocks. By sampling sediments along the nearby beaches and subjecting them to analysis in a Gamma-Ray spectrometer, it has been possible to determine concentrations of thorium and thus establish the prevailing direction of littoral drift. In a similar type of sampling and analysis of sediments in various streams in a watershed, it has been established that the usual geological map is not in sufficient detail and accuracy to provide information on whether or not the rocks in the area can be considered as a source of radioactive materials to serve as a tracer.

Schaefer, Milner B. AT(11-1)34-99  
E2D85 COMPREHENSIVE SUMMARY OF  
OCEANOGRAPHY OF THE EASTERN PACIFIC  
FROM LATITUDE 30°N TO LATITUDE 40°S.

California. Univ., La Jolla. Inst. of Marine Resources. SAN. SP 5; MYr 7.5.

To complete, during a period of 18 months after 1 January 1963, a comprehensive summary of existing knowledge of the physical, chemical and biological oceanography (including fisheries) in the upper 1000 meters of the eastern Pacific Ocean between latitudes 30°N to 40°S, east of 130°W to the mainland, including the Gulf of Panama.

It is proposed not only to summarize information available from published literature, but also to complete the analysis and summarization of a large quantity of data, unpublished or published only in data reports, collected in recent years. Most such data is already in the hands of the investigators and their associates at the Scripps Institution of Oceanography.

This is an augmentation of research already under way. The support from AEC is to provide assistance to accelerate its completion.

Morgan, A. R. AT(45-1)1731  
E2D95 THE OFFSHORE-INSHORE EXCHANGE  
OF GROUND FISH STOCKS OFF NORTHERN OREGON  
AND SOUTHERN WASHINGTON.

Oregon. Fish Commission, Portland. RLOO. SP 1;  
MYr  $\frac{1}{12}$ .

The purpose of this study is to determine the offshore-inshore exchange of groundfish stocks off northern Oregon and southern Washington. The method to be employed is tagging the fish caught by the U. S. Bureau of Commercial Fisheries trawlers John N. Cobb and Commando during AEC contract studies in this area. The Oregon trawl landings in Astoria, Newport, and Coos Bay will be monitored closely for tagged fish. Other areas north and south of these ports will also be checked. It is expected that the bulk of the recovered tagged fish will appear in catches of Oregon trawlers since these vessels predominate in this area.

The principal species expected in the study area are Dover sole (Microstomus pacificus) and black cod or sablefish (Anoplopoma fimbria). Only species in appreciable abundance will be tagged in order to maximize the likelihood of significant numbers of recaptured tagged fish for analytical purposes. By augmenting the present vessel-interview and catch sampling program it is likely that quantitative measures can be obtained for tag recoveries from in-shore areas.

The minimum duration of the study would be 6 years. Based upon past experience, this would provide sufficient time to obtain adequate recoveries from the first two years of tagging. A longer period (up to 10 years) would be very desirable in order to replicate the experiment to permit a more precise measure of the variation in behavior of these fish. Dover sole and sablefish are both long-lived animals and appreciable numbers of tag recoveries can be expected for at least 5 years after tagging. During the first year the principal activity will be tagging.

Anderson, William W. AT(49-7)2239  
E2D96 BIOLOGICAL-STATISTICAL CENSUS  
OF THE SPECIES ENTERING FISHERIES IN THE  
CAPE CANAVERAL AREA.

Fish and Wildlife Service. Biological Lab., Brunswick, Ga. WASH. SP 4; MYr 2.

The project's objective is to review and analyze all available data on fisheries in the coastal waters from the coastline to the edge of the Continental Shelf, and in the Indian River and Banana River, within the area extending from approximately 40 miles north to 20 miles south of Cape Canaveral, Florida.

These data will yield information on the composition of the commercial catch by species by months, gear and number of fishermen, and value of catch. Data from past operations of the Bureau's explora-

tory and research vessels will provide information on species composition in the more offshore areas of the Continental Shelf and on composition of catches by shrimp trawls on the inshore fishing grounds. Field work is in progress to determine the extent of and seasonal variation in fisheries in the Indian River and Banana River within the study area. The literature is being searched for pertinent information regarding life histories, migrations, growth, etc., of species of the work area.

Hood, Donald W. AT(40-1)2799  
E2D105 CHEMISTRY AND ANALYSES OF TRACE METALS IN SEA WATER.

Texas. Agricultural and Mechanical Coll., College Station. OROO. Feb. 1, 1963-Jan. 30, 1964. SP 7; MYr 3.1.

This project is concerned with the investigation of the chemical forms of Mn, Cu, and Zn, which contribute to the total concentration of these elements in sea water. Samples obtained from widely different oceanic areas at many depths have been analyzed for the total, particulate, ionic and non-dialyzable forms of Mn, Cu, and Zn using neutron-activation analysis. Results indicate a substantial portion of Cu and Zn are present in ultrafilterable ( $<10 \text{ m}\mu$ ) but non-dialyzable ( $>4 \text{ m}\mu$ ) form. Studies into the nature of this non-dialyzable material are underway. Preliminary studies of other trace metals, particularly the rare earths, have also been undertaken.

Sampling of sea water following the Swordfish Program indicated that most of the  $\text{Zr}^{95}$ ,  $\text{Ru}^{103}$ , and  $\text{Ce}^{141-144}$  present 3 to 7 weeks after addition to the ocean existed in the dissolved rather than solid state in the upper water layers. Additional studies are now underway to ascertain the content and form of the stable isotopes of these elements in sea water.

### E3 ATMOSPHERIC RADIOACTIVITY AND FALLOUT

Hanunian, N. A. AT(04-3)414-3  
E3-48 STUDY OF POST-ATTACK ENVIRONMENT RESULTING FROM THERMONUCLEAR WAR. RAND Corp., Santa Monica, Calif. SAN.

The purpose of this study is to explore the intermediate and long-term changes in the environment which might result from thermonuclear attacks with varying weights and targeting objectives. While mathematical models will be used to assess damage from blast, fire and radiation, the primary aim is not damage assessment but to study the changes in

the environment over time brought about by the damage from the attack.

Specifically, post-attack biological problems resulting from the combined effects of blast, radiation and fire on agricultural, forest and grass lands will be investigated from an ecological point of view, using such information as is available from historical surveys of past large scale disasters such as fires, floods, hurricanes, pest infestations and epidemics. Where possible the implications of these environmental changes for post-attack recovery plans and programs, such as land management, control of disease and pests, flood control and public health will be examined. Also, where possible, the influence of various pre-attack postures on the post-attack environment will be investigated.

During the course of this work it is expected that important areas requiring additional research will be uncovered which will lead to continuing improvement in our understanding of the post-attack environment.

### E3A Atmospheric Chemistry

*See also E3B158.*

Owe Berg, T. G. AT(04-3)474  
E3A36 INVESTIGATION ON THE MECHANISM OF COALESCENCE IN THE WASH-OUT OF PARTICULATE MATTER BY RAIN. Aerojet-General Corp. Ordnance Div., Downey, Calif. SAN.

The proposed effort is an experimental study of the mechanism of coalescence between water drops and solid particles by high-speed photography using drops and solid particles in the millimeter size range. The main factors to be studied are: (a) Electrostatic charge represented by a voltage applied between the drop and the particle; (b) Nature of the solid, e.g., metal, glass, metal oxide, or metal halide; (c) Water content of the solid when applicable, e.g., metal oxide or metal halide.

Sekera, Zdenek AT(11-1)34-72  
E3A37 STUDIES OF ATMOSPHERIC TURBIDITY. California. Univ., Los Angeles. SAN. SP 4; MYr 2.

Particulate matter (such as atomic test debris) in the atmosphere affects scattering properties of the air, and hence the skylight polarization. Previous measurements indicated the possibility of atomic debris detection from the change in this polarization. Theoretical studies by Mr. Kano support quantitatively these results. The change in skylight polariza-

tion is quite different when the concentration of particulate matter is located in the upper or in the lower atmosphere.

For example, BABINET neutral point is located in larger angular distance from the sun for high level concentration, closer to the sun for low level concentration. This abnormal position of BABINET point was found at UCLA in early fall 1962, gradually changing during the fall to the normal position, corresponding to low level concentration. The study of upper air trajectories is being conducted in order to correlate this shift with the possible occurrence of temporary atomic debris concentration above Los Angeles at this time.

In further studies it is intended to derive a relationship between particle concentration in the upper atmosphere and changes in skylight polarization, which can be used for indirect estimate of particle concentration from the skylight polarization measurements.

Wood, Rex C. AT(11-1)401  
E3A77 PARTICLE COLLECTION STUDY.  
General Mills, Inc., Aerospace Research Dept.,  
St. Paul, COO.

This program is aimed at achieving an improved understanding of the characteristics of stratospheric dust, together with the geophysical processes involved in fallout from the stratosphere.

Current work is emphasizing the extension of sampling capabilities to altitudes approaching 150,000 feet. One of the more important phases of this effort has involved the development of a high volume (1000 cfm) air ejector pump to replace the less-reliable motor blowers used operationally at altitudes below 100,000 feet. Because filter collectors do not readily yield particle size and morphology, the use of impactors as particle collectors is being studied in the laboratory. This work includes a basic study of impactor principles, the development of surfaces to minimize particle bounce-off, and collecting substrates that are compatible with electron microscope and radio-chemical analysis. Candidate particle collectors are tested in a high altitude chamber using sub-micron, monodisperse test aerosols of known size and density.

Supporting instrumentation, data recorders, altitude and volume flow sensors are being developed and improved as a necessary part of the continuing research balloon flight program.

Kuroda, P. K. AT(401)2529  
E3A103 RADIOACTIVE FALLOUT.

Arkansas. Univ., Fayetteville. OROO. April 1962-March 1963.

Artificially produced fission products, Sr<sup>90</sup>, Sr<sup>89</sup>, Ba<sup>140</sup>, Ce<sup>141</sup>, Ce<sup>144</sup> etc. in entire series of rainfalls at Fayetteville, Arkansas, are being measured. Attempts are being made to calculate the stratospheric and tropospheric residence times and stratospheric inventories of the fission products from the rain data. The isotope ratio data are being utilized to elucidate the general pattern of global movement of air masses, differences in the behavior of various isotopes in the atmosphere, as well as to evaluate the relative contributions from delayed and non-delayed fallout from the nuclear explosions.

Studies are being made on the mechanism which causes the spring peaks of Sr<sup>90</sup> fallout and also the relationships between the amount of rainfall and the fission product concentration in rain.

Analytical procedures for the determination of various fission products, as well as a number of naturally occurring radioactive nuclides are being investigated.

Korkisch, Johann AT(301)2623  
E3A133 ION EXCHANGE SEPARATION OF URANIUM AND THORIUM IN NON-AQUEOUS AND MIXED MEDIA.  
Vienna. Universitat. Analytisches Institut. NYOO.  
SP 5; MYr 3.

The main purpose and scope of the proposed research work is to investigate the ion exchange behavior of uranium and thorium in non-aqueous and mixed solvents. Through the determination of distribution coefficients, separation factors etc. on various ion exchangers from solutions of these actinide elements in organic solvents (e.g., alcohols, ketones, ethers etc.) novel techniques for the separation of uranium and thorium from each other as well as from other elements are to be developed. Furthermore studies as to the effect of solvent composition, acidity, the use of complexing agents (mineral or organic acids) etc. on the ion exchange and spectrophotometry of these elements will have to be carried out. During the first year of this project a series of suitable separation methods of uranium and thorium by means of anion exchange in alcohol media were developed together with spectrophotometric procedures for the assay of these elements in non-aqueous and mixed solvents. These methods will in the field of atomic energy help to solve some of the most pressing needs of reactor chemistry, as for instance the removal of fission products from reactor fuels and the separation of uranium from thorium in respect to the nuclear processes occurring in the breeder reactors.

Patterson, R. L., Jr. AT(49-7)13  
E3A207 80TH MERIDIAN AIR SAMPLING  
PROGRAM.

Naval Research Lab., Washington, D. C. WASH.

A program of sampling the ground level air for fission product radioactivity by the use of filters has been carried out since 1956 at a number of sites along the 80th Meridian (West) under the direction of the U. S. Naval Research Laboratory with the cooperation of interested agencies in this country and abroad.

The purpose of this network of stations is to provide a means of studying the effect of latitude on the distribution of fission products in the atmosphere, to obtain information on the mechanism and rate of mixing of fission debris in a north-south direction and particularly across the equator, and to serve as a reference line to which the various independent measurements of fission product concentrations can be related.

During 1962 gross  $\beta$  measurements were made weekly on samples from each of 14 sites; radiochemical analyses were performed bimonthly on the above samples for  $\text{Sr}^{89}$ ,  $\text{Sr}^{90}$  ( $\text{Y}^{90}$ ),  $\text{Y}^{91}$ ,  $\text{Cs}^{137}$ ,  $\text{Ce}^{141}$ ,  $\text{Ce}^{144}$  ( $\text{Pr}^{144}$ ),  $\text{Pm}^{147}$  and  $\text{Pb}^{210}$ . Effective 1 January 1963 operation of this network was turned over to HASL; analysis of 1962 samples and reporting of results will be completed by July 1, 1963.

Payne, Bryan R. AT(30-1)3162  
E3A408 THE MEASUREMENT OF HYDROGEN  
AND OXYGEN ISOTOPES IN NATURAL WATERS  
AND ITS APPLICATION TO METEOROLOGY AND  
HYDROLOGY.

International Atomic Energy Agency, Vienna.

The aims of the project are the development of methods for the routine enrichment of tritium in water at concentrations down to a few tritium units and improvement of existing methods for both scintillation and gas counting of tritium, suitable for the routine analysis of a large number of samples. Samples of precipitation collected from a world-wide network of stations will be analyzed for tritium, deuterium and O-18. The data on tritium obtained in this programme will be presented on maps showing the concentration and deposition of tritium. The results of this survey will be applied to the interpretation of possible transport mechanisms of water in nature due to the atmospheric and terrestrial environment and also to the solution of hydrological problems.

Friedlander, S. K. AT(30-1)-2165  
E3A410 FUNDAMENTAL INVESTIGATIONS OF

THE BEHAVIOR OF AEROSOLS.

Johns Hopkins Univ., Baltimore.

Experimental work on the measurement of the particle size distribution of the atmospheric aerosol will continue. The purpose of this work is to check the regularities which have been observed in other locations around the world and to provide new data for theoretical studies. A new sampling method for particles less than a few tenths of a micron in diameter is being developed. It is a diffusion method involving the use of a small wind tunnel carrying air in turbulent flow.

A report on the experimental and theoretical aspects of aerosol formation during the mixing of a hot vapor and cool air has been prepared and will soon be issued.

Pasternack, B. S. AT(30-1)3136  
E3A418 STATISTICAL ANALYSIS OF ENVIRONMENTAL  
GAMMA-RAY SCINTILLATION SPECTRA.  
New York Univ., New York. Medical Center.

Gamma-ray spectroscopy has become, during the past several years, a widely used technique for the assaying of a mixture of gamma-emitting radionuclides with minimum sample alteration. As a result, considerable savings in time and labor have been achieved due to the reduction of the number of samples requiring extensive radiochemical analysis. The specific research objectives of this project are:

1) Modification and improvement of the existing method of gamma-ray spectra analysis for a known mixture of radionuclides. Pasternack, Technometrics, 4: 565-571, 1962.

2) Subsequent development of an automated data handling and computational procedure.

3) Specification of lower limits of detection for the individual components of various combinations of radionuclides based upon the method of analysis ultimately developed.

4) Identification and quantification of radionuclides present in a mixture with unknown radioactive components. The types of environmental samples to be considered are (i) liquids, (ii) biological tissue, (iii) air sampling filters, and (iv) soil.

Richter, Harold G. AT-(40-1)-3070  
E3A424 DEVELOPMENT OF A TECHNIQUE FOR  
THE RAPID ANALYSIS OF FALLOUT ACTIVITIES  
IN NATURAL WATERS.

Research Triangle Inst., Durham, N. C. SP 2; MYr  
0.25.

A-I Research to be Performed by Contractor

The Contractor will conduct work on the development and investigation of new techniques for concentration and measurement of fallout radioisotopes present in natural waters, based on procedures involving (1) electrodeposition of trace ions onto a mercury surface, and (2) sequential amalgam exchange stripping of deposited metals. The perfection of the techniques involved would permit quantitative and rapid concentration of many radioactive ions in a single sample and ready separation for counting with speed and economy.

Hall, H. P. AT(49-7)-1773  
E3A528 ASH CAN OPERATIONS—GOODFELLOW  
AFB, TEXAS.  
Air Force, Washington, D. C.

AT(49-7)-1908  
E3A529 PROJECT HIBAL.  
Australia.

Di Giovanni, H. J. AT(30-1)-2363  
E3A530 RESEARCH AND DEVELOPMENT ON AN  
ELECTROSTATIC STRATOSPHERIC DUST SAMPLER.  
Del Electronics Corp., Mount Vernon, N. Y.

Edwards, R. R. AT(30-1)-3082  
E3A533 THE CHEMICAL AND PHYSICAL STATES  
OF FISSION-PRODUCTS IODINE IN FALLOUT.  
Nuclear Science and Engineering Corp., Pittsburgh.

### E3B Atmospheric Dynamics

Kruger, Paul AT(04-3)457  
E3B70 METEOROLOGICAL EVALUATION OF  
RADIOACTIVE FALLOUT.  
Hazleton-Nuclear Science Corp., Palo Alto, Calif.  
SAN. SP Approx. 4; MYr Approx. 4.

Meteorological and radiochemical analyses are combined to study  $\text{Sr}^{90}$  concentration in precipitation reaching the ground for several types of storms. These include (1) large-scale uplift, (2) convective showers, (3) Pacific coastal storms, and (4) orographic precipitation. Temporal and spacial distributions of  $\text{Sr}^{90}$  concentrations in the precipitation are determined from periodic collections at individual sites and simultaneous network collections over significant topographical areas. Preliminary results for the first two types of storms show significant effects on  $\text{Sr}^{90}$  concentration by ceiling heights of clouds during stratiform conditions; and by cloud top heights and their location with respect to regions

of high concentrations of  $\text{Sr}^{90}$ -bearing aerosols in the atmosphere for convective activity. Current efforts are continuing for these two storm types and initial collections are being made for the latter two types of storms.

MacCready, P. B., Jr. AT(04-3)458  
E3B83 TURBULENCE FORECASTING STUDY.  
Meteorology Research, Inc., Altadena, Calif. SAN.  
SP 2.

During the summer of 1961 special turbulence measurements were taken at the 1430-foot Dallas T. V. tower which supplemented the regular temperature and wind measurements. Starting with these measurements, the present research is being conducted to relate: (1) Turbulence spectra obtained on the Dallas tower at various heights to stability and wind speed factors. (2) Turbulence total intensity values for 5, 30, and 180 seconds sampling times to stability and wind speed factors for various temporal and height values. (3) Geostrophic wind (pressure field) and changes in geostrophic wind to observed temporal changes in turbulence characteristics for development of turbulence prediction techniques.

Turbulence factors are being studied in relationship to other meteorological variables measured on the Dallas tower; to the mesometeorological regimes in the vicinity of the tower, and to the over-all meteorological regime affecting the tower.

Other primary objectives of the project include the study of the turbulence measurements from the Dallas tower with respect to other related studies available from the literature, the study of total turbulent energy as related to other aspects of the energy spectra, and the making of estimates of the vertical turbulent energy budget as it is affected by other meteorological variables.

Badgley, F. I. AT(45-1)1545  
E3B100 WIND COMPONENT METER.  
Washington. Univ., Seattle. RLOO. June 1962-  
August 1963.

It is planned to improve a presently existing instrument for measuring three components of the natural wind near the earth's surface. The present instrument developed under J. Fuquay of the Atmospheric Physics group at Hanford uses hot wire sensors and a servo-mechanism to turn a wind vane so that it faces the horizontal wind. Other sensors then determine the speed and vertical component of the wind. Planned improvements should increase its sensitivity and reliability, speed up its time response, and adapt it to recording on magnetic tape. The basic change, a conversion to allow the heated sensor to

operate at a constant temperature irrespective of wind speed, has been accomplished.

Dingle, A. Nelson AT(11-1)739  
E3B157 RAIN SCAVENGING OF PARTICULATE  
MATTER FROM THE ATMOSPHERE.  
Michigan. Univ., Ann Arbor. COO. May 1962-  
April 1963. SP 5; MYr 2.

Rain samples will be collected by means of the aero-dynamic raindrop sorter reported upon previously. In particular a special effort will be made to sample the spring rains, when high radioactivity concentrations are anticipated, and to sample the specially heavy rains during summer and fall seasons, because of the problem of getting large enough samples in terms of radioactivity content. Coordinated special observations will be made using the photoelectric raindrop-size spectrometer, the APQ-40 radar and the MU-1 zenith-pointing radar in addition to standard and recording rain gages and to specialized wind instrumentation. Conventional weather observations will be procured from the nearby U. S. Weather Bureau Station at Willow Run Airport.

Additional rain samples, separate in time, will be collected by means of a pair of pans having a total surface area of 5.2 m<sup>2</sup>. The data will be analyzed and interpreted in terms of the behavior of storms in relation to the generation of precipitation and the collection and rainout of airborne particulates.

In addition, laboratory investigations of the washout process will be conducted with a view toward future field experiments to be done collaboratively with the Atmospheric Physics Group, Hanford Atomic Products Operation.

A continuing effort will be made to resolve the experimental findings with theoretical concepts.

Stout, Glenn E. AT(11-1)1199  
E3B158 STUDY OF RAIN-OUT OF RADIOACTIVITY IN ILLINOIS.  
Illinois. State Water Survey, Urbana. COO.

An investigation is being conducted in central Illinois to determine the relationships between radioactive rainout and various meteorological factors in intense, localized, convective storms and in large-scale, stratified, precipitation systems. Samples of rainwater are collected on three recording raingage networks of 10, 12, and 400 square miles in which the raingage sampling density is approximately one gage per square mile, one per two square miles, and one per eight square miles, respectively. Weather radar observations are made to determine the 3-dimensional characteristics of storms, and surface and upper air synoptic conditions within the storms are analyzed.

Studies are being made of the space and time variation of rainout on the concentrated raingage networks in various types of storms, and efforts are being directed toward establishment of relationships between radioactivity and rainfall, taking into account the effects of precipitation type, intensity, duration, and amount. Relationships between radar reflectivity, radar-indicated cloud heights and volume, and radioactive rainout are under investigation. Synoptic interpretations of the air mass characteristics, general history of storm systems, and tropopause characteristics are made in conjunction with the studies.

Saucier, Walter J. AT(40-1)3083  
E3B419 SEVERE CONVECTIVE STORMS AND THE STRATOSPHERIC SCAVENGING OF RADIOACTIVE PARTICLES.  
Oklahoma. Univ., Norman, Research Inst.

The major objective of this program is to investigate the relationship between convective storms that penetrate into the stratosphere and the fallout, or washout by precipitation, of the radioactive debris that has been injected into the stratosphere as a result of nuclear weapons tests. As a second objective, we may hope to add to our knowledge of the physics of cloud growth and precipitation of such storms by using radioisotopes as a tracer. Each of these objectives has been the subject of extensive research in the past by other techniques, and their importance cannot be overemphasized.

Walton, Alan AT(30-1)-2415  
E3B532 RESEARCH ON RADIOACTIVE FALLOUT DEPOSITION.  
Isotopes, Inc., Westwood, N. J.

Bolin, Bert AT(30-1)-2458  
E3B534 AN INVESTIGATION OF TRITIUM IN ATMOSPHERIC MOISTURE, RAINWATER, RIVERS, AND THE SEA IN THE EUROPEAN AREA.  
Stockholm. Univ.

Starr, V. P. AT(30-1)2241  
E3B560 PLANETARY TRANSPORT PROCESSES IN THE STRATOSPHERE.  
Massachusetts Inst. of Tech., Cambridge. Dept. of Meteorology.

The A.E.C. participates jointly with the U. S. Air Force in supporting this program of study of the transport processes and related phenomena in the stratosphere over the Northern Hemisphere. The subject involves the mechanisms of the entire general

circulation and is an underlying study for the whole of meteorology.

Specific investigations include: (a) horizontal exchange processes and the distribution of total ozone for the IGY period; (b) momentum balance of the stratosphere using IGY period data; (c) energy balance of the stratosphere, which includes input of the momentum-balance results; (d) vertical exchange processes across the stratosphere and troposphere, as well as across other levels, employing vertical velocity components of the air motions for IGY and current measurements; (e) diurnal variation of stratospheric winds using a statistical treatment of a considerable number of observations for a complete year; (f) theoretical studies toward formulation of a multi-layer numerical model of the atmosphere; (g) solar weather studies from IGY data; and (h) horizontal transport of fallout products in the troposphere is receiving extensive computational treatment related to low-level tropospheric wind effects.

### E3C Fallout Formation and Source Effects

Gleit, Chester E. AT(04-3)453  
E3C38 PHYSICAL, CHEMICAL AND RADIO-CHEMICAL ANALYSIS OF FILTER DEBRIS, Tracerlab, Inc., Richmond, Calif. SAN. SP 5; MYr 1.2.

The particulate debris formed in air bursts of nuclear tests, consists of an oxidized matrix of ballistic and case materials in which is incorporated low concentrations of fissile and fusile materials, fission products and induced radioactivities. These particles may differ in chemical composition, physical characteristics and nuclear properties due to processes which occur at the time of condensation. Although ground bursts have been extensively investigated little work has been published on particles from air bursts. It is of special interest in predicting fallout patterns to understand the distribution of the radioactive materials and how it is related to altitude and particle size.

Specimens of freshly formed nuclear weapon debris have been collected by airborne direct-flow filters from Dominic tests. These filters are surveyed for activity and autoradiographed. The number of particles of different sizes and colors and gross activity are noted and compared with flight path and weapon characteristics. Individual particles are isolated and the size, color, shape, specific activity and apparent beta and gamma-decay half-periods measured. Radiochemical analysis of se-

lected filter sections, aggregate of particles and individual particles have been performed. Gamma spectra of >600 individual particles have been measured at predetermined intervals. Data are reduced by computer techniques to determine significant correlations. The goal of this program is to elucidate the mechanisms and extent of fractionation and to provide the technical foundation for an improved method of predicting fallout.

Schwob, C. R. AT(49-7)2236  
E3C216 ANALYSIS AND EVALUATION OF THE BIOLOGICAL AND ENVIRONMENTAL CONSEQUENCES OF NUCLEAR WAR. Naval Radiological Defense Lab., San Francisco. WASH. SP 11; MYr 2<sup>3</sup>/<sub>4</sub>.

This project is for the purpose of assisting the TAB in meeting its overall objectives and providing technical input data in NRDL's peculiar areas of competence (biological effects, fission products and induced activities, partition, fractionation, fallout models, computing techniques). Assistance to the TAB comprises, firstly, the acquisition of a computational model for assessing the biological and ecological consequences of nuclear warfare. Secondly, we will be concerned with (1) acquiring and developing input data for the model, including operational and technical assumptions; (2) specifying the kinds of output data needed for evaluating the biological, ecological and sociological consequences; and (3) the feedback in sensitivity between input and output.

During FY 1963, detailed consideration will be given, regardless of model type, to what is really needed in terms of input assumptions and output at the Emergency Phase stage (consequences within a few weeks after attack). The Operational Recovery phase will be next studied in the light of OCD assumptions. Some operational and technical input assumptions will be collected.

Volchok, H. L. AT(30-1)-3055  
E3C531 SAMPLING AND ANALYSIS OF FRESH NUCLEAR DEBRIS. Isotopes, Inc., Westwood, N. J.

### E3D Radioactivity in Soil, Food and Man

*See also A2B429.*

Eisenbud, Merril AT(301)2577  
E3D99 A STUDY OF ARTIFICIAL AND NATURAL CONTAMINATION IN BRAZIL.



Pontifícia Universidade Católica, Rio de Janeiro.  
Instituto de Física. NYOO.

Objectives: (1) to continue the survey on fallout in Brazil (equator to 30°S), (2) to continue the study of high background areas.

In view of the fact that an extensive and intensive survey on external radiation levels in high background areas has been carried out under the terms of the first contract, the question of internal contamination and of irradiation doses resulting therefrom should be considered next. The following line of investigation is proposed:

1. Field survey of high background areas (both farm and pasture land) as sources of agricultural produce for consumption (by humans and animals).
2. Properties of soils (geology, composition, particle size, U, Th, and decay products, total and partial percentages, exchangeable amounts, etc.).
3. Water contamination (radiochemical and alpha spectrometric analysis of Ra<sup>228</sup>, Ra<sup>226</sup>, Th<sup>232</sup>, Po<sup>210</sup>, Pb).
4. Systematic collection of samples (plants, tissue, bones, teeth, milk, droppings etc.).
5. Laboratory examination, spectroscopic and radiochemical analysis of agricultural produce (Ra, Th, Po, Pb), discrimination factors.
6. Micro-ecological studies (uptake, distribution and storage of radioisotopes) on plants grown in the laboratory under controlled circumstances.
7. Analysis of human teeth of known origin and history as a possible substitute for human bone studies.
8. Breath analysis under conditions of chronic (high background areas), and of one time assimilation (thorotrast) as a preliminary substitute for whole body counters and a means of a rapid human population survey.
9. Internal irradiation dose estimates in all cases above.
10. Natural contamination of the atmosphere (gaseous and solid decay products, deposition rate), systematic Rn/Th ratio determination and study of its dependence on season, and on meteorological conditions.

The program outlined needs to be supplemented by other research groups in the line of:

1. Field studies of Flora and Fauna (species, morphological and biological changes etc.).
2. Laboratory experiments with animals fed with produce of contam. areas (uptake, storage, residence time, overall ratio etc.).
3. Human population studies.

Ward, Gerald M. AT(11-1)1171  
E3D159 A STUDY OF CESIUM-137 PASSAGE  
FROM PRECIPITATION TO MILK.  
Colorado State Univ., Fort Collins. COO. SP 5;  
MYR 1 $\frac{1}{3}$ .

The project was initiated on April 15, 1962 to study the relationship of Cesium-137 from fallout as found in air, and precipitation to the levels in soil, cattle feeds, meat and milk. These products were sampled throughout the summer with particular attention to the difference between cows on pasture and those fed in the dry lot. To date all milk, meat and precipitation samples have been completed and feed samples are nearly completed. Very few analyses of air and soil samples have been finished.

The Cs-137 content of the milk from cows on pasture increased at the end of May from levels of 20 to 30 to levels of 50 to 200 picocuries per liter. Levels of 50-90 picocuries per liter were maintained throughout the summer with only apparently random variations except for sharp rise between July 19th and 25th. At the same time the level of I<sup>131</sup> reached a peak value of 4500 picocuries per liter. One month after the termination of pasture the level of Cs-137 in milk had dropped to levels about equal to those found in the previous spring.

To date, there has not been time to relate milk levels to the levels found in other samples.

Alexander, L. T. AT(49-7)2  
E3D208 COLLECTION AND PREPARATION OF  
SAMPLES OF SOILS, PLANTS AND ANIMALS FOR  
CALCIUM AND STRONTIUM ANALYSES.  
Department of Agriculture. Soil Survey Labs., Beltsville, Md. WASH. SP 2; MYR  $\frac{1}{2}$ .

This project is in cooperation with the Health and Safety Laboratory of the AEC and the U. S. Weather Bureau. It provides a world-wide soil sampling network to estimate total strontium-90 deposition. Sampling is made to sufficient depths to obtain the strontium-90 present in the sample area. Sites are selected that represent the accumulation of fallout deposited (minimizing run-off, etc.). Special soil studies are made as necessary for increasing our knowledge of fallout distribution. These have included detailed studies of variability with environmental, meteorological, geographical and geomorphological factors, as well as sampling methods and improvement of analytical procedures.

Beninson, D. AT(30-1) 2753  
E3D595 "STRONTIUM-90 LEVELS IN THE DIETS  
AND BONES OF CHILDREN."

Argentina. Comisión Nacional de Energía Atómica, Buenos Aires. June 1962–May 1963.

It is planned to obtain data on  $\text{Sr}^{90}$  in children's bones and in the "integrated" diet of the child up to his death. For this purpose analysis will be carried out on items of children's food and the data will be used together with information on past diet of the child.

Bones will be sampled from federal pediatric hospitals, in many cases from children who have spent most of their lives under medical control and for which good diet information is available.

## F RADIOLOGICAL AND HEALTH PHYSICS, AND INSTRUMENTATION

### F1 RADIOLOGICAL AND HEALTH PHYSICS

#### F1A Radiological Physics

Laughlin, J. S. AT(301)1451  
F1A2 THE DIRECT MEASUREMENT OF LOCAL ABSORBED DOSE PRODUCED BY RADIATION BEAMS IN TISSUE MATERIALS.  
Sloan-Kettering Institute for Cancer Research, New York. Nov. 1, 1962–Oct. 31, 1963.

The local absorbed dose calorimeter will be used in conjunction with the Fricke ferrous sulphate dosimeter system to extend the calibration of this dosimeter system further with high energy electrons up to 35 Mev. The calorimeter will also be used to determine absorbed dose and calibrate the Fricke dosimeter for low energy x-rays below 250 kv. A portable field calorimeter is near completion and will be put into use for comparisons with other laboratories. The absorbed dose calorimeter will also be used to calibrate other radiation detection devices including solid state detectors.

Boring, John W., Sr. AT(40-1)2911  
F1A8 "THE TOTAL IONIZATION PRODUCED BY HEAVY, LOW ENERGY IONS IN GASES."  
Virginia. Univ., Charlottesville. Research Labs. for Engineering Sciences. OROO.  
SP 2; MYr  $1\frac{1}{4}$ .

The total ionization produced in gases when atomic ions of mass 1–40 amu are stopped in the gas is to be measured in the energy range 5–200 kev.

The results of these measurements will then be of value in determining the relative importance of the various physical processes that occur when these ions interact with the atoms of the stopping gas. The following gases are scheduled for investigation: nitrogen, carbon dioxide, ethylene, and hydrogen.

The results of these measurements are expressed in terms of W (average energy expended by the incident particle in producing an ion pair). For a given gas W is to be determined as a function of the energy and type of incident ion. The observed fact that for a number of gases W is essentially independent of energy and type of particle for protons and alpha particles with energies above 0.5 Mev is not expected to be true for heavy ions with energies less than 200 kev. It is in this low energy region that the velocity of the incident ion becomes comparable to that of the orbital electrons of the gas atoms and it is expected that charge exchange and elastic collisions will become important processes in the stopping of the incident ion.

Loevinger, Robert AT(04-3)326-04  
F1A69 ENERGY DISSIPATION BY BETA-PARTICLE SOURCES.  
Stanford Univ., Calif. Biophysics Lab. SAN. SP 4; MYr 2.

The radiobiological effect of radioisotopes distributed in tissues is under most circumstances due to the energy deposited by the emitted beta particle, though under some circumstances might be due to transmutation or recoil. Existing information on absorbed energy distribution from beta-particle sources in tissue is incomplete in a number of respects, particularly at very low energies. Ionization measurements will be made using thin plane sources of beta particles and an extrapolation chamber. These results will be combined with the theoretical results of Spencer and others to attempt a unified formulation of dose-distribution information for beta-particle sources in biological materials. Special experimental techniques are necessary at low energies. In particular, tritium will be used in a gaseous form to try to obtain direct information on the elementary point-source dose distribution.

A precision extrapolation chamber has been built, with the special feature of interchangeable collecting electrodes, so that measurements can be made as a function of atomic number of the absorbing material, and with any desired collecting area. This chamber allows the easy use of air gaps as small as 0.05 millimeters, and has a background current of about

$2 \times 10^{-16}$  amperes, with fluctuations of the same magnitude.

A study has been completed of recombination loss in air ionization chambers. It has been found that this phenomenon is more complex in several respects than is indicated by current theories. In particular, for plane parallel air gaps less than one millimeter, there is appreciable loss by recombination at the electrodes.

Shamos, Morris H. AT(30-1)-1704  
F1A486 THE STUDY OF ENVIRONMENTAL RADIATION.  
New York Univ., New York.

Environmental radiation studies are being conducted by the Cosmic Ray Laboratory at the Washington Square Center of New York University, under Atomic Energy Commission Contract AT(30-1)-1704.

The 73.6 liter freon-filled plexiglas ionization chamber has been used to continually monitor background radiation. Temperature regulation as well as data programming and print-out have been added. A marked diurnal variation has been observed as well as a seasonal variation. Mean weekly dose rates are tabulated, with maximum and minimum values, and daily averages are tabulated in an attempt at correlation with precipitation. This is the same chamber used earlier to measure the absolute cosmic ray ionization at sea level with high precision. Additional measurements are planned at sea to establish the origin of the diurnal variations.

An ultra thin wall ionization chamber with a wall thickness of  $1.77 \text{ mg/cm}^2$  and volume of 38 liters has been used for background measurements on a pier located on the New York waterfront. A filter study made with this chamber revealed a very soft ionizing radiation having an ionization density about 5% of the total background ionization intensity. Calculations indicate that if radon and its decay products are present to an activity of about  $10^{-13}$  curies/liter, this soft component is satisfactorily accounted for.

Work has proceeded on distinguishing the low energy photonic and electronic background components. A dual phosphor system (phoswitch) was constructed in this connection. This technique has been extended by the construction of a thin-walled proportional counter-scintillation detector assembly, with the proportional counter above the phosphor acting as an electron detector and discriminator against photons. The latter arrangement is presently being used to study the electronic component of the environmental radiation.

A stainless steel differential parallel plate ion chamber has been constructed for use in an experiment which will study columnar recombination in

non Electronegative gases. This experiment has as its motivation further understanding of those columnar ionization processes which play an integral role in the success of our technique of discriminating against wall alpha contamination in the 38 and 73.6 liter ion chambers mentioned above.

Rossi, Harald H. AT(30-1)2740-P-1  
F1A591 ABSORBED DOSE NEAR AN INTERFACE OF TWO DIFFERENT MATERIALS.  
Columbia Univ., New York. Coll. of Physicians and Surgeons. April 1962-March 1963.

The variation of the dose from x-irradiation with distance from the interface of two dissimilar materials is of importance in several biological problems. The effect of the close proximity of a higher atomic number material to a soft tissue structure has been demonstrated biologically but to date the increase in dose due to this material has only been calculated. A method has been developed to determine experimentally the variation in dose with distance from the interface. The data obtained remain to be reduced and information is required to accomplish this reduction. This information includes the values of W for the various gas mixtures employed in the dose experiment.

Rossi, Harald H. AT(30-1)2740,P-3  
F1A593 CAVITY IONIZATION AND THE BRAGG-GRAY PRINCIPLE.  
Columbia Univ., New York. Coll. of Physicians and Surgeons.

Recent theoretical treatments indicate that the ionization density in small air cavities in high atomic number materials may increase markedly as cavity size is reduced. The experimental evidence is somewhat contradictory and in general has been obtained in cavities sufficiently large as to alter the electron flux in the solid. It is planned to use a copper extrapolation chamber irradiated with Cesium-137 gamma rays to investigate the ionization density in very small cavities in an attempt to check the validity of the new theories.

Rossi, Harald H. AT(30-1)2740,P-4  
F1A594 DEVELOPMENT OF SPHERICAL COUNTERS FOR THE MEASUREMENT OF LOCAL ENERGY DENSITY IN IRRADIATED TISSUES.  
Columbia Univ., New York. Coll. of Physicians and Surgeons.

Development of methods for the determination of variations in local energy density that exists in irradiated tissues on a microscopic scale. Detailed investigations of these variations are to be performed with respect to three parameters: the distribution of absorbed dose in LET, the distribution of absorbed

dose in terms of the normalized energy deposited by individual charged particles, and the distribution of local energy densities produced by given absorbed doses. Studies are to be performed for fast neutrons and for gamma radiation. Initial work will be concerned with studies of such in-homogeneities over distances ranging downward to 3,000 angstroms. A new type detector will be developed which may extend the range down to 100 angstroms. Tests are also to be performed on the applicability of this method to radiation protection surveys around high energy radiation sources (100 Mev and higher).

## F1B Health Physics

See also F1A486.

## F2 RADIATION INSTRUMENTS

### F2A Materials

Cameron, John R. AT(11-1)1105  
F2A146 INVESTIGATIONS OF THERMOLUMINESCENT RADIATION DOSIMETRY.

Wisconsin, Univ., Madison. COO. SP 5; MYr 3.

It is planned to continue the investigations of the various mechanisms involved in the phenomenon of thermoluminescence especially as it relates to radiation dosimetry. The emphasis will be on the physical and chemical effects in thermoluminescence rather than applications of the dosimeter to particular problems in medicine or health physics. In particular we plan to study 1) the filling of metastable electron traps by ionizing radiation of various types, energies, and amounts; 2) the induction of new unfilled electron traps by radiation and other means; 3) the energies involved in emptying these various traps by thermal or other excitation; 4) the spectra of the emitted light during de-excitation; 5) the crystal structure by means of x-ray diffraction before and after exposure to large amounts of radiation; 6) the neutron response of  $\text{Li}^7\text{F}$  and  $\text{Li}^6\text{F}$ ; 7) the various other phenomena other than ionizing radiation that are capable of inducing stored thermoluminescence; 8) crystals other than  $\text{LiF}$  to aid in studying the various mechanisms.

Shonka, Francis R. AT(11-1)323  
F2A147 SPECIAL PROBLEMS IN NUCLEAR INSTRUMENTATION AND MEASUREMENT OF W IN GASES.

Saint Procopius Coll., Lisle, Ill. Physical Sciences Lab. COO. SP 10; MYr 7.

The work on conducting plastics which simulate muscle, bone, air, and other materials of interest for all types of radiations including neutrons, is being continued. A facility had been set up to produce these materials in moderate quantities. These materials in the form of molding granules, solid stock and molded parts are supplied to other research laboratories.

Techniques and instruments applicable to dosimetry are being developed. These include work in plastic optics and quartz fibers. A new type of electrometer has been developed. It consists of a vibrating fiber which is observed optically. Its charge sensitivity is greater than any other type of electrometer. It is extremely rugged, portable, and its most desirable feature is that drifts of any type do not affect the accuracy of a measurement. Eighteen of these electrometers have been built and most of these are being used at other laboratories. This experience has proven the worth of the instrument and it will be produced commercially and made available during the 1963 calendar year.

A continuation is planned of the general program of the study of  $W$ , the average energy to produce an ion pair in an ionized gas. This includes the mode of variation of  $W$  as a function of the kind of ionizing particle, the energy of the particle, and the nature of the gas ionized.

Daub, Guido H. AT(29-2)915  
F2A169 THE SYNTHESIS AND PROPERTIES OF COMPOUNDS WHICH MAY BE USED AS SCINTILLATORS.  
University of New Mexico, Albuquerque, N. M. ALOO.

An investigation of the steric inhibition of resonance on the effectiveness of liquid scintillation solutes is one of the subjects under investigation. *p*-Terphenyl and *p*-quaterphenyl derivatives are being synthesized in which a bridge across two adjacent rings interferes with coplanarity. Bridges of one to six atoms in size are under investigation with some of the bridge atoms being hetero-atoms rather than carbon. The hetero-atoms used in this study include nitrogen, oxygen, sulfur, selenium. In addition, di- and tetramethylated *p*-terphenyls and *p*-quaterphenyls having the methyl groups in positions causing them to interfere with coplanarity are being studied.

An investigation of 1,2-diarylethylenes as potential liquid scintillation solutes is being conducted. Structural types related to trans-1,2-diarylethylenes

which cannot revert to the cis- structures are being synthesized and studied. Specifically 2-arylindenes (and benzo-derivatives), 2-aryl-3,4-dihydronaphthalenes (and benzo-derivatives), and 8-aryl-6,7-dihydro-5H-benzocycloheptenes (and benzo-derivatives) are being studied. The aryl substituents being used are phenyl, 1-naphthyl, 2-naphthyl, and 4-biphenyl. It is expected that this study may lead to an explanation of the poor behavior of trans-stilbene as a liquid scintillation solute.

Schulman, James H. AT(49-7)1864  
F2A223 RADIATION EFFECTS IN DIELECTRIC SOLIDS.

Naval Research Lab., Washington, D. C. WASH.

Radiation Characteristics of Solid State Dosimetry Systems.

The purposes of this program are (a) to study the performance characteristics of existing solid state dosimetry systems, (b) to improve these systems where possible, (c) to devise new and useful solid state dosimeters, and (d) to investigate the basic phenomena underlying dosimeter operation.

The major effort is in the following areas:

(1) Improvements in thermoluminescent (TL) dosimeter and reader design. Both  $\text{CaF}_2:\text{Mn}$  and LiF are under investigation. Miniature glass-enclosed dosimeters have been designed, constructed and applied in various measurements. Special methods have been devised for permitting repetitive readings of TL dosimeters. The effect of the heating program on the glow curve shape is being studied; elimination of the apparent fading of the stored signal in  $\text{CaF}_2:\text{Mn}$  may thereby be made possible.

(2) The response/rad of  $\text{CaF}_2:\text{Mn}$  and LiF TL dosimeters and of three types of Ag-activated phosphate glass dosimeters is being studied as a function of LET and of types of radiation. Experiments with  $\alpha$ -particles up to 900 Mev have been carried out, and corresponding proton runs are planned. Response to neutrons will also be investigated.

(3) The chemical constitution and preparation conditions which control the sensitivity of TL LiF are being investigated. LiF is being prepared in controlled purity, additions of doping agents are being made, and it is being melted under controlled conditions. The effect of doping and of melting procedure upon both the sensitivity and the glow spectrum produced is being studied.

Halpern, B. D. AT(30-1)-1931  
F2A535 PROPOSAL FOR PLASTIC SCINTILLATORS.

Borden Chemical Co. Central Research Lab., Philadelphia.

Oster, Gerald AT(30-1) 2206  
F2A559 COLOR-FORMING DOSIMETERS FOR IONIZING RADIATION.

Brooklyn. Polytechnic Inst. NYOO. November 1961-October 1962.

The purpose of this research is to devise chemical systems which become colored on exposure to dosages of ionizing radiation below about 1000 roentgens.

A number of systems suggest themselves but the most fruitful results in our laboratory have been with three unrelated high polymer systems.

Leuco methylene blue dissolved in a film of polyvinylalcohol is highly sensitive to X-rays. As little as one roentgen will produce a distinct coloration. The leuco dye is produced photochemically by means of red light.

The second system of interest involves the pre-illumination of a film of polyvinylidene chloride with far ultraviolet light. The film is thereby rendered more sensitive to ionizing radiation than if it had not been previously illuminated.

The third system involves the cleavage of cross-links in a film of gelation which had been thiolated and then oxidized. The decrosslinked gel releases pigment which was entrapped in its interstices.

All three systems are of interest from a basic point of view since they illustrate three diverse effects of ionizing radiation on organic high polymers.

Cowan, Clyde L. AT(30-1) 2419  
F2A564 CONSTRUCTION OF A LARGE HIGH-SENSITIVITY LIQUID SCINTILLATION SYSTEM.  
Catholic Univ. of America, Washington, D. C. June 1962-May 1963.

During the past year, several new techniques applicable to construction of large liquid scintillation detectors have been developed. These include the development of an inexpensive, safe, and efficient scintillator solvent, decalin, which is prepared by removal of impurities on an  $\text{Al}_2\text{O}_3$  column, saturation with argon, and activation with terphenyl and alpha-naphthylphenyloxazole. This solvent does not attack acrylic polymers, and so has provided great freedom of design and simplicity of assembly of large liquid systems.

Accordingly, the former design of our system which employed less ideal geometry, light transmission, and flexibility has been changed to take advantage of this capability. A rather radical departure from former designs will employ some 52 cylindrical modules, each independently filled and sealed and carrying its own

set of photomultiplier tubes. These modules have been tested individually.

It is the purpose of the present work to investigate its sensitivity, resolution power for gamma ray energy, and sources of background. These data will then be employed in efforts to further improve each of them, and the detector will be employed to measure very low specific activities in various materials as these come into range of its capabilities.

Rossi, Harald H. AT(30-1)2740,P-2  
F2A592 DEVELOPMENT OF TISSUE EQUIVALENT  
IONIZATION CHAMBERS FOR PURPOSES OF RADIO-  
BIOLOGY AND RADIATION PROTECTION.  
Columbia Univ., New York. Coll. of Physicians and  
Surgeons.

Continued development of tissue equivalent ionization chambers for the measurement of all ionizing radiations with particular emphasis on neutrons, separate chamber designs for the measurement of first collision dose and for the measurement of absorbed dose, the latter type including construction of appropriate tissue equivalent phantoms. Development of a device for the determination of total RBE dose in mixed radiation fields employing tissue equivalent chambers and CO<sub>2</sub> filled conducting teflon chambers with the varying neutron response of the latter utilized to compensate for changes of RBE with neutron energy.

## F2B Systems and Special Components

Juenker, D. W. AT(11-1)274  
F2B148 FUNDAMENTAL RESEARCH IN PHOTO-  
EMISSION.  
University of Notre Dame, Notre Dame, Ind. COO.  
September 1962–August 1963.

This research is basic to photoelectric devices such as multiplier tubes. Its aim is to make a thorough experimental and theoretical study of the fundamental influences on the outer photoelectric effect for metals and semiconductors. Among these are the optical behavior of the emitter, the mechanism and locality of the electron–radiation energy transfer, the disposition of the electrons before and after excitation, and the process of escape. Either separately or in combination, these facets of the problem are being investigated by a variety of methods, including studies of the dependence of photoelectric yield and optical reflectivity on the angle of incidence and state of polarization of the illumination, the effect of purposely distorting the

field at the emitter surface, the effect of thickness on thin-film emitters, the energy distribution of the emitted electrons, and the extension of the spectral range of excitation into the vacuum ultraviolet. Since photoemissive characteristics can be assumed to be sensitive to surface conditions, present emphasis is on the study of clean metals in ultra-high vacuum.

Thurston, M. O. AT(11-1)1226  
F2B435 HIGH SENSITIVITY FAST NEUTRON  
DOSIMETER.  
Continental Electronics Corp., Columbus, Ohio.

A semiconductor diode of the p–i–n type has a forward voltage drop when conductivity modulated that depends upon the excess carrier lifetime and the thickness of the high resistivity region. When such a diode is irradiated with fast neutrons the carrier lifetime is decreased and the forward voltage drop is increased. Diodes of this type have been found useful as fast neutron dosimeters in the range from about ten rads to several thousand rads.

It is the purpose of this study to evaluate the feasibility of developing a high sensitivity semiconductor fast neutron dosimeter for monitoring personnel exposure. A theoretical study will be made of the influence of diode geometry, materials and processing on sensitivity to fast neutrons. The main emphasis will be on silicon diodes although other structures and materials may be considered. Test diodes embodying changes suggested by the theoretical analysis will be fabricated as needed and will be irradiated with fast neutrons to determine their sensitivity and performance characteristics.

Since the sensitivity of the dosimetry system is also dependent on the characteristics of the readout circuitry, an analysis will be made of readout design limitations.

Linden, B. R. AT(30-1)-3047  
F2B536 PROPOSAL FOR THE DEVELOPMENT  
OF A LARGE AREA PHOTOMULTIPLIER FOR  
WHOLE BODY COUNTING.  
CBS Labs. Div. of Columbia Broadcasting System,  
Inc., Stamford, Conn.

Engstrom, R. W. AT(30-1)-3032  
F2B537 DEVELOPMENT OF A PHOTOMULTI-  
PLIER HAVING A PULSE RISE TIME LESS THAN  
 $0.5 \times 10^{-9}$  SECOND.  
Radio Corp. of America. Electron Tube Div., Lan-  
caster, Penn.

Mansfield, W. O. AT(30-1)-2825  
F2B538 DEVELOPMENT OF A TRANSMISSION  
SECONDARY EMISSION TYPE PHOTOMULTIPLIER.  
Westinghouse Electric Corp., Pittsburgh.

Robinson, Charles V. AT(30-1)1726  
F2B553 DEVELOPMENT OF SMALL IN VIVO  
DETECTORS.  
New England Center Hospital, Boston.

Projects underway or completed include:

1. Placement of ten brain tumor localization units for use at operation with P<sup>32</sup>. Each unit consists of a pair of detectors, an electronic unit, and accessories. They have been placed as a part of a program of evaluation of the method. Additional units are presently under construction in order to permit expansion of the evaluation program.

2. Development of a 2 mm diameter proportional counter for  $\beta$ -detection on the end of a cardiac catheter. Two such detectors have been tested in the laboratory.

3. Posterior eye counter. A second posterior eye counter for diagnosis of lesions with P<sup>32</sup> on the posterior half of the eye is now in use.

## F2C Special Techniques

See also A2A452.

Ely, Ralph L., Jr. AT(40-1)2513  
F2C7 DEVELOPMENT OF A SENSITIVE TRITIUM MONITOR.  
Research Triangle Inst., Durham, N. C. OROO.  
SP 3; MYr 1.

Commercial air monitors have a sensitivity quite adequate for measuring the H<sub>2</sub><sup>3</sup> content of air but their detection sensitivity for airborne HTO is about 50% of the occupational maximum permissible concentration. Thus, there is a need for a more sensitive tritium monitor.

The present program is to investigate the feasibility of concentrating the tritiated water vapor in the air by condensation and measuring the tritium content of the water using a water-vapor Geiger counter previously developed here (see ORO-484). Calculations indicate that a sensitivity of 0.01 MPC should be readily achieved. The ultimate sensitivity of this technique appears to be about 10<sup>-8</sup>  $\mu$ C/cc or about 0.0005 MPC.

An instrument has been constructed using a room dehumidifier to condense the water. The initial tests indicate that the design goal of 0.01 MPC appears to have been achieved. However, the response time of 8-10 minutes to a step change in tritium content is

too long and redesign work is under way to minimize this.

The ultimate aim is to develop a prototype tritium-in-air monitor which includes sampling apparatus, counter, high voltage supply, ratemeter for manual and automatic indication, and appropriate warning sounds for preset levels of activity.

Ney, Wilbert R. AT(49-2)1165  
F2C209 ASSISTANCE TO THE NATIONAL COMMITTEE ON RADIATION PROTECTION AND MEASUREMENTS.

National Bureau of Standards, Washington, D. C. WASH.

Assist the National Committee on Radiation Protection and Measurements by providing funds for travel, meeting expenses, secretarial expenses and other miscellaneous expenses connected with the operation of the Committee. The Committee provides basic recommendations for radiation protection and measurement. The Committee is actively continuing its program of revising recommendations previously issued and preparing new recommendations. During the last year, two reports have been essentially completed and will be published in the near future—"Safe Handling of Radioactive Materials," and "Protection Against High Energy Electron Beams." During the next year, efforts will be made to complete reports on:

1. Monitoring Methods and Instruments
2. Radiation Protection in Teaching Institutions
3. Incineration of Radioactive Wastes
4. Measurement of Ionizing Radiation in the Presence of a High Radio Frequency Field

Work will continue on development of recommendations on RBE, on internal emitters and on basic aspects of radiation protection. New programs are planned on exposure from patients released from hospitals with radioactive material in their bodies and on dental x-ray protection.

Petree, B. AT(49-2)1165  
F2C210 ENERGY AND ABSORBED DOSE MEASUREMENTS.  
National Bureau of Standards, Washington, D. C. WASH. MYr 1.

A. Modern techniques of adiabatic calorimetry now permit the measurement of heating rates with an accuracy exceeding one part in a thousand. That degree of accuracy can be realized in suitable instruments at rates at least as small as ten milliwatts. We estimate that by calorimetry the power output of samples of certain radioisotopes could be determined with an accuracy approaching or exceeding that pos-

sible by counting or ionization chamber techniques. Thus, if the gamma ray power,  $P$ , of a source, determined by a calorimeter, were known, then the relation,  $\mu P = W\dot{J}$  could be used to verify the accuracy of the ionization measurement  $\dot{J}$  of the same source, and possibly to furnish improved values for  $\mu/W$  (the quotient of energy absorption coefficient in air to the average energy required to produce an ion pair).

A total absorption calorimeter designed for measuring the power output of cobalt-60 sources of about 1 curie will be constructed. The accuracy and sensitivity of the instrument will be studied. A measurement will be made of the power output of a source of high specific activity. This power will be related to the ionization produced by the source in a free-air chamber.

B. An absorbed dose calorimeter of small dimensions will be constructed to measure the energy deposited in carbon by the water-shielded cobalt-60 sources at NBS. This energy will be related to cavity ionization measurements of the sources to provide a check on the constants in the relation,  $E_M = WS_M J$ .

C. Measurements and calculations to determine the spectral distribution for a cobalt-60 source in water will be completed.

Mann, W. B. AT(49-2)1165  
F2C211 MEASUREMENTS OF LOW-LEVEL  
RADIOACTIVITY.

National Bureau of Standards, Washington, D. C.  
WASH. SP 5.

This project is solely to support, by providing additional equipment, a National Bureau of Standards project for the Evaluation and Development of Analytical Procedures and Radioactivity Standards for Low Levels of Radionuclides (NBS Project No. 04191) which was undertaken chiefly to provide information and data to the Atomic Energy Commission. Equipment has been, and is being, installed for the assay of low-level radioactive samples and has already been used in a number of international comparisons of such low-level samples and for the testing of analytical procedures for the determination of micro-gram quantities of radionuclides such as strontium-90 in water and uranium in water and urine. Work is progressing on the testing of such analytical procedures for the assay of thorium in water and urine and will be extended to cesium, iodine, plutonium and other radionuclides of interest in such environmental media as water, urine, milk, bone and soil. Counting methods are supplemented by the methods of spectrophotometry, flame photometry, gas and paper chromatography. In order to

obtain reasonable precision in the counting of a large number of radioactive samples at low-level it is necessary to invest quite heavily in suitable counting equipment.

Ehrlich, M. AT(49-2)1165  
F2C212 (F2) EVALUATION AND TESTING OF  
RADIATION INSTRUMENTS.

National Bureau of Standards, Washington, D. C.  
WASH. SP 6; MYR 2.7.

Through the use of the Bureau's competence and facilities in the field of radiation standards, practical systems of measurement of ionizing radiations are investigated and extended. These include:

A. Tests and evaluation studies of radiological instruments, such as survey meters and dosimeters, for calibration, stability of response and radiation sensitivity to photon energy, orientation and dose rate for x rays and gamma rays; environmental influences, such as temperature, humidity atmospheric pressure, etc.; and such other special studies in this general field as may be agreed upon.

B. Studies in photographic dosimetry, such as investigation of the mechanism of latent-image intensification by means of infrared exposures following the exposure to x or gamma radiation; the luminescence of film during exposure to high-energy heavy particles and electrons; and feasibility of the use of a combined developing-fixing bath for personnel dosimetry.

C. Studies in solid state dosimetry, such as: investigation and comparison of the sensitivity and energy dependence of the response of silicon cells of different type and structure to x rays; and the dependence of radiation damage produced by x and gamma rays in silicon cells on exposure, exposure rate, and photon energy.

D. Studies in chemical dosimetry such as: investigation of different analytical read-out methods for chemical dosimeters, and of ferrous sulfate systems.

Costrell, L. AT(49-2)1165  
F2C213 INSTRUMENTATION FOR NUCLEAR  
APPLICATIONS.

National Bureau of Standards, Washington, D. C.  
WASH. SP 5; MYR 1.4.

This project involves development work and technical assistance in connection with nuclear instrumentation as required by the Radiological Physics and Instruments Branch of the Division of Biology and Medicine. This has involved radiation monitoring systems, special radiation detection instrumentation, and development work on specialized instrumentation. The development of a "charge-storage" type pulse



height analyzer for use with pulsed accelerators has been reported in NBS Report 7181. This analyzer provides for temporary electrostatic storage of pulse height information accumulated during bursts with analysis and permanent storage being accomplished in the long time intervals between bursts. Work is progressing on increasing the storage capacity to 32 per burst from the present value of 9. Some work has been done to indicate the feasibility of considerably increased speed of operation. This is to be pursued further upon completion of the storage capacity increase. A palladium leak control circuit for use with pressurized accelerators is to be described in NBS Report 7812 which is currently in preparation. Work recently accomplished for health physics instrumentation is reported in NBS Report 7776. Radiation monitoring systems developed are described in NBS Reports 5471, 5927, 5214, 4148 and 2502. In addition to pursuing development of the "charge-storage" analyzer, development work will continue on health physics and nuclear physics instrumentation.

Caswell, R. S. AT(49-2)1165  
F2C214 FAST NEUTRON SPECTROSCOPY.  
National Bureau of Standards, Washington, D. C.  
WASH. SP 3; MYR .4.

Measurements are needed for the spectra of neutron sources such as  $\text{Pu}^{239}\text{-Be}(\alpha, n)$ ,  $\text{Po}^{210}\text{-B}(\alpha, n)$ , and  $\text{Am}^{241}\text{-Be}(\alpha, n)$ , which are or soon will be widely used as standards for neutron dosimetry. There is indirect evidence from moderation methods for a very large number of neutrons in a peak somewhere below 1 Mev in the neutron spectrum. These neutrons have never been directly detected to our knowledge. Measurement of the neutrons below 1 Mev is very important for neutron dosimetry since the dose from a source of given neutron emission rate depends upon the number of these neutrons present in the spectrum.

First, development will be continued on a new low energy neutron spectrometer, which uses a hydrogenous proportional counter as a radiator and a silicon junction detector as an energy detector. Efforts will be made to improve the energy resolution and to minimize a rather large tail to the response curve which occurs at low energy. Then an attempt will be made to measure the spectrum of an  $\text{Am}^{241}\text{-beryllium}$  neutron source which is now on order. This type of source seems likely to replace plutonium-beryllium as a standard source for neutron dosimetry and flux measurement. For plutonium-beryllium there is some indirect evidence from methods based on moderation of neutrons that there is a very large number of neutrons in a peak somewhere below 1 Mev in the

neutron spectrum. Presumably the low energy neutrons would also be present for the  $\text{Am}^{241}\text{-Be}$  neutron source, but a specific determination is required.

Powell, C. J. AT(49-2)1165  
F2C215 ELECTRON SCATTERING.  
National Bureau of Standards, Washington, D. C.  
WASH.

The objectives of this project are to extend and improve the measurements of elastic and inelastic scattering of 0 to 100 keV electrons in matter under the various conditions affecting such scattering, and to relate the information so obtained to current theories of the interaction of electrons with matter where these exist or aid in developing new theories where present ones are found inadequate. Measurements have been made of the characteristic electron energy loss spectrum of various materials and its variation with electron scattering angle. In recent years, this work has led to increased understanding of the various energy loss processes, and it has been found possible to correlate the characteristic energy loss data with the other physical properties of the specimens, particularly their optical properties. It is planned to extend previous work measuring cross-sections for inelastic scattering in various metals, and to make new measurements of the electron excitations in liquid metals and alloys.

Krinsky, Albert AT(49-2)1165  
F2C365 HIGH TEMPERATURE STRAIN SENSITIVE FILMS.  
National Bureau of Standards, Washington, D. C.  
WASH. MYR  $\frac{1}{2}$ .

The objectives of this project are (a) to study the electrical resistance strain characteristics of vacuum evaporated thin films, and (b) to develop a high temperature thin film strain gage.

A study of the resistance strain characteristics of thin films of elemental metals and semi-conductors and some alloys deposited on substrates at  $\approx 25^\circ\text{C}$  was made. The films had polycrystalline structures. This study showed that (a) the observed film resistance strain sensitivity is an intrinsic property of the film, independent of substrate or contact effects; (b) the strain sensitivity is a function of film thickness; and (c) the function is qualitatively similar for all the materials studied. Instability with respect to time and/or temperature resulting from changes in the structure of the films precluded their use at elevated temperatures.

A new alloy of Fe-Al-Ti was developed which produces films that are hard, bond tenaciously to various substrates (metal, glass, ceramic), and are oxidation

resistant in air up to  $\approx 400^{\circ}\text{C}$ . These films produce a linear resistance strain characteristic with essentially zero hysteresis, and are stable with respect to time and temperature. A thin ( $< .003$  in.) ceramic coated metal foil substrate and a means for contacting the film, stable up to  $600\text{--}700^{\circ}\text{C}$ , were also developed. The resulting strain gage can be bonded to test structures with epoxy adhesive for use at  $\approx 200^{\circ}\text{C}$ . For high temperature use the substrate can be welded to the test structure or attached by burying in ceramic cement.

## G CHEMICAL TOXICITY

### G1A Metabolism

*See also G1B115.*

Scott, Arthur F. AT(45-1)1542  
G1A477 COMPARATIVE STUDY OF TRACE  
METAL CONTENT OF NORMAL AND PATHOLOGICAL  
TISSUE BY MEANS OF ACTIVATION ANALYSIS.  
Reed Coll., Portland, Ore. RLOO.

The purpose of this project is a comparative study of the trace element content of tissue samples, by means of neutron activation analysis.

Samples obtained from various sources (e.g. surgical and autopsy material; tissue culture cells; etc.) have been subjected to neutron irradiation in a Hanford reactor, and the resultant radioactive nuclides have been identified by conventional means, including multi-channel pulse height analysis of gamma photo-peaks. In the initial work considerable attention has been given to the problem of the rapid, quantitative removal of contaminating cations, particularly sodium and potassium. The investigation to date has shown that chelating resins, with stringent control of pH, appear to provide the most effective radiochemical separation.

The ultimate goal of the project is the study of trace elements in normal and pathological human tissue, particularly the relationship between these elements in cellular enzyme systems of cancerous and non-cancerous tissue from the same individual. Various lines of evidence suggest that a knowledge of the trace element content may be of considerable value in an understanding of the abnormal physiology which occurs when an otherwise normal tissue cell becomes malignant.

### G1B Biological Effects

Swenson, M. J. AT(11-1)1170  
G1B115 COMPARATIVE TOXICITY OF STABLE  
RARE EARTH COMPOUNDS.  
Iowa. State Univ., Iowa City. COO. SP 8; MYr 6.5.

This project is concerned with the comparative toxicity of various rare earth compounds in laboratory animals. The principle objectives are to obtain basic data in both acute and chronic studies using several different species of laboratory animals. Different species are used in order to give a reasonable method of evaluating these elements as a possible industrial health hazard.

Acute toxicity studies have been carried out on mice, guinea pigs, dogs, and rabbits. All of the rare earth elements with the exception of promethium and with the addition of yttrium have been studied on a comparative basis in the form of chlorides, citrate complexes and EDTA complexes. These compounds were administered by intraperitoneal and intravenous injections and by intunctions

The present program is one of chronic toxicity studies using yttrium, cerium, neodymium, dysprosium, gadolinium and ytterbium. These studies are divided into three categories; implants, feeding and inhalation.

The implant mouse experiment involves the implanting of stable rare earth pellets subcutaneously in C-57 black and CFW albino mice.

The mice on the oral chronic toxicity program are fed the rare earth compounds as citrates in a synthetic diet at two dose levels. This experiment is designed to cover the life span of the mice.

Current inhalation experiments involve the exposure of monkeys, dogs, guinea pigs, and mice to aerosols of  $\text{Nd}_2\text{O}_3$ ,  $\text{Gd}_2\text{O}_3$ , and  $\text{Y}_2\text{O}_3$ .

Sunderman, F. W. AT(30-1)-1397  
G1B489 METABOLIC AND CYTOLOGIC CHANGES  
INDUCED BY METALLIC CARBONYLS.  
Jefferson Medical Coll., Philadelphia. NYOO.

1) In previous investigations in our laboratory, pulmonary carcinomas have been induced in rats by exposure to the inhalation of nickel carbonyl. Long-term studies of pulmonary carcinogenicity following exposure of rats to nickel carbonyl are being continued.

2) Investigations within the current year have been concerned with the binding of trace metals to ribonucleic acid. Measurements have been undertaken of nickel and other trace metals in RNA from tissues of normal rats and of rats exposed to nickel carbonyl.

Acute exposure of rats to nickel carbonyl resulted in an increase in the concentration of nickel in NaCl-precipitable (high molecular weight) lung RNA, and a decrease in the concentration of nickel in NaCl-soluble (low molecular weight) lung RNA. Following inhalation of nickel carbonyl, changes which were consistent with an increase in metal-binding, were observed in the phase transition curve of NaCl-precipitable lung RNA. The change which was observed in the phase transition curve of NaCl-soluble lung RNA was consistent with disruption of hydrogen bonds.

3) Ultracentrifugal separations of subcellular particles of rat lung are being currently undertaken to ascertain whether or not the observed alterations of lung RNA may be localized in the microsomal RNA or soluble RNA moieties. It is planned to extend these investigations to a study of the influence of nickel carbonyl upon the amino acid acceptor activity of lung RNA.

Hardy, Harriet L. AT(30-1)2629  
G1B575 BERYLLIUM CASE REGISTRY,  
Massachusetts Inst. of Tech., Cambridge.

This work is a continuation of that begun in 1952 to discover and record knowledge of cases of beryllium disease in the United States. Certain clinical studies are undertaken each year to increase knowledge of how to diagnose beryllium poisoning. Follow-up studies in the field are made. Help with diagnosis is offered to physicians in all parts of the country. Attempts to document cases of malignancy in beryllium-exposed populations are under study, and during the coming year study of the value of the Kveim test as a point in differential diagnosis between beryllium disease and sarcoidosis will be continued.

## H NUCLEAR ENERGY CIVIL EFFECTS

White, C. S. AT(29-2)1242  
H-174 "SELECTED ASPECTS OF WEAPONS EFFECTS."

Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex. ALOO. SP 6; MYr 2.

The work in Selected Aspects of Weapons Effects involves follow-on studies stemming from the 1957 test operation at the Nevada Test Site and earlier activities assessing the comparative biological significance of the major effects of nuclear explosions. Currently, three tasks are under way; namely, updating a brochure entitled "Comparative Nuclear

Effects of Biomedical Interest" to be consistent with available data including those in the 1962 revision of The Effects of Nuclear Weapons; assessing the significance of field data related to the occurrence of dust in closed protective shelters; and gathering available information helpful in better understanding the range-yield relationships for all the major immediate hazards of nuclear detonations.

## J CANCER RESEARCH

### J1A Metabolic Aberrations

Whitehead, R. W. AT(11-1)1218  
J1A237 A STUDY ON THE COMBINED ACTION OF ADRENAL STEROIDS WITH X-RADIATION AND CERTAIN OTHER IONIZING RADIATIONS ON GROWTH AND METABOLISM OF CERTAIN MALIGNANT CELLS IN CULTURE AND IN ANIMALS. Colorado. Univ., Denver. School of Medicine. COO. SP 5; MYr 2<sup>13</sup>/<sub>20</sub>.

It is well known that adrenal cortico-steroids exert an inhibitory effect on the growth of certain tumors. However sooner or later the neoplastic cells become resistant and the tumors resume their growth. Our studies are designed to explore the possibilities of using a combination of steroids with other drugs or radiations to overcome the resistance as well as to learn more about the mechanism of resistance of neoplastic cells to cortico-steroids.

An established line of neoplastic cell (HeLa) and cells of a primary tumor (ca of cervix) are grown in serum bottles as a monolayer attached to glass. They are freed from the glass by mild trypsinization and redispersed as a monocellular suspension. By dilution of a predetermined number of suspended cells, replicate Petri dishes are prepared. Cells are subjected to corti-costeroids, irradiation or both and incubated for from nine to fifteen days. The survivor cells are determined by counting the macroscopic clones. After replicate Petri dishes are seeded with a definite number of HeLa cells or other cells the corticoid is added to medium 24 hours after plating in varying concentrations. A steroid concentration is sought which will permit 90% and another at which 60% of the cells will live. Further replicate dishes of cells are exposed to a selected dose of x-radiation and the predetermined dose of a cortico-steroid known to exert a definite effect on cell growth as revealed by clone count. The synergistic or

potentiating effect of a steroid (if any) can thereby be assessed.

Resistant forms appearing on plates exposed to corticosteroids are further cultured and a strain resistant to the steroids are being developed. Morphological and chemical studies of these resistant forms are being employed to secure information regarding the mechanisms of resistance.

Other studies will be designed to determine the effect of steroids and x-radiation in the intact animal bearing transplantable tumors.

Baserga, Renato AT(11-1)1131  
J1A249 AN INVESTIGATION OF TUMOR-  
INDUCTION IN MICE FROM INTRANUCLEAR  
IRRADIATION WITH THYMIDINE LABELED WITH  
TRITIUM AND CARBON-14.  
Northwestern Univ., Chicago. Medical School,  
COO.

The purpose of the present investigation is to determine if radioactive thymidine can induce tumors in mice. Thymidine, a specific precursor of deoxyribonucleic acid, is incorporated into the nucleus of cells ready to divide. If the incorporated thymidine is labeled with tritium, 90 per cent of the energy of the disintegrations taking place in a nucleus will be dissipated within that nucleus. When labeled with C-14, the radioactive thymidine will irradiate the nucleus as well as the cytoplasm, because of the longer range of the beta particles from C-14. Under these conditions, it is possible to study the damage produced by a form of irradiation restricted to cells, in contrast to other types of radiation exposure which ordinarily involve all cellular and non-cellular components of a tissue or an organ. The investigation will initially involve approximately 1800 mice, of which about 500 will serve as controls. The others will be injected with varying amounts of either tritiated thymidine or C-14-thymidine. The animals will be allowed to live out their life span, and the occurrence of tumors will be recorded.

Pressman, D. AT(30-1)2651  
J1A326 LOCALIZATION OF ANTIBODIES IN  
SPONTANEOUS AND INDUCED TUMORS.  
Roswell Park Memorial Inst., Buffalo. NYOO.  
SP 5; MYr 5.

Antibodies to autochthonous tumors in animals are being studied by means of radiolabel techniques with the aim of localizing enough radioactivity to be of therapeutic or diagnostic use. We had previously found that some antibodies against hepatic tumors of rats (induced N-2-fluorenylacetamide) localize preferentially in tumor and do not localize appreciably

in normal liver. Some antibodies prepared simultaneously can localize in normal liver. We are using a paired label technique in which antibody preparations labeled with I<sup>131</sup> and control preparations labeled with I<sup>125</sup> are injected simultaneously so that localization from antibody preparations and control preparations in each individual piece of tissue assayed can be determined. By use of this paired label technique, we can obtain reliable information which is impossible to obtain otherwise. We are now in the process of separating out fractions of the tumor in order to see if we can get components which will purify localizing antibodies better. Our program has been expanded to include methyl-cholanthrene induced sarcomas in mice in order to determine how antibodies against these tumors localize.

Smith, Hilton A. AT(40-1)-2784  
J1A404 RESEARCH ON MALIGNANT LYMPHOMA  
IN ANIMALS.

Baylor Univ., Houston, Tex. Coll. of Medicine.

The principal phases of this research include:

(1) Classification and complete study of malignant lymphomas in all species, as material is available from the American Registry of Veterinary Pathology maintained by the Armed Forces Institute of Pathology, from the Meat Inspection Division, ARS, USDA, from veterinary clinics and hospitals and from other sources. Living patients, gross and microscopic tissues, body fluids, clinical histories, all are studied and correlated.

A summary of findings in the canine species was presented on February 11, 1963, at the Conference on the Epizootiology of Cancer in Animals and will shortly be published by the New York Academy of Sciences.

(2) Epidemiological studies on incidence according to species, age, sex, and geographical location. There are indications that some regions of the U. S. may have a much higher incidence than others. This feature is being studied, especially as to accuracy and cause. Determination of radio-activity at certain farms will be undertaken in the search for causative environmental factors, as will also the heredity of animals at sites of high incidence.

(3) Efforts to reproduce the disease in cattle by any and all conceivable means, ranging all the way from radiation to detection of a possible virus. No transmission or reproduction of lymphoma has occurred during the first two years of experimentation.

Chaikoff, I. L. AT(11-1)34-11  
J1A437 STUDIES ON THE INDUCTION OF THY-  
ROID CANCER BY IRRADIATION AND ON THE

NATURE OF THE METABOLIC BLOCKS INDUCED BY IRRADIATION, EMPHASIZING A POSSIBLE THERAPEUTIC APPROACH TO IRRADIATION DAMAGE.

California. Univ., Berkeley. SAN.

The first part of this project deals with the induction of malignant tumors in the thyroid gland of rats by single and repeated injection of  $I^{131}$ . We are attempting to learn just how  $I^{131}$  administrations induce tumor formation, and what factors accelerate and diminish the incidence of thyroid tumor formation under these conditions.

The second phase has to do with the nature of the metabolic blocks induced by irradiation. We are attempting to localize the enzymatic site or sites where irradiation interferes with carbohydrate utilization and lipogenesis in tissues. In this study we are making use of  $C^{14}$ -labeled hexoses and intermediates. Individual enzyme systems are also being investigated. By detecting which of the enzyme systems is vulnerable to irradiation, we hope to devise means of circumventing damaged enzyme systems and so restore to the irradiated animal a normal capacity for metabolizing glucose.

Ontko, Joseph A. AT(40-1)2748

J1A469 BIOCHEMICAL EFFECTS OF RADIATION ON ASCITES TUMOR CELLS.

Tennessee. Univ., Memphis. Coll. of Medicine. OROO.

The research being conducted on this project is designed to investigate the biochemical effects of radiation using Ehrlich ascites tumor cells as the biological system. These cells are grown in the peritoneal cavity of mice. Emphasis is being placed on the effects of x-irradiation on the division of the Ehrlich ascites tumor cells. Several phases of this project are under investigation. The effect of radiation on the synthesis of various biopolymers in the ascites cells is being studied through the use of radioactive precursors. Both carbon-14 and tritium labeled substrates are administered intraperitoneally to mice and the resulting incorporation of those isotopes into various fractions of the ascites cells is determined by isolating and purifying, if necessary, the desired components under study and determining their radioactivity using liquid scintillation techniques. Efforts are also in progress to utilize an *in vitro* tissue culture system of rapidly dividing cells since such a biological system has advantages in certain experiments over the *in vivo* culture of tumor cells in the peritoneal cavity of mice. The effect of radiation on the metabolism of compounds capable of yielding energy in ascites tumor cells is also under

study. The relationship between measured biochemical activities and the ultrastructure of control and irradiated ascites cells is being studied using electron microscopy.

Albert, Roy E. AT(30-1) 2785

J1A597 THE TUMORGENIC ACTION OF BETA RADIATION ON THE RAT SKIN: THE EFFECT OF VARYING THE SIZE AND CONTINUITY OF THE AREA OF IRRADIATED SKIN ON THE INCIDENCE OF EPIDERMAL TUMORS.

New York Univ., New York. Medical Center. April 1962-March 1963.

This project concerns the relationship between the incidence of beta ray induced skin tumors in the rat and the amount of irradiated skin at several dose levels. This study stems from the question of whether or not the probability of tumor formation at any given dose bears a simple arithmetic proportionality to the number of treated cells. The mechanics of the study will involve the application of plane  $P^{32}$  sources of varying sizes and geometrical arrangements to the shaved skin of the rat and the subsequent enumeration and histological classification of the resultant tumors.

J1B Unique Applications of Radioisotopes

Bavetta, L. A. AT(11-1)113-13

J1B47 EFFECT OF IRRADIATION ON BIOSYNTHESIS OF COLLAGEN.

University of Southern California, Los Angeles. SAN.

The influence of various levels of x-irradiation on collagen synthesis in both skin and polyvinyl sponge implants is being studied. The irradiation studies are being conducted under both acute and chronic conditions of exposure. It is also planned to study the effect of irradiation on the (1) salt, (2) citrate soluble and (3) insoluble fractions of collagen in an effort to determine where the inhibition of synthesis occurs.

We are also studying the effect of irradiation on both spleen and thymus from the point of view of uptake of glycine- $1-C^{14}$  and the concentration of  $\alpha$ -aminoisobutyric acid (AIB- $1-C^{14}$ ). Preliminary findings indicate that the concentration of AIB in thymus was linearly dependent on dose up to level of 100 r. The spleen, however, shows no changes in concentration of AIB with dose. Differences were also observed in the uptake of radioglycine by thymus and spleen. These differences in behavior of

thymus and spleen, indicate that these lymphatic tissues may not respond in similar fashion to the stress of irradiation.

Wangenstein, Owen H. AT(11-1)897  
J1B245 DEVisING TECHNIQUES UTILIZING  
THE DIFFERENTIAL UPTAKE OF RADIOACTIVE  
PHOSPHORUS FOR IN VIVO DETECTION OF OC-  
CULT OR SILENT GASTRIC CANCER AND FOR  
MULTIPLE ORGAN SCRUTINY.

Minnesota. Univ., Minneapolis. COO.

The increased uptake of radioactive phosphorus ( $P^{32}$ ) by malignant tissues is a well established fact. We have demonstrated successfully an affinity for  $P^{32}$  by in vitro radioautography in gastric malignancies. Our aim is to devise techniques which will permit performance of in vivo radioautography, screening several parts of the body, in recognition of asymptomatic and symptomatic cancer. Initial studies, using a thin-walled rubber balloon which is coated with a latex base photosensitive emulsion, have been carried out in the diagnosis of cancer of the stomach. This method appears to be promising although some minor modifications are being studied. Diagnostic radioautographic studies of other areas are in progress and include studies on the breast, skin (melanomas), urinary bladder and cervix. Suitable containers coated with a photosensitive emulsion and individually shaped for use in the particular area of the body are used in these studies. Early studies on melanomas have been particularly effective. Ultimately, it is hoped that a single injection of  $P^{32}$  may suffice to screen multiple areas and organs, which may harbor on occult cancer.

McQueen, J. Donald AT(30-1) 2182  
J1B353 THE USE OF POSITRON EMITTING ISO-  
TOPES IN THE LOCALIZATION OF INTRACRANIAL  
LESIONS.

Baltimore City Hospitals. NYOO. May 15, 1962 -  
May 14, 1963. SP 1; MYr 2.45.

As-74 sodium arsenate, As-74 arsanilic acid, and As-74 azoproteins were injected into tumor-bearing mice for evaluation as possible tumor-localizing agents. Tumor to brain ratios for As-74 arsenate were about 8:1 and for As-74 arsanilate about 16:1 (1 hour after injection). The uptake of As-74 arsanilate was about one-third less than that of As-74 arsenate. The enhanced tumor to brain ratios obtained with arsanilate are due to a decreased uptake in brain tissue. The As-74 azoproteins contained 8, 5, or 1-2 molecules of As-74 arsanilate per molecule of protein. Our results indicate that more extensive

labeling results in more rapid disappearance from the blood stream, greater accumulation in kidney and liver, and less uptake in tumor. Tumor to brain ratios obtained with the less extensively labeled material averaged about 20-40:1 and were maintained for at least 48 hours. Available azoproteins have been rejected for immediate clinical trial because of the problem of retentivity in liver and kidney. Current investigation is directed to a similar study of the tumor-localizing properties of 3 promising conjugates.

Hodges, Clarence V. AT(45-1)1089  
J1B368 INTRACELLULAR PICKUP OF RADIO-  
ACTIVE PHOSPHORUS BY PROSTATIC EPITHE-  
LIAL CELLS.

Oregon. Univ., Portland. Medical School. RLOO.

"This experimental study includes an investigation of the hormonal factors (estrogens, androgens, orchietomy and combinations thereof) which influence the uptake of  $P^{32}$ , in both organic and inorganic forms, by the epithelial cells of the prostate gland.

The main method used for introducing  $P^{32}$  is regional perfusion of the dog's prostate, using extracorporeal circulation, with oxygenation, after exclusion of the remainder of the circulation. The second method (retrograde per urethram injection) is being evaluated; it consists of injection of the isotope-containing material into the prostatic urethra after occlusion of the bladder neck and ligation of the vasa deferentia.

A related study is concerned with the determination of the fate of phosphorus after its deposition in the prostate gland. A method of performing a prostatic fistula has been designed (modification of Huggin's technique). After preoperative determinations of phosphorus in serum, urine and prostatic fluid, the prostate is perfused with  $P^{32}$ . Postoperative determinations of the same data are accomplished daily and the values are compared with the preoperative studies.

Microradioautography is used to demonstrate the site and extent of deposition of  $P^{32}$  within the prostate gland subsequent to administration by the above techniques."

Zipf, Robert E. AT(11-1)1253  
J1B399 THE POTENTIAL OF P-32-LABELED  
POLYPHOSPHATES IN THE THERAPY OF CANCER.  
Miami Valley Hospital, Dayton, Ohio. SP 3; MYr  
0.5.

$P^{32}$ -labeled linear inorganic polyphosphates of varying chain lengths will be synthesized and char-

acterized and injected into Sprague-Dawley rats. Subsequently, animals will be sacrificed at various time intervals and tissues, especially bone, will be removed and analyzed for  $P^{32}$ .

The biological half-life of injected  $P^{32}$ -labeled polyphosphates will be calculated and its relationship to polyphosphate chain length, injected polyphosphate dose, and tissue specificity in adult and growing animals as well as animals bearing the Mound Strain of transplantable chloromyeloid leukemia will be determined.

Goldie, Horace AT(40-1)3089

J1B417 DEVELOPMENT IN EXPERIMENTAL ANIMALS OF NEW METHODS FOR RADIOISOTOPES APPLICATION IN CAVITARY CARCINOSIS AND IN PARTICULAR AGAINST TRANSCOELOMIC METASTASES.

Meharry Medical Coll., Nashville. SP 5; MYr 3,25.

Our project will explore the mechanism of a malignant human condition known as cavitary (peritoneal and pleural) carcinosis and in particular one of its facets named "transcoelomic metastases," and assay various procedures of radioisotopes application for their inhibition or prevention. The term "transcoelomic metastases" means spontaneous spread of malignant cells, by flotation in a serous effusion, from a tumor-bearing area of peritoneal or pleural cavity to an intact area of the same cavity. Our project deals with experimental investigation imitating, as closely as possible, the analogous pathological condition in human patients; we shall assay pure beta emitting radioisotopes for their ability of inhibiting these metastases after their occurrence or preventing their occurrence by affecting early stages of cavitary carcinoses. The scope of the proposed research is to extend applications of radioisotopes in cavitary carcinosis beyond their palliative effect which is inhibition of fluid exudation and accumulation in the cavity. Briefly, it will be attempted to destroy and to prevent transcoelomic metastases by combining routine technique of intracavitary administration of beta-emitting isotopes with various new methods or adjuvant techniques.

Bender, Merrill A. AT(30-1) 2455

J1B455 TUMOR LOCALIZATION WITH RADIOISOTOPES.

Roswell Park Memorial Inst., Buffalo. NYOO. September 1962-August 1963.

During the preceding year a 19 crystal prototype of the autofluoroscope has been constructed. The effects of non-uniformity of crystal response and inter-crystal crossover were investigated. The lat-

ter was found to be insignificant and the marked differences noted in crystal response have been circumvented by a new design.

The search for pancreas specific tracer agents led to the investigation of the specificity of a variety of amino acids. Studies with C-14 and S-35 labeled amino acids revealed remarkable pancreas specificity. Gamma emitting derivatives of tryptophane were prepared but these compounds had no pancreas specificity. The close chemical similarity of selenium and sulphur suggested that the selenium-75 analog of methionine might provide us with a gamma emitting localizing agent. This material was prepared biosynthetically and had the same specificity as the C-14 labeled methionine in the rat and dog.

During the ensuing year the full scale autofluoroscope will be constructed and tested. It will be used for the localization of human tumors and for the visualization of slow dynamic processes. Selenomethionine will be administered to humans and the rate and amount of pancreas localization determined.

Makari, Jack G. AT(30-1)2692

J1B580 THE LOCALIZATION OF TUMORS WITH LABELED POLYSACCHARIDE ANTIGENS.

Muhlenberg Hospital, Plainfield, N. J. May 1962-April 1963.

Two immunologic methods have already been developed by us which are capable of detecting the presence of tumors in man. One of these methods is based on the use of the Schultz-Dale test, while the other utilizes a skin test. In this study an attempt will be made to localize tumors with labeled polysaccharide antigens.

## J1C Teletherapy

Lampe, Isadore AT(11-1)245

J1C244 CLINICAL EVALUATION OF CESIUM-137 TELE THERAPY.

Michigan. Univ., Ann Arbor. COO.

Comparative clinical evaluation of Teletherapy units housing isotope sources in the radiation treatment of malignant disease is being carried out. The isotope sources are Cobalt-60 and Cesium-137. A Cobalt-60 Teletherapy unit has been in use since 1955. Modification of a Theratron-B to permit clinical employment of a Cesium-137 source has been achieved and the radiation from this isotope is being applied clinically to evaluate the potential role of this radiation in clinical radiotherapy in comparison with Cobalt-60 radiation and past and

current experience with orthovoltage radiation. Experience to date indicates that Cesium-137 radiation is not competitive with Cobalt-60 radiation employed at a source-skin distance of 75 or more centimeters but has the potential of displacing orthovoltage radiation in all fields except surface neoplasms. Plans have been executed for a new apparatus to house the Cesium-137 source involving modification of commercially available apparatus. The apparatus is currently being built and will increase the utility of Cesium-137 radiation because it will do away with the field size limitation of the currently used unit.

## J1D High Energy and Neutron Therapy

Snyder, H. R. AT(11-1)314  
J1D239 EXPERIMENTAL RESEARCH ON  
SYNTHESIS OF BORON-CONTAINING DYES.  
Illinois. Univ., Urbana. COO.

The ultimate purpose of the project is to find a means of building up in or on a growing tumor a concentration of an organic compound containing boron-10, such that the growth of the tumor can be reversed by irradiation with slow neutrons. The immediate purpose is to synthesize systems of boron-containing functions in unusual environments, as part of the search for compounds of exceptional stability to hydrolytic and oxidative removal of boron, to make available new types of boron compounds for study of toxicity and differential concentration in or on mouse-brain tumors, and to develop the chemistry of promising new types of such boron-containing functions so that they can be incorporated into complex compounds.

Sweet, William H. AT(30-1)1242  
J1D323 EXTERNAL LOCALIZATION OF BRAIN  
TUMORS EMPLOYING POSITRON-EMITTING  
ISOTOPES.  
Massachusetts General Hospital, Boston. Aug. 1,  
1952-July 31, 1963.

The proposed research is a continuation of previous studies on the use of positron-emitting radioisotopes for the localization of intracranial focal lesions. It has been shown that this is a clinically useful procedure, yielding diagnostic information comparable to the conventional surgico-radiological procedures. The present proposal is to continue this study in several directions. First, to obtain more clinical data, particularly with respect to non-neoplastic lesions. This will be done by scanning patients, obtaining tissue samples where

possible, evaluating the clinical record, and comparing scans with other tests. A second problem is the mechanism by which localization of radioisotopes takes place. This is being studied biochemically and with the use of implanted tumors and other lesions in animals. A third facet of the work is the investigation of other positron-emitting isotopes and chemical forms, seeking better uptake ratios to make scanning faster and more precise. In particular, short-lived isotopes are being examined for use in a camera-type detector that is in process of development and which eventually will supplant the mechanical scanners presently standard.

Dewar, Michael J. S. AT(11-1)889  
J1D371 HETEROAROMATIC BORON COM-  
POUNDS AS POTENTIAL AGENTS FOR NEUTRON  
IRRADIATION THERAPY.  
Chicago. Univ. COO. SP 3; MYr 1.6.

A number of N-aminoalkyl derivatives of 2,1-borazaronaphthalene and 10,9-borazarophenanthrene have been subjected to preliminary tests on rats by Dr. A. H. Soloway at Massachusetts General Hospital. The compounds were not concentrated in brain tissue and proved rather toxic. However the toxic symptoms were different from those produced by boric acid indicating that the compounds are not degraded *in vivo*; this is encouraging. The compounds were also tested for antibacterial activity by Professor W. Shive at the University of Texas in Austin but proved inactive.

Our synthetic work has been mostly concentrated on monocyclic aromatic compounds, and on compounds where boron and nitrogen are at the bridgeheads between aromatic rings; for we feel that these are most likely to show low toxicity. We have prepared one deviation of the monocyclic benzene analogue, borazarene (JACS 84, 3782 (1962)) by desulphurizing a borazarobenzothiophene with Raney nickel; this proved stable to acid or alkali. We are preparing more of this material for test and also trying to prepare other derivatives of borazarene. We have obtained two compounds with B and N at bridgeheads, 12,11-borazarophenanthrene and 14,13-borazarotriphenylene. These also seem stable and we are now introducing solubilizing groups into them for test. We have also been trying to make heteroaromatic boron compounds with more than one other heteroatom; the ultimate object is to make boron analogues of nucleotides. We have made a number of derivatives of the very stable 4,3-borazaroisoquinoline; some of them are being tested. The isomeric 4,3-borazaroquinoline system has been made from phenylurea and boron tribromide with aluminum bromide; we hope to use this



novel cyclization to make purine analogues from imidazolylurea. Attempts to make borazaropyridines or borazaropyrimidines have not so far been successful. We are also making large quantities of some of the aminoalkyl derivatives of borazonaphthalene for additional tests, and also some related carboxylic acids.

Sweet, William H. AT(30-1)1093  
J1D415 THE USE OF THERMAL AND EPITHERMAL NEUTRONS IN THE TREATMENT OF NEOPLASMS.

Massachusetts. General Hospital, Boston.

Previous irradiations of patients with brain tumors using boron-slow neutron capture therapy at the Massachusetts Institute of Technology reactor has been unsatisfactory for three reasons: a) inadequate dosimetry, b) injury of the blood vessels of the normal brain in the radiation field as a consequence of the high boron level in blood, and c) inadequate penetration of slow neutrons in tissue.

Work is currently underway in the Physics Laboratory on a continuous alpha probe counter to supply essential dosimetric information during the course of such therapy. Utilization and modification of existing commercial instruments presents the most promising approach. The second factor would appear to require binding of a boron compound to tumor cells with concomitant lowering of the boron level in blood. Previous research has been pragmatic in approach, and it would now appear to be fruitful to determine biochemical differences between tumor and brain and to utilize this information to synthesize boron compounds which may be more selectively incorporated into neoplasms. Further studies on the biological effects of *in situ* produced alpha particles on brain neoplasms and normal brain in mice and larger animals will be assessed histologically using light and electron microscopy and by other parameters as well. In the third factor, some major improvement in neutron spectra has already been achieved in studies at the M.I.T. Research Reactor and the Brookhaven Medical Reactor. Close collaboration between these two groups will permit prompt utilization of such advances in portal redesign at the medical therapy area of the M.I.T. Reactor.

Bonte, Frederick J. AT(40-1)2582  
J1D468 CHANGES IN RADIATION QUALITY WITH DEPTH MEASURED BY A BIOLOGICAL SYSTEM. Texas. Univ., Dallas. Southwestern Medical School. OROO. SP 4; MYr 3.1.

A system has been devised for appraising the biological effects of radiation at depth within a tissue-equivalent absorber system, employing single cell

suspensions of mammalian tissue culture cells and based upon the ability of the irradiated survivors to produce macroscopic colonies. The method has been used in the recent past to study the relative biological effectiveness of beams in range 50-250 kvp, and the beam from a cobalt-60 medical unit, and is now being extended to studies of mixed reactor and neutron beams and interstitial emitters. At the same time the effects of various chemical and physical factors upon the performance of a mammalian cell biological dosimetry system are being evaluated. Alteration of temperature during radiation from 37.1, or ambient, has already been done. Various protection and enhancement systems are now being studied. Work will be extended employing a mouse ascites tumor which may be irradiated *in vitro* or *in vivo*, permitting appraisal of whole-animal radiation response.

## K SELECTED BENEFICIAL APPLICATIONS

### K1A Medical Research

*See also A1F41 and D1C344*

Thomas, Sydney P. AT(04-3)193  
K1A87 RADIOACTIVE COLLOIDS IN MEDICAL RESEARCH.

Palo Alto Medical Research Foundation, Calif. SFOO. March 1962-February 1963.

Research under AEC contract AT(043)193 is concerned with introduction of radioactive or radio-opaque components into spherical polymer particles. Particles will range from 0.1 to 10 microns in diameter, but individual lots of such particles are to be uniformly of one size. Cross-linked co-polymers of polystyrene-divinyl benzene are employed because under usual biological conditions, there is no alteration in size or shape of these particles. Physical and biological characteristics of the particles will be investigated, including stability of colloidal suspension, tendency to agglomerate, diffusion through cell membranes, phagocytosis by reticulo-endothelial cells and leucocytes, and disposition through the body and excretion. Correlations of biological phenomena will be made with particle size, surface charge, density of suspensions and concentration of particles within tissues of experimental rats

In preparation of radioactively tagged particles for biological use, the effects of aging of the suspensions upon their stability are of prime importance. A study of this problem is underway.

Clinical applications of appropriately labeled particles are foreseen in roentgen diagnosis, cancer therapy, and in the study of physiological and biological aspects of circulation hematology, ovum and sperm transport.

Ross, O. Burr AT(11-1) 1063  
K1A238 WHOLE BODY COUNTER STUDIES.  
Illinois. Univ., Urbana. COO.

The whole body counter research initially will involve the following general areas:

1. Physiology
  - (a) Growth
  - (b) Aging
2. Genetics
3. Nutrition
4. Fallout

Initial studies will involve measurement of naturally occurring radioactive potassium in the live animal. It is anticipated that the quantitative potassium measurement of the live animal may be very useful in determination of tissue composition of the animal and thus provide a very attractive tool for studying growth and aging processes. Tissue content of meat animals is a very important economic and physiological problem. Initial studies have involved correlations of whole body K40 counts with actual physical and chemical quantitative measurements of muscle, fat and bone of large meat animals. Quantitative tissue indices are being developed for use in population genetic and nutrition studies. Possible fallout interaction with whole body counts has been observed and if additional equipment can be obtained fallout studies will be pursued.

Carr, Edward A., Jr. AT(11-1)1208  
K1A242 DEVELOPMENT OF SCINTILLATION SCANNING OF THE MYOCARDIUM AND PANCREAS.  
Michigan. Univ., Ann Arbor. COO. June 15, 1962-June 14, 1963. SP 5; MYr 1 $\frac{3}{4}$ .

It has been demonstrated that rubidium concentrates in the myocardium. It has also been demonstrated that mercury 203-labeled Chlormerodrin concentrates in brain tumors and in myocardial infarcts, as well as areas of myocardial ischemia. The proposal will study the mechanism underlying the above phenomena and its possible applicability.

In addition to the compounds rubidium 86 chloride and mercury 203 labeled Chlormerodrin (Neohydrin), other compounds of these isotopes will be studied

where feasible as well as compounds of other elements which might be expected on the basis of their chemical structure to have a similar distribution. The work will be carried out principally in dogs, who will receive the compounds intravenously. The concentration of radioisotope in the heart and other tissues of interest will be determined both by scintillation scanning, employing a photoscanner, as well as by well counting. The distribution of compound in sub-fractions of tissue will also be studied.

Marvin, Horace N. AT(40-1)2681  
K1A284 TO OPERATE THE WHOLE BODY COUNTER AND CONDUCT RESEARCH.  
Arkansas. Univ., Little Rock. School of Medicine. OROO. February 1962-January 1963. SP 3; MYr 2.5.

A. Humans. Studies will be carried out on survival of erythrocytes tagged with chromium-51 in normal and vitamin deficient premature and term babies. This study is predicated upon determination of minimal detectable amounts of isotope.

The biological decay of iodine-131 in patients with increased and decreased thyroid activity will be determined and compared with results from normal persons.

B. Animals. Studies will be continued on biological decay of erythrocytes tagged with chromium-51, and organ localization of erythrocyte residues in normal and splenectomized rats, and normal pigeons.

Survival of erythrocytes in normal and thyroid-treated rats will be extended and completed.

The biological turnover of intravenous manganese-54 in the bird and rat will be investigated.

Heyssel, R. M. AT(40-1)2401  
K1A286 UTILIZATION OF A LOW LEVEL WHOLE BODY COUNTING FACILITY IN THE MEASUREMENT OF ELECTROLYTE COMPOSITION AND METABOLISM IN MAN.  
Vanderbilt Univ., Nashville. School of Medicine. OROO. Feb. 1, 1963-Jan. 31, 1964. SP 19; MYr 7.07.

A human low level whole body counter affords several opportunities: 1) To identify and quantitate radioisotopes normally present in the human or radioisotopes present due to biospheric or industrial contamination; 2) To determine overall losses or acquisition of minerals or substances labeled with gamma emitting isotopes without time-consuming and expensive metabolic balance studies; and 3) To allow tracer work in the latter area to be done with less overall radiation exposure to the individual.

The Vanderbilt Clinical Research Center (PHS Grant OG-2) affords the opportunity to use the Vanderbilt whole body counter to study various applications of whole body counting, e.g., albumin turnover, absorption and turnover of iron, absorption and turnover of Vitamin B<sub>12</sub>, and, to cross-compare the results with more routine, established techniques. Patients are studied in cooperation with the Divisions of Endocrinology, Gastroenterology, and Hematology.

In addition to these purely medical applications, measurement of cesium-137 body burdens in a selected group of persons at regular time intervals and cooperation in the nationwide cesium-137 calibration program are being continued. Studies of iodine-131 accumulation in human thyroids as a result of fallout from nuclear weapon tests will be expanded.

Floyd, Ross AT(45-1)1379  
K1A336 "RESEARCH AND DEVELOPMENT OF A HIGH-INTENSITY PULSED X-RAY SYSTEM FOR BIOLOGICAL STUDIES."  
Linfield Coll., McMinnville, Ore. Linfield Research Inst. RLOO, September 1961-December 1962.

The objective of the program is to design, construct, and test, an X-ray pulser, tube and accessories including filament supply and trigger amplifier in accordance with the following specifications:

(1) The design specifications of the foregoing X-ray system shall be determined by mutual agreement between the Commission and the Contractor as the work progresses; the following are regarded as initial design objectives but not necessarily requirements:

- (a) Voltage, 600 kv (pulser output and tube anode).
- (b) Current, 2000 amperes (pulser output and tube beam).
- (c) Pulse length, 10 micro seconds.
- (d) X-ray anode cylinder, 1 1/2" diameter x 3" long (minimum).
- (e) Specimen chamber, 1" diameter x 3" long (minimum).

(2) Presently available chemical dosimeters will be used to establish the dosimetry of the tube.

Krivit, William AT(11-1)1274  
K1A400 "ACTIVATION ANALYSIS: A NEW STABLE ISOTOPE METHOD FOR HUMAN BIOLOGICAL TRACER STUDIES."  
Minnesota. Univ., Minneapolis.

Stable isotopes of iron, calcium, chromium, selenium, and gold can be used as tracers. These tracers are quantitated using activation analysis. They will

be ideal for use in children and other populations where the question of radiation hazards precludes the use of radioactive isotopes.

Iron-58 in tracer concentrations in serum will be activated and quantitative recovery shown. The necessary radiochemical separations necessary will be developed. This isotope theoretically will be useful for *in vivo* iron and red cell metabolic studies.

The techniques necessary to separate the various isotopes listed from interfering isotopes in the feces, blood in tissue as indicated will be developed. The separations will include gamma ray spectroscopy and radiochemical procedures.

*In vivo* studies will include only those necessary to prove the applicability of the isotope for this use.

Kuhl, David E. AT(30-1)3175  
K1A422 NEW APPROACHES TO IMAGE FORMATION IN RADIOISOTOPE SCANNING.  
Pennsylvania. Univ., Philadelphia.

This project is concerned with the development of a system of recording and image formation which will improve data collection, and analysis in medical radioisotope scanning. Particular attention will be directed to new problems of recording which have arisen with the introduction of section scanning of radioactivity in patients. A recording, storage, and display system will be designed and constructed in our laboratory to permit investigation of new methods of extraction of a maximum amount of information from not only the usual rectilinear scanning procedure but from the newer forms of scanning as well.

Saenger, Eugene L. AT(30-1)3044  
K1A459 METABOLISM OF GAMMA EMITTING FISSION PRODUCTS IN HUMAN BEINGS (DEVELOPMENT, DESIGN AND ASSEMBLY OF A WHOLE BODY COUNTER).  
Cincinnati. Univ. Coll. of Medicine. NYOO.

The program is to be divided into three phases: (1) design and construction of the whole body counter, (2) calibration and standardization and (3) metabolic studies of radionuclides of interest in human beings (and animals).

The purpose of this installation is to provide an area within which the natural and environmental radioactivity is reduced to the very lowest practical level so as to permit the detection of extremely low levels of radioactivity in human beings by use of ultra large and sensitive scintillation detectors. The counter is a 6" thick iron room to lower the background. Its principal uses are as follows: (a) To advance the studies of the uptake, retention and methods

of elimination of radioactive fallout in the population; (b) To study the metabolism of many radioactive compounds encountered in the environment and industry so that peaceful uses of radiation may be extended without hazard; (c) To develop new methods for using radioactive isotopes in the diagnosis, treatment and understanding of many human diseases; (d) To aid in diagnosis and treatment of individuals injured in radiation accidents.

Data will be coded for computer programing so that data analysis can be carried on in Cincinnati or elsewhere as desired.

Burrows, B. A. AT(30-1)-3099  
K1A539 A LOW-LEVEL RADIATION MEASUREMENT FACILITY AT THE NEW MEDICAL RESEARCH BUILDING OF THE BOSTON UNIVERSITY SCHOOL OF MEDICINE.  
Boston Univ.

Blumgart, H. L. AT(30-1)916  
K1A549 THE LONG-TERM EFFECTS OF I-131 ON THE THYROID GLAND.  
Beth Israel Hospital, Boston. NYOO. SP 3; MYr 2.

Continuing observations on the long-term toxic effects of I-131 in man are being carried out. The therapeutic effectiveness of I-131 of intractable congestive failure due to various types of heart disease is being evaluated. The mechanism of the improvement associated with the induction of I-131 hypothyroidism is under active investigation.

Layrisse, Miguel AT(30-1)2694  
K1A581 RADIOISOTOPE STUDY OF INTESTINAL ABSORPTION IN HOOKWORM INFECTED PATIENTS. Fundación Luis Roche. Instituto Venezolano de Investigaciones Científicas, Caracas. January 1962–August 1962.

Although iron deficiency is the main cause of the anaemia in patients infected with hookworm, low serum vitamin B12 concentration, impairment of folic acid and nitrogen have been observed in patients with heavy infection. In addition, it is noteworthy to emphasize that the infected people have an almost exclusive hydrocarbonate diet, occasionally eating eggs, meat, and fat.

The authors would like to go further in the investigation of folic acid and vitamin B12 absorption using various techniques and to complement the study with the determination of fat and D-xylose absorption and intestinal biopsy. Iron metabolism including hemociderin in the marrow, plasma iron, and ferrokinetics with Fe<sup>59</sup> will also be performed.

It is hoped to obtain from this investigation a better idea about the iron metabolism and the absorption of

nutrients in hookworm-infected patients and in consequence a reasonable plan to treat these patients.

Koller, P. C. AT(30-1)2702  
K1A582 TISSUE THERAPY AFTER IRRADIATION. London. Royal Cancer Hospital. Inst. of Cancer Research. February 1962–January 1963.

It is proposed to study in mice the possibility and consequences of haematopoietic tissue replacement after total body irradiation. The factors controlling such replacement are principally the dose and dose-rate of irradiation, the type and number of cells used to effect the replacement and the genetical relationship between the irradiated animal and the replacement tissue. Each factor will be systematically varied. The properties of the animals resulting (radiation chimaeras) will be studied with particular attention to the development of their haematopoietic system as assessed by peripheral blood analysis and immunological reactivity gauged by skin grafting.

The chimaeric state will be identified by appropriate marker techniques—principally serological and cytological. The duration of chimaerism induced after irradiation will be studied in relation to reactions of injected donor tissue against a genetically different host which is often evidenced as a wasting syndrome. Special study will be made of these chimaeras which do not show or do not die with a wasting syndrome despite immunogenetic differences between their components.

## K1B Agriculture — Crop Improvement

See also D1D304 and D1E378.

Woods, Frank W. AT(40-1)2790  
K1B109 DETERMINATION OF THE EXTENT OF ROOT DISTRIBUTION BY THE USE OF RADIO-TRACER TECHNIQUES.  
Duke Univ., Durham, N. C. School of Forestry. OROO.

The spatial distribution of roots in two forest types of the North Carolina sandhills has been investigated employing a technique which utilizes radiiodine as a tracer. Roots in a small volume of soil are killed *in situ*, and radiiodine is flooded into the conducting tissues, from whence it is passively transported to trees which have root connections with the small volume of soil into which the isotopes are introduced. Trunks of trees are monitored to determine whether they have taken up the isotopes. For a planted stand of longleaf pine (*Pinus palustris*) 23 years old, roots in the surface foot

were found to have connections with all trees within a radius of 10 feet, and with none outside of a 40-foot radius. In a mixed natural stand of longleaf pine and turkey oak (*Quercus laevis*) with many age classes, roots of pines were found to extend 65 feet, while those of oaks extend no further than 50 feet. The radius of complete presence was 16 feet for pines and 8 feet for oaks. In all cases, trees at increasing intermediate distances, are progressively less likely to have root connections with any given cubic volume of soil. Future investigations will include more complex forest types.

Crafts, A. S. AT(11-1)34-38  
K1B140 THE UPTAKE, DISTRIBUTION, AND FATE OF LABELED COMPOUNDS USED AS TRACERS IN PLANTS.

California. Univ., Davis. SAN. SP 10; MYr 2.7.

Having demonstrated that labeled tracers applied to leaves penetrate and move in the phloem along a pattern from source to sink of assimilates, and that such tracers applied to roots may penetrate the cortex and move acropetally in the transpiration stream, a survey was made studying distribution of tracers applied to roots and to leaves of barley and bean and given times of 1, 4, and 16 days. Previously 24 compounds had been so studied; this year pentachlorophenol and arsenic were added to the list. Penetration studies show that water soluble tracers may penetrate cuticle; penetration is greatly enhanced when plants are in saturated atmosphere. Some compounds such as 2,4-D applied to roots in low concentration accumulate but do not readily ascend the stem. High concentration causing injury and dinitrophenol at  $10^{-4}$  M, an inhibitor of oxidative phosphorylation break the barrier and allow movement to foliage via the transpiration stream.

Autoradiographic studies show that the lysigenous glands of cotton leaves accumulate the triazine herbicides. This effect is great enough to lend partial protection against these toxicants. Histoautoradiography with substituted ureas prove the apoplastic distribution of these compounds. Continued work by this method is being used to distinguish between symplastic (cytoplasmic) and apoplastic (cell wall) movement.

Whitehead, E. I. AT(11-1)1031  
K1B224 METABOLISM OF SULFATE.  
South Dakota State Coll., Brookings. COO. SP 3; MYr 2.1.

Certain aspects of sulfate metabolism are being studied to determine the effects of selenium (selenite or selenate) on sulfate incorporation into organic

sulfates. Toward that end, injections of radiosulfate or sub-lethal doses of selenium 75 (as selenate or selenite) are placed in the air-sac of eggs containing 14-day chick embryos. After 60 hours, the extent of incorporation of sulfur or selenium into taurine (whole embryo homogenates) or chondroitin sulfate (condyle homogenates) and the molar ratios of incorporation are determined.

The sulfur 35 content of chondroitin sulfate and taurine will be used to test the effect of simultaneous injection of selenite or selenate with sulfate on sulfur incorporation into these compounds. If substantial suppression of sulfur incorporation is found, enzyme extracts prepared from the chick embryos, labeled sulfate, sulfate acceptor compounds and necessary co-factors will be used to explore *in vitro* the effects of selenium salts on the sulfate-activating and active-sulfate transfer systems.

The effect of selenium salts on arylsulfate synthesis by rat livers is being studied. Livers of control and selenized (non-radioactive) rats is being checked for possible impairment of the sulfate transfer enzyme system due to dietary selenium.

Casida, John E. AT(11-1)1187  
K1B230 RADIOTRACER STUDIES ON THE MECHANISM OF INSECTICIDAL ACTION.  
Wisconsin. Univ., Madison. COO. June 1962-March 1963.

The metabolism of carbamate insecticides will be intensively investigated using  $C^{14}$ -labeled materials. Dimethylcarbamates labeled in the carbonyl grouping and N-methylcarbamates labeled in the carbonyl, methyl and aromatic groups will be considered. Compounds to be examined will include the dimethylcarbamate, dimetilan, and the N-methylcarbamates of 1-naphthol, *o*-isopropoxyphenol, *m*-isopropylphenol, 4-methylthio-3,5-xyleneol and 4-dimethylamino-3,5-xyleneol. Characteristics of the compounds to be considered include residual persistence and fate in plants, metabolic pathway and rate of detoxication in mammals, enzymatic mechanisms of detoxication, resistance mechanisms and the mode of action of synergists.

Graham, Ellis R. AT(11-1)1064  
K1B247 RADIOACTIVE ISOTOPES STUDIES OF BODY COMPOSITION, BODY FUNCTION, SOILS AND FOOD SUPPLY.  
Missouri. Univ., Columbia. COO. SP 9; MYr 2.

The overall objective is to study the natural and acquired radioactive isotopes in soils, foods, animals and humans and their relationship to body composition and function as measured by liquid scintillation

and/or sodium-iodide crystal, counting techniques. These techniques should be of great value in elucidating (a) actual nutritional requirements, (b) the development and heritability of musculature, (c) the genetic correlation between traits of economic importance, (d) radioactivity of soils and foods and (e) electrolyte activity in man during the treatment of various syndromes. These enumerated objectives will be investigated through the cooperative efforts of specialists in each of the following areas, respectively; soils, animal sciences, biochemistry, medicine, economics and nutrition.

Gregory, Walton C. AT(40-1)2909  
K1B268 THE NORTHWARD MIGRATION OF  
CITRUS BY MEANS OF RADIATION-INDUCED  
MUTATION.

North Carolina State Coll., Raleigh, OROO. SP 2;  
MYr  $\frac{1}{2}$ .

It is proposed to induce a greater degree of winter hardiness in Citrus by a combination of radiation-induced mutations and environmentally induced shortened generation time as means for obtaining a population of variations susceptible of selection in a cold climate of intermediate severity. The next immediate objectives will consist of work directed at the following:

1. To determine the relative tolerance of various citrus species and varieties when grown in the Raleigh, North Carolina, latitude.
2. To show the relationship between the development of the branching system and the artificial induction of flowers.
3. To determine the effects of various levels of radiation treatment on the vegetative buds of various species and varieties of citrus.

Initial tests show that all commercial citrus varieties succumb to the low temperatures of the test area in early winter. As important as a cold resistant citrus would be to the citrus industry the greater significance of the present study has to with the artificial adaptation of an organism to a truly hostile environment by means of mutagenesis.

Levels of radiation tolerance have been determined for a number of different kinds of citrus. It appears that for most types a maximum of 10 Kr of X-rays may be delivered to fully hydrated non-dormant but inactive tissues.

Goss, James A. AT(11-1)1015  
K1B361 CARBON-14 DIOXIDE FIXATION BY  
LUPINUS LUTEUS POLLEN.

Kansas State Univ., Manhattan, COO.

In our past studies of carbon<sup>14</sup> dioxide fixation by Lupinus luteus pollen, it was found that carbon<sup>14</sup> di-

oxide was fixed into the organic constituents of the pollen. However, no stimulation was attributed to light which casts doubt on the function of chlorophyll, in this pollen, on photosynthesis. In the future we plan to:

1. Extend our research to the pollen of other species to compare their behavior in this respect. Especially, we are interested in those pollens that may contain chlorophyll.
2. Follow the pathways of in vitro C<sup>14</sup>O<sub>2</sub> fixation in these and compare them with pathways observed by us with L. luteus pollen.
3. Continue our study with L. luteus pollen to verify the reported occurrence of chlorophyll in this pollen and to find where the block in photosynthesis occurs.

Christian, J. E. AT(11-1)876  
K1B373 THE CONSTRUCTION, INSTALLATION  
AND OPERATION OF A 2 PI LARGE VOLUME  
LIQUID SCINTILLATION COUNTER.

Purdue Univ., Lafayette, Ind. COO. SP 19; MYr 5.5.

The determination of body composition through determinations of total body potassium, the estimation of naturally occurring radionuclides, and the determination of levels of artificially introduced radionuclides in vivo in man and large animals are of considerable importance. The major objective of this project was the construction, installation, and operation of a 2 pi large volume liquid scintillation counter for use in research in biology, agriculture, and related areas. The counter has been constructed, checked for operational characteristics, and a number of projects are well underway utilizing the equipment. A second 2 pi tank has been installed on the detector providing for 4 pi counter operation.

Major projects in process include:

1. Studies of the physio-genetic factors affecting the body composition of large animals.
2. Studies of the body composition and physical fitness state of human subjects.
3. Studies of the effect of nutritionally complete food substitute therapy on the body composition of obese human subjects.
4. Studies of the effect of anorectic agents on body composition.
5. Studies of potassium-42 vs. potassium-40 measurements in human subjects.
6. Studies of the effect of selected diuretics on potassium depletion.
7. Studies of altered metabolism of I-131 in animals.

Moh, Carl C. AT(30-1)2043  
K1B391 THE APPLICATION OF NUCLEAR EN-

ERGY TO AGRICULTURE IN LATIN AMERICA. Inter-American Inst. of Agricultural Sciences, Turrialba, Costa Rica. NYOO.

This program involves two main lines of work: 1. to train Latin American students in the use of radioisotopes; and 2. to do agricultural research in the tropics. In the training aspect of this program, graduate courses in laboratory methods, radioisotope methodology, cytogenetics, plant breeding are given. The research work in progress involves: 1. Radiation botany. The radiosensitivity of tropical plant species continues to be studied, including banana, cassava, papaya, sugar cane, pine species, and several hardwood species. The sensitivity of seed, tuber, cutting and the whole plant of the same plant variety, if the method of propagation allows, are also compared.

Using beans as a biological material, work is being carried out on the comparative effects of chronic and acute irradiation in inducing chromosome aberrations and point mutations. 2. Cytogenetics of disease resistance of beans. More than 200 bean varieties, including 5 species have been collected. The chromosome morphology of *Phaseolus* species is being studied. Low temperature pre-treatment (4°C) of the radicles has been found to be advantageous to cytological observation, since the chromosome movement at metaphase is completely blocked by low temperatures.

The resistance of different bean varieties to *Rhizoctonia* is being tested. Among the 16 isolates of *Rhizoctonia* found in Central America, an isolate, H-23, is the most pathogenic. 3. Sterilization of the Mediterranean fruit fly, and its application to fly eradication. The relationship between dosage and sterility was studied. It was found that a dose of 10 Kr of gamma radiation is capable of inducing dominant lethal mutations in all sperm. Studies on the effects of different atmospheric conditions on the mating vigor and sperm production of the male flies, and the radiosensitivity of spermatogenesis at different stages are being carried out.

Wang, C. H. AT(45-1)573  
K1B420 RADIOACTIVE TRACER STUDIES OF INTERMEDIARY METABOLISM IN FRUIT. Oregon State Univ., Corvallis. SP 3.

Under this project it is proposed to study the following problems pertaining to fruit metabolism:

1. Biosynthesis of ethylene in tomato fruit and the mold, *Penicillium digitatum*.

Previous results obtained in this laboratory indicate that fumaric acid is a close precursor to ethyl-

ene. C<sup>14</sup>- and H<sup>3</sup>-labeled substrates such as fumarate, succinate and others will be administered to tomato fruit or the mold. The specific activity of ethylene produced by these organisms will be determined to establish the exact metabolic relationships between ethylene and the respective substrates. The work will be followed by enzymological studies to illustrate in full the biosynthetic mechanism for ethylene production.

2. Total fate of glucose in tomatoes.

C<sup>14</sup> specifically labeled samples will be administered to tomato fruit. Labeled fruit constituents derived from the C<sup>14</sup> glucose will be isolated and degraded to obtain the respective isotope's distribution patterns. It is hoped that the data so obtained will provide much information to the participation of various catabolic sequences in the overall fruit metabolism.

Beard, Benjamin H. AT(49-7) 2021  
K1B484 THE UTILIZATION OF IONIZING RADIATION FOR CHROMATIN MANIPULATION. I. THE PRODUCTION OF TRANSLOCATIONS AND USEFUL MUTATIONS IN FLAX (*LINUM USITATISSIMUM*). Department of Agriculture. Southwestern Irrigation Field Station, Brawley, Calif. WASH. SP 1 to 10; MYr .375.

A recurrent irradiation study of flax seed with 4 or 5 irradiation cycles is planned. The number of useful flax characteristics for genetic studies is limited. At present no loci have been located on specific chromosomes and only one instance of linkage has been found.

Seven varieties of flax were selected for study. These vary widely in flower color, seed color, disease resistance, oil content of the seed, and iodine number of the oil. The first cycle has been partially completed. If possible 5 branches were harvested per X<sub>1</sub> plant and the seed from a branch was used as a unit for mutation studies. Although mature plant characteristics will also be noted, seedling chlorophyll mutants have been recorded. These data indicate that a primary branch generally represents the progeny from a single meristematic region. From 14,816 separate branches in the irradiated group, 41 instances of chlorophyll mutation were found. The mutant progeny were found in a single branch in all but 2 cases. The exceptional cases had the same mutants in the progeny from 2 and 3 branches respectively. The control group with 4,227 branches has shown no mutations. Any change in mutation frequency with further irradiation cycles will be interesting.

Cytological studies to obtain translocations and monosomics or trisomics will also be attempted. Techniques for such screening have not been perfected.

## K1C Agriculture — Animal Physiology

See also A1A218, A1A312, A2B390,  
D1B315, D1C187, and D1C370.

Stark, Ronald W. AT(11-1)34-86  
K1C139 THE EFFECTS OF GAMMA RADIATION  
ON THE BIOLOGY AND BEHAVIOR OF FOREST IN-  
SECTS AND THE POSSIBILITY OF THEIR CONTROL  
BY MEANS OF IRRADIATION TECHNIQUES.  
California. Univ., Berkeley. SAN. MYr  $\frac{7}{10}$ .

This project was initiated in 1962. The objectives are to investigate the feasibility of irradiation techniques for control of forest insects, particularly a bark beetle *Ips confusus* (LeConte) and a sawfly (defoliator) *Neodiprion fulviceps* complex.

A Model 2, Cobalt<sup>60</sup> irradiator (1,000 Curies) calibrated at 1,000 r per three minutes of exposure was used to irradiate various stages of the sawfly and adults of the bark beetle at dosages ranging from 5,000 to 140,000 r.

Irradiation of feeding larvae, ultimate instar larvae, and prepupal larvae of the sawfly at dosages of 5,000 r or greater prevented successful development. Irradiation of pupae stimulated emergence and significant mortality did not occur below 100,000 r. Behavioral processes of larvae, particularly feeding and cocoon formation, were markedly affected. Sterilizing effects cannot be determined until spring, 1964.

Sterilization of both males and females of the adult bark beetle apparently occurs at low radiation levels (less than 10,000 r). Gallery patterns, oviposition, mating behavior and longevity seem to be little affected at this dosage level. Sterilization to aid in control appears to be a distinct possibility if used in conjunction with the use of natural attractants.

Turner, Chas. W. AT(11-1)301  
K1C201 STUDY OF THE INHERITANCE OF  
PRODUCTIVE PROCESSES IN DOMESTIC ANIMALS  
BY ENDOCRINE METHODS USING RADIOACTIVE  
ISOTOPES AS TRACERS.  
Missouri. Univ., Columbia. COO.

The thyroxine secretion rate (TSR) of 68 heifers, 33 steers and 74 bulls of the Angus, Shorthorn and Hereford breeds was determined during various seasons of the year. No significant difference was

found due to sex, castration, breed or season. Individual variations ranged from 0.1 to 0.7 mg/100 lb./day with mean of 0.27 mg thyroxine. This mean is significantly lower than that reported for dairy cattle (0.40 mg/day).

TSR's of 25 ewes were made when pregnant, lactating and after weaning. No significant difference in TSR was observed due to season, pregnancy or lactation. TSR ranged from 0.1 to 0.6 mg/100 lbs./day with a mean of 0.26 mg thyroxine. Twenty lambs showed TSR ranging from 0.3 to 0.5 mg/day with a mean of 0.43 mg which was significantly higher than the ewes.

A method has been developed for the determination of the thyrotropic hormone secretion rate in fowls in comparison with their TSR. The strain of birds with low and high TSR had thyrotropin secretion rates quite similar. It was concluded that the difference in the TSR was due to the difference in responsiveness of the thyroid glands to thyrotropin.

A method is being developed for the determination of the progesterone secretion rate of pregnant cows, based upon the progesterone blood level and progesterone  $t_{1/2}$ . The  $t_{1/2}$  is being determined using progesterone 4 C<sup>14</sup>.

In dairy cattle by administering thyroxine daily at a level 50% above their TSR, milk yield was increased in 9 cows by 27.6%, with a range from 12.1 to 67.9%. Upon withdrawal of the hormone it was shown that 12 days were required for I<sup>131</sup> uptake to begin indicating thyroid function had been restored. When thyroxine was first reduced to the secretion level, then withdrawn, thyroid gland function was restored in 8 days.

Edwards, H. M., Jr. AT(40-1)2395  
K1C264 THE ROLE OF MINERAL ELEMENTS IN  
POULTRY NUTRITION.

Georgia. Univ., Athens. OROO. SP 2; MYr 1.

Studies are to be carried out to determine if Strontium is an essential element for normal physiological and biochemical function in the growing chick. Preliminary studies will be conducted to determine if any type of observable response can be obtained from supplementing a purified diet with Strontium. The use of competitive mechanisms to develop a Strontium deficiency will be investigated. Toxic levels of Group 2 elements and some of the Period 4B, 5A and 5B elements will be fed to chicks. Strontium will be fed to other groups of chicks along with toxic levels of these elements to determine if it can reverse the toxicity of these elements. The displacement of radioactive Strontium from the soft tissue by feeding the various elements of the groups listed above will be investigated. Trace amounts of



high specific activity Strontium 85 will be given to chickens and allowed to come to equilibrium in the soft tissues. Also the ability of the elements listed above to overcome Strontium toxicity will be investigated.

Hill, Berton F. AT(49-1)643  
K1C364 INSTITUTE OF LABORATORY ANIMAL  
RESOURCES.

National Research Council. Inst. of Lab. Animal  
Resources. WASH. SP 3; MYr 3.

The main objective of the Institute of Laboratory Animal Resources is the organization and mobilization of animal resources for bio-medical research. Three basic functions can be delineated under the general objective: information development and dissemination; establishment of standards; and development of training programs. The formation program includes the maintenance of the Laboratory Animal Information Center; publication of the quarterly newsletter, Information on Laboratory Animals for Research (currently sent to 1400 individuals and institutions in the United States and 42 foreign countries); preparation and distribution of the periodic directory of animal and equipment suppliers, Animals for Research; publication of monographs on experimental animal topics and the sponsorship of conferences and symposia (germfree animals, animal housing, genetics and breeding systems, laboratory animal zoonoses, etc.). Standards established by the Institute include those for the breeding, care and maintenance of mice, rats and hamsters; the transportation of dogs and primates and the use of animals at the university-industrial level and the high school-science fair level. The training activity has resulted in the development of curricula for the education of laboratory animal colony technicians at the junior and senior ranks. Similar programs are being drawn up for supervisory personnel.

Hueter, F. G. AT(45-1)1441  
K1C476 THE STUDY OF NORMAL AND ALTERED  
RUMINANT LIVER METABOLISM UTILIZING RADIO-  
ISOTOPIC TECHNIQUES.

Oregon State Univ., Corvallis. SP 2.

Liver biopsy samples will be obtained from ruminant animals and utilized for incubation with various  $C^{14}$ -labeled substances to fulfill the following objectives:

(1) Continued studies on the metabolic interrelationships of the various acids, particularly when they are present in widely variant ratios to one another.

(2) The oxidative metabolic pattern of butyrate-3- $C^{14}$  and beta-hydroxybutyrate-1- $C^{14}$ .

(3) The effect of endogenously high levels of ketone bodies on the oxidative metabolism of formate, acetate, propionate and butyrate.

(4) The effects of fasting on the oxidative metabolism of the  $C_1$  through  $C_4$ ,  $C^{14}$ -labeled aliphatic acids.

(5) To determine the ability of liver slices, obtained from calves with qualitatively and quantitatively immature rumina, to utilize the  $C_1$  through  $C_4$  aliphatic acids.

(6) Determine if important metabolic differences exist between various ruminant species, and if so, their extent and importance.

Hansen, M. F. AT(11-1) 1209  
K1C548 X-RADIATION EFFECTS ON THE BIOLOGY OF HETERAKIS GALLINARUM, CECAL WORM OF FOWL, AND A PATHOGENIC PROTOZOAN, HISTOMONAS MELEAGRIDIS.

Kansas State Univ., Manhattan. June 15, 1962-June 14, 1963.

Techniques will be developed for x-radiation of Heterakis eggs in various stages of segmentation. The infective larvae not only free from their enclosing membranes but also within the vitelline membrane will be irradiated. Heterakis, showing possible changes in morphology, infectivity, and pattern of life cycle following initial irradiation will be transmitted through several generations of chickens. Passage in chickens will give information not only of the immediate effects from irradiation but also possible latent changes and/or mutations. Both in vitro and in vivo studies will be used, where applicable, with Histomonas to investigate the effects of irradiation on survival, morphology, infectivity, and changes in pathogenicity.

The effects of localized x radiation on Heterakis will be studied with the aid of a slitted system in an x-ray microscope.

X rays in the range of 20 kv to 200 kv will be employed so that a specific roentgen dosage will be utilized on the worm specimens and the protozoan. The penetration of the container walls and the maintenance medium is the important problem relative to irradiation. Higher energy x-rays will be used when the need is present for greater penetration.

## L FOOD PRESERVATION

Romani, Roger J. AT(11-1)34-73  
L-23 THE BIOCHEMISTRY OF RADIATION AND  
FRUIT MATURATION.

California. Univ., Davis. Coll. of Agriculture. SAN.  
SP 6; MYr 4.

The physiological responses of fruit tissues to large doses of ionizing radiation, i.e., 100 to 500 kilorads are being investigated because of the relationship they bear to applied aspects of fruit radio-pasteurization and because of the approach provided in the study of radiation physiology and biochemistry per se. The quiescent cells of fruit can survive abnormally high doses of radiation and can, therefore, provide a good tissue source for the study of radiation stress and cellular response. Initial studies have identified the respiratory response of fruit concomitant with irradiation, changes in pectins, in vitamin C and sulphhydryl groups, and in mitochondrial nitrogen. Associated enzyme systems are now under investigation.

Investigation of the radiation response of fungi associated with fruit spoilage has shown that the recovery of Rhizopus stolonifer sporangiospores has demonstrated a 25 to 50 fold, or greater, increase in colony formation after irradiation if the spores were inhibited from germinating by placing in concentrated suspensions. Measurements of pectinase activity by the sporangiospores suggest that "soft rot" decay fungi are capable of considerable tissue maceration even after the growth potential has been destroyed by irradiation.

Graikoski, John T. AT(11-1)1095  
L-190 A STUDY OF THE EFFECT OF IONIZING RADIATION ON RESISTANCE, GERMINATION AND TOXIN SYNTHESIS OF CLOSTRIDIUM BOTULINUM SPORES, TYPES A, B AND E.  
Michigan, Univ., Ann Arbor. COO. SP 2; MYr 1 1/2.

The ability of Clostridium botulinum Type E spores to grow and synthesize toxin at refrigeration temperatures is important when evaluating the refrigerated storage of seafoods pasteurized with ionizing radiations. Our studies are directed towards obtaining information on the germination, growth and rate of toxin synthesis of botulinum spores in the temperature range of 0-30°C (32-68°F). The studies will include irradiated and non-irradiated spores of representative strains of C. botulinum Type E, as well as Types A and B, in various irradiated seafoods and defined media. Studies on the radiation resistance of botulinum spores and the environmental factors which may affect the radiation sensitivity of the spores will continue. Factors such as irradiation temperature, chemicals i.e. salts, nitrite, smoke extracts will be evaluated. The germination requirements of Type E spores as measured by conventional methods such as loss in heat resistance, changes in refractability, optical density and enzymatic activity will be studied.

An attempt will be made to determine the effect of irradiation on the germination process and the synthesis of toxin by irradiated and germinated spores. Since C. perfringens can also cause food poisoning in fish, the radiation resistance of this organism will also be tested.

Slavin, J. W. AT(49-11)1889  
L-331 LOW LEVEL RADIATION PRESERVATION OF FISHERY PRODUCTS.  
Fish and Wildlife Service. Technological Lab., Gloucester, Mass.

As part of a study to develop process parameters that will permit shipment of refrigerated, radiation pasteurized fishery products to distant inland markets, this laboratory has investigated the effects of radiation and storage on the amino acids and B-vitamins of haddock (Melanogrammus aeglefinus) fillets and soft shell clam (Mya arenaria) meats. In general, it was found that the amino acids and B-vitamin of both products were not significantly affected as a result of irradiation at levels in the ranges of 150,000 to 250,000 rads for haddock and 350,000 to 450,000 rads for clam meats. Some of the free amino acids were found to increase after 30 days of storage at 33°F. Subjecting the products to radiation doses ten times that above did not affect the amino acid content to any greater degree than did the low dose radiation followed by refrigerated storage for 30 days. Radiation pasteurized haddock fillets and clam meats did not exhibit marked changes in their B-vitamin content. Subjecting clams to an exaggerated radiation dose of 4,500,000 rads resulted in a slight alteration of the pyridoxine content, and when haddock fillets were subjected to 2,500,000 rads, slight losses in vitamin B<sub>1</sub> and B<sub>12</sub> were evident. However, in either case, these changes are not nutritionally significant.

In order to obtain more fundamental information on the factors which influence flavor and odor changes in seafoods, the volatiles of these products are under investigation. The technique employs high vacuum distillation combined with low temperature condensation of the volatiles from the samples. The compounds are separated by gas chromatography using a Sr<sup>90</sup> ionization detector and a column temperature programmer to facilitate the resolution of the more highly volatile compounds at low temperatures in the range of -65°C to 0°C. Identification of compounds will be accomplished by mass spectrometry.

Briggs, George M. AT(11-1)34-95  
L-366 RADIATION OF HEME PROTEINS.  
California, Univ., Berkeley. SAN. SP 4; MYr 1.75.

Solutions of highly purified tuna and mammalian myoglobins will be irradiated with Co-60 in an effort to learn particularly about changes in the proteins. Since these proteins are extremely well characterized and can be prepared in highly purified form they serve well as model compounds; they are also responsible for the color of most fish and meat products and information obtained in such a study has a direct bearing on color problems inherent in radiation preservation of such foods.

Of particular interest is the fact that the tuna myoglobins contain a free sulfhydryl group (1 cysteine/mole) while mammalian myoglobins do not. An opportunity is thus afforded to study the effects of ionizing radiation on -SH groups in model proteins rather than in amino acids or similar systems.

Following varying levels of radiation, changes in titrable -SH, total cysteine, electrophoretic, chromatographic, sedimentation velocity and related parameters of size and shape will be measured. Changes in the heme portion of the molecules will be followed spectrophotometrically.

Dollar, A. M. AT(45-1)1730

L-478 STUDY OF THE BASIC MICROBIOLOGI-

#### CAL AND BIOCHEMICAL FACTORS INVOLVED IN THE IRRADIATION PRESERVATION OF MARINE PRODUCTS.

Washington, Univ., Seattle. HOO. April 1962 - September 1963.

During the contract period April 1, 1962 through September 30, 1963, the Contractor proposes to conduct studies of the basic microbiological and biochemical factors involved in the irradiation preservation of marine products. It is proposed to study the problem within the scope outlined in the following three tasks:

(1) Study the microflora of crab and flounder before and after exposure to pasteurizing radiation (less than 1 megarad) with particular reference to (a) organisms known to be important in spoilage, and (b) organisms of public health significance, including coliforms and enteric pathogens, coagulase positive staphylococci, clostridia and streptococci.

(2) Compare the biochemical and chemical in crab and flounder before and after exposure to pasteurizing radiation (less than 1 megarad).

(3) Initiate preliminary investigations of the biological safety and quality of crab and flounder subjected to irradiation pasteurization.

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B1B299 STUDY OF MUTATION TO RADIATION RESISTANCE IN SPORES.

B1B588 THE GENETIC BASIS FOR DIFFERENCES IN RADIOSENSITIVITY WITHIN A SINGLE STRAIN OF BACTERIA (E. COLI STRAIN B).

B1B589 THE PROBLEM OF THE SPONTANEOUS "BACKGROUND" IN THE STUDY OF RADIATION-INDUCED MUTATION.

B1F590 THE SOMATIC MUTATION THEORY OF THE AGING PROCESS - THE EFFECT OF TEMPERATURE ON SPONTANEOUS MUTATION RATE AND LONGEVITY IN DROSOPHILA MELANOGASTER.

C1C569 "STUDIES ON BONE DEMINERALIZATION WITH EMPHASIS ON THE REMOVAL OF STRONTIUM."

D1C296 STUDY OF THE CONDENSING UNITS IN NUCLEIC ACID BIOSYNTHESIS.

D1D319 STUDIES ON TRANSPORT AND METABOLISM OF ISOTOPICALLY-LABELED MATERIALS IN THE EYE.

F1A591 ABSORBED DOSE NEAR AN INTERFACE OF TWO DIFFERENT MATERIALS.

F1A593 CAVITY IONIZATION AND THE BRAGG-GRAY PRINCIPLE.

F1A594 DEVELOPMENT OF SPHERICAL COUNTERS FOR THE MEASUREMENT OF LOCAL ENERGY DENSITY IN IRRADIATED TISSUES.

F2A592 DEVELOPMENT OF TISSUE EQUIVALENT IONIZATION CHAMBERS FOR PURPOSES OF RADIOBIOLOGY AND RADIATION PROTECTION.

Columbia Univ., Palisades, N. Y.  
Lamont Geological Observatory

E2C566 CO<sub>2</sub> EXCHANGE BETWEEN THE ATMOSPHERE AND OCEANS.

E2C577 MIXING, DIFFUSION AND CIRCULATION RATES IN OCEAN WATERS.

Connecticut. Agricultural Experiment Station, New Haven.

E1B144 FIXATION OF CESIUM-137 BY SOIL CLAYS.

Connecticut. Univ., Storrs

A1A300 A COMPARATIVE STUDY OF THE EFFECTS OF RADIATION ON PROTOZOA AND MAMMALS.

E1B143 ION INTERACTIONS IN PLANT TISSUES.

E2A128 RADIOACTIVE ZINC-65 IN MARINE ORGANISMS IN FISHERS ISLAND SOUND AND ITS ESTUARIES.

Dartmouth Coll., Hanover, N. H.

E2A138 THE EFFECTS OF TRITIUM OXIDE ON AQUATIC ORGANISMS.

E2B71 RADIATION DOSIMETRY OF GEOLOGIC ENVIRONMENTS.

Continental Electronics Corp.,  
Columbus, Ohio

Dartmouth Coll., Hanover, N. H.  
Dartmouth Medical School

F2B435 HIGH SENSITIVITY FAST NEUTRON DOSIMETER.

D1A598 STRUCTURE AND ACTIVITY OF THE PHOTOCHEMICAL APPARATUS IN PHOTOSYNTHETIC BACTERIA.

Cornell Univ., Ithaca, N. Y.

Del Electronics Corp., Mount  
Vernon, N. Y.

B1D491 THE INVESTIGATION OF THE GENETIC STRUCTURE OF POPULATIONS.

E3A530 RESEARCH AND DEVELOPMENT ON AN ELECTROSTATIC STRATOSPHERIC DUST SAMPLER.

E1B66 THE LOSS OF ORGANIC AND INORGANIC MATERIALS FROM ABOVE-GROUND PLANT PARTS WITH ESPECIAL REFERENCE TO DECONTAMINATION OF PARTS UTILIZED FOR FOOD.

Delaware. Univ., Newark

Creighton Univ., Omaha. School  
of Medicine

D1C500 NUCLEIC ACID AND PROTEIN METABOLISM IN CELLS STUDIED BY TRITIUM AND OTHER ISOTOPICALLY LABELED PRECURSORS AND AUTORADIOGRAPHY.

D1E92 Ca-45 AND Sr-85 METABOLISM IN MAN.

Department of Agriculture. Agricultural Research Service, Beltsville, Md.

B1F485 UTILIZATION OF MUTAGENS TO INVESTIGATE THE GENETICS OF BARLEY, *HORDEUM VULGARE*, THE FUNGUS *ERYSIPHE GRAMINIS* F. SP. *HORDEI*, AND THEIR INTER-RELATIONSHIPS.

C1C483 REMOVAL OF RADIOACTIVE CONTAMINATION FROM MILK.

E1B524 EQUIPMENT AND METHODS FOR DECONTAMINATION OF AGRICULTURAL LANDS CONTAMINATED BY RADIOACTIVE FALLOUT.

Department of Agriculture. Agricultural Research Service. Soil and Water Conservation Research Div., Beltsville, Md.

E1B50 ACCUMULATION AND MOVEMENT OF FISSION PRODUCTS IN SOILS AND PLANTS.

Department of Agriculture. Soil Survey Labs., Beltsville, Md.

E3D208 COLLECTION AND PREPARATION OF SAMPLES OF SOILS, PLANTS AND ANIMALS FOR CALCIUM AND STRONTIUM ANALYSES.

Department of Agriculture. Southwestern Irrigation Field Station, Brawley, Calif.

K1B484 THE UTILIZATION OF IONIZING RADIATION FOR CHROMATIN MANIPULATION. I. THE PRODUCTION OF TRANSLOCATIONS AND USEFUL MUTATIONS IN FLAX (LINUM USITATISSIMUM).

Duke Univ., Durham, N. C.

D1D471 STUDIES ON THE EFFECTS OF RADIATION ON MUCOSAL AND FOETAL BRAIN ENZYMES AND RADIATION RECOVERY STUDIES ON SINGLE CELLS.

E1B3 THE PATH OF RADIAL MOVEMENT OF MINERALS FROM SOIL TO XYLEM IN ROOTS.

Duke Univ. Durham, N. C. School of Forestry.

K1B109 DETERMINATION OF THE EXTENT OF ROOT DISTRIBUTION BY THE USE OF RADIO-TRACER TECHNIQUES.

D'Youville Coll., Buffalo

D1B345 THE EFFECTS OF X-IRRADIATION ON THE FREE  $\alpha$ -AMINO NITROGEN FRACTION OF THE MEAL WORM, TENEBRIO MOLITOR, OVA.



Eltex Research Corp., Lincoln,  
R. I.

C1C354 THE DEVELOPMENT OF ORGANIC CHE-  
LATING AGENTS FOR ENHANCING THE URINARY  
EXCRETION OF RADIOSTRONTIUM.

Emory Univ., Atlanta.

B1A253 RADIATION RECOVERY AND CELL  
METABOLISM.

D1D374 EFFECTS OF X-IRRADIATION ON  
MUSCLE MEMBRANE.

E1A4 EFFECTS OF RADIATION ON PLANT  
AND ANIMAL COMMUNITIES IN NORTHERN  
GEORGIA.

Fish and Wildlife Service. Bio-  
logical Lab., Brunswick, Ga.

E2D96 BIOLOGICAL-STATISTICAL CENSUS  
OF THE SPECIES ENTERING FISHERIES IN THE  
CAPE CANAVERAL AREA.

Fish and Wildlife Service. Explor-  
atory Fishing and Gear Research  
Base, Seattle

E2A332 DEEP-WATER MARINE INVESTIGATIONS.  
BUREAU-A.E.C. COOPERATIVE STUDY OF THE  
MARINE FISH FAUNA OFF THE MOUTH OF THE  
COLUMBIA RIVER.

Fish and Wildlife Service. Radiobio-  
logical Lab., Beaufort, N. C.

E2A333 CYCLING OF RADIONUCLIDES AND  
THEIR EFFECTS UPON ORGANISMS IN THE MA-  
RINE ENVIRONMENT.

Fish and Wildlife Service. Tech-  
nological Lab., Gloucester, Mass.

L-331 LOW LEVEL RADIATION PRESERVA-  
TION OF FISHERY PRODUCTS.

Florida. Agricultural Experiment  
Station, Gainesville.

B1A258 A CYTOLOGICAL STUDY OF RADIA-  
TION INDUCED ALTERATIONS IN CYTOPLASMIC  
FACTORS CONTROLLING MALE STERILITY IN  
CORN.

B1F260 MUTATION RESEARCH WITH GAMMA  
RADIATION AT A SPECIFIC LOCUS IN A HIGHER  
PLANT.

D1B259 METABOLISM OF MOLECULAR OXYGEN  
BY PLANTS.

E1B5 THE EFFECTS OF GAMMA RADIATION  
ON SOIL MICRO-ORGANISMS AND THEIR META-  
BOLIC PROCESSES.

Florida State Univ., Tallahassee.

A1F11 A STUDY OF THE USES OF X RAYS AS  
MOTIVATING STIMULI.

B1B254 THE MOLECULAR BASIS OF FORWARD  
AND BACK MUTATION.

B1D255 A STUDY OF GENE AND CHROMOSOME  
CHANGES INDUCED BY IONIZING RADIATIONS IN  
DROSOPHILA MELANOGASTER.

D1A261 RESEARCH IN PHOTOSYNTHESIS.

D1A516 RESEARCH PROGRAM IN MOLECULAR  
BIOPHYSICS.

D1C256 IDENTIFICATION OF THE SITE RE-  
SPONSIBLE FOR RADIATION-INDUCED MITOTIC  
DELAY.

Florida Univ., Gainesville.

B1A406 STUDIES OF THE EFFECT OF IONIZING  
RADIATIONS ON THE PROCESSES OF CELLULAR  
PROLIFERATION, MEGASPOROGENESIS, AND  
EMBRYO-SAC DEVELOPMENT.

D1A257 RADIATION AFTER-EFFECT AND LONG-  
LIVED FREE RADICALS IN SEEDS.

E1C110 RATES, AMOUNTS, NUCLIDE ORIGIN  
AND EFFECTS OF RADIATION ACQUIRED BY  
FRESH-WATER AND SALT-WATER MICRO-  
ORGANISMS UNDER EXPERIMENTAL CONTROL.

Florida. Univ., Gainesville.  
J. Hillis Miller Health Center

B1A383 EVALUATION OF FOUR CHEMICAL  
MUTAGENS FOR EFFECTIVENESS IN PRODUCING  
CHROMOSOMAL ABERRATIONS IN MOUSE LIVER.

Fundación Luis Roche. Instituto  
Venezolano de Investigaciones  
Científicas, Caracas.

K1A581 RADIOISOTOPE STUDY OF INTESTINAL  
ABSORPTION IN HOOKWORM INFECTED PATIENTS.

General Mills, Inc. Aerospace  
Research Dept., St. Paul.

E3A77 PARTICLE COLLECTION STUDY.

General Motors Corp. Defense Re-  
search Labs., Santa Barbara, Calif.

E2C173 A SURVEY OF THE OCEANOGRAPHIC  
LITERATURE OF THE SANTA BARBARA CHANNEL  
AREA.

Georgia. Univ., Athens.

A1F12 EFFECT OF IONIZING RADIATION ON  
CONDITIONING.

D1A263 MECHANISM STUDIES ON BIOLUMI-  
NESCENT REACTIONS WITH EMPHASIS ON EN-  
ERGY TRANSFER PROBLEMS.

D1A265 AN INVESTIGATION OF CHEMILUMI-  
NESCENT COMPOUNDS AS RADICAL DETECTORS.

E1A6 A STUDY OF GENETIC VARIANCES AND  
COVARIANCES IN A NATURAL BREEDING POPU-  
LATION OF PEROMYSCUS POLIONOTUS AND THE  
EFFECT OF RADIATION ON THESE GENETIC  
PARAMETERS.

K1C264 THE ROLE OF MINERAL ELEMENTS IN  
POULTRY NUTRITION.

Georgia. Univ., Athens. Inst. of  
Radiation Ecology.

E1A17 ECOLOGICAL AND RADIOECOLOGICAL  
INVESTIGATIONS AT THE SAVANNAH RIVER  
PLANT.

Georgia. Univ., Athens. School  
of Forestry

E1A78 THE EFFECT OF WHOLE BODY AND  
GONADAL IRRADIATION ON REPRODUCTION  
AND SURVIVAL IN FERAL POPULATIONS OF  
SMALL MAMMALS.

E1A79 AN EVALUATION OF THE EFFECTS OF  
HIGH LEVEL RADIATION ON THE ANATOMY OF  
LIVING TREES.

E1A80 RADIATION AND POPULATION STUD-  
IES ON A LARGE PREDATOR (LYNX RUFUS) ON  
THE SAVANNAH RIVER PROJECT.

Georgia. Univ., Tifton. Georgia  
Coastal Plain Experiment Station

B1F262 GENETIC AND CYTOGENETIC ANALYSIS  
OF THE EFFECTS OF RECURRENT IRRADIATION  
AND CHEMICAL MUTAGENS ON SPECIFIC AND  
GENERAL COMBINING IN PEARL MILLET (PEN-  
NISETUM GLAUCUM).

Harvard Univ., Boston

D1B515 MECHANISMS OF PROTEIN AND NUCLEIC ACID SYNTHESIS, AND THEIR POSSIBLE RELATIONSHIP TO RADIATION DAMAGE.

Harvard Univ., Boston. Massachusetts Eye and Ear Infirmary

D1B321 CARBOHYDRATE METABOLISM OF OCULAR TISSUES.

Harvard Univ., Boston. School of Public Health.

C1C454 RESPIRATORY PROTECTIVE EQUIPMENT.

Harvard Univ., Cambridge, Mass.

D1D320 PERMEABILITY OF MEMBRANES.

D1E498 METABOLISM OF ALKALINE EARTH METALS.

Hawaii. Univ., Honolulu.

B1A24 RADIOBIOLOGICAL STUDIES OF POLLEN CELL ELONGATION AND POLLEN CYTOGENETICS.

E2A35 A STUDY OF THE EFFECTS OF IONIZING RADIATION UPON DEVELOPING SEA URCHINS.

E2A120 ENIWETOK MARINE BIOLOGICAL LABORATORY.

Hawaii. Univ., Honolulu. Hawaii Marine Lab.

E2A121 AN INVESTIGATION OF THE POSSIBLE EFFECTS OF INGESTION OF RADIOACTIVE FISH AND THE NATURE AND BIOLOGY OF TOXINS FOUND IN CERTAIN FISHES.

Hazleton-Nuclear Science Corp., Palo Alto, Calif.

E3B70 METEOROLOGICAL EVALUATION OF RADIOACTIVE FALLOUT.

Hebrew Univ., Jerusalem.

D1A407 A STUDY OF LIQUIDS UNDER OPTICAL AND IONIZING EXCITATION WITH EMPHASIS ON EXCITATION IN THE VACUUM ULTRAVIOLET.

Houston, Tex. Univ.

D1C339 AN INVESTIGATION OF AMINO ACID INCORPORATION INTO PROTEIN IN CELL FREE PREPARATIONS FROM LEAVES AND SEEDS DURING DEVELOPMENT AND AGING.

Howard Univ., Washington, D. C.

D1A497 KINETIC AND MASS SPECTROMETRIC STUDIES OF BIOPHYSICAL SYSTEMS WITH RADIOACTIVE AND STABLE ISOTOPES.

Howard Univ., Washington, D. C. Coll.  
of Medicine

D1A584 CHEMICAL EFFECTS OF IONIZING RADIATIONS ON THE INDIVIDUAL AMINO ACIDS WITHIN INTACT AND PURE PROTEIN MOLECULES.

Humboldt State Coll., Arcata, Calif.

E2C84 THE CIRCULATION, WATER QUALITY, AND SEDIMENTATION OF HUMBOLDT BAY, CALIFORNIA.

Illinois. State Water Survey, Urbana.

E3B158 STUDY OF RAIN-OUT OF RADIOACTIVITY IN ILLINOIS.

Illinois. Univ., Urbana

B1F540 ERYTHROCYTE AUTOMOSAICISM.

D1B444 MECHANISM OF BIOCATALYSIS AND OF METABOLIC CONTROL.

D1D182 RECOVERY FROM RADIATION-INDUCED DIVISION BLOCK IN PROTISTS.

D1D358 THE ROLE OF RIBONUCLEIC ACID IN THE ACCUMULATION OF IONS BY PLANT CELLS.

D1D442 THE ROLE OF RIBONUCLEIC ACID IN  
THE ACCUMULATION OF IONS BY PLANT CELLS.

Indiana. Univ. Foundation Re-  
search Div. Bloomington

E1C398 THE FATE OF IRON AND ZINC IN NATU-  
RAL SURFACE WATERS.

D1C183 COMBINATION OF ANTIGENS AND  
ANTIBODIES. BIOSYNTHESIS AND SPECIFICITY  
OF NORMAL AND IMMUNE PROTEINS.

J1D239 EXPERIMENTAL RESEARCH ON  
SYNTHESIS OF BORON-CONTAINING DYES.

Indiana. Univ., Indianapolis.  
Medical Center

K1A238 WHOLE BODY COUNTER STUDIES.

D1D184 THE RELATIONSHIP OF VIRUSES TO  
IRRADIATION-INDUCED TUMORS.

Indiana. Univ., Bloomington

Indiana. Univ., Indianapolis. School  
of Medicine

B1B185 CELLULAR HEREDITY IN PARAME-  
CIUM.

C1A513 HYPOXIA AND PARAAMIPROPIOPHE-  
NONE AS RADIOPROTECTIVE AGENTS.

Indiana. Univ., Foundation.  
Bloomington

D1C432 CONTROL OF THE BIOSYNTHESIS OF  
ALKALINE PHOSPHATASE.

B1F359 THE INFLUENCE OF RADIATION IN  
ALTERING THE INCIDENCE OF MUTATIONS IN  
DROSOPHILA.

Institut Pasteur, Paris (France)

B1B346 (1) STUDY OF THE MECHANISM OF  
ACTION OF IONIZING RADIATIONS ON THE  
GENETIC MATERIAL OF E. COLI K 12. (2) A  
MUTATION OF YEAST RESISTANT TO IONIZING  
RADIATIONS.

Institute for Cancer Research, Philadelphia

International Atomic Energy Agency,  
Vienna

B1E301 MODIFICATION OF GENETIC DAMAGE  
PRODUCED BY IONIZING RADIATION.

A2A457 DOSIMETRY IN HUMAN RADIOEPI-  
DEMIOLGY, WITH SPECIAL REFERENCE TO  
SKELETAL DOSE RATES IN THOROTRAST CASES.

D1D562 STUDIES OF THE EFFECTS OF ULTRA-  
VIOLET RADIATION ON CELL STRUCTURE AND  
BEHAVIOR.

E3A408 THE MEASUREMENT OF HYDROGEN  
AND OXYGEN ISOTOPES IN NATURAL WATERS  
AND ITS APPLICATION TO METEOROLOGY AND  
HYDROLOGY.

Inter-American Inst. of Agricultural  
Sciences, Turrialba, Costa Rica

Iowa. State Univ., Iowa City

K1B391 THE APPLICATION OF NUCLEAR EN-  
ERGY TO AGRICULTURE IN LATIN AMERICA.

A2A154 RADIOIODINE STUDIES OF FETAL AND  
OTHER THYROIDS.

International Atomic Energy Agency.  
Pavia, Italy. Università.

G1B115 COMPARATIVE TOXICITY OF STABLE  
RARE EARTH COMPOUNDS.

B1D509 INVESTIGATIONS ON MUTABILITY OF  
POLYGENES AND ON UTILIZATION OF INDUCED  
GENETIC VARIABILITY.

Iowa State Univ., Iowa City. Radia-  
tion Research Lab.

International Atomic Energy Agency,  
Trieste. Università.

A1H153 A COMPARISON OF THE CYTOLOGI-  
CAL EFFECTS PRODUCED BY IONIZING RADIA-  
TIONS OF DIFFERENT L.E.T.

D1C517 STUDY AND COMPARISON BETWEEN  
NECROLYTIC AND RADIOLYTIC LESIONS AT THE  
MITOCHONDRIAL LEVEL (LYSOSOMES) IN ASEPTI-  
CAL PERFUSED BEEF HEART MUSCLE.

Iowa State Univ. of Science and Tech.,  
Ames

B1C186 A QUANTITATIVE STUDY OF LIFETIME SICKNESS AND MORTALITY AND PROGENY EFFECTS RESULTING FROM EXPOSURE OF ANIMALS TO PENETRATING IRRADIATION.

B1C329 GENETIC EFFECTS OF IRRADIATING SWINE.

D1C187 EFFECT OF GAMMA RADIATION ON BIOLOGICAL PROPERTIES RELATED TO STRUCTURE OF SELECTED ANIMAL VIRUSES.

E1B436 MISCIBLE DISPLACEMENT OF TAGGED NITROGEN AND PHOSPHORUS IN SATURATED AND UNSATURATED POROUS MATERIAL.

Iowa State Univ. of Science and Tech.,  
Ames. Inst. for Atomic Research

D1E360 THE CHEMISTRY OF BORON IN PLANTS.

Isotopes, Inc., Westwood, N. J.

E3B532 RESEARCH ON RADIOACTIVE FALLOUT DEPOSITION.

E3C531 SAMPLING AND ANALYSIS OF FRESH NUCLEAR DEBRIS.

Jefferson Medical Coll., Philadelphia.

A1E599 FRACTIONATION OF THE CELLULAR ELEMENTS OF BONE MARROW AND OTHER HEMATOPOIETIC TISSUES IN AN ATTEMPT TO AVOID HOMOLOGOUS DISEASE AND AID THE ACCEPTANCE OF HOMOLOGOUS TISSUE GRAFTS.

A1J101 THE EFFECT OF EMBRYONIC IRRADIATION ON ADULT LIFE EXPECTANCY AND ADULT PATHOLOGY.

C1B409 REDUCTION OF POST-IRRADIATION INFECTIONS BY REPLACEMENT OF THE NORMAL ENTERIC FLORA AND BY SPECIFIC IMMUNIZATION.

C1B490 TRANSPLANTATION OF PRESERVED MARROW BETWEEN ANIMALS AND FROM ONE HUMAN BEING INTO ANOTHER.

G1B489 METABOLIC AND CYTOLOGIC CHANGE INDUCED BY METALLIC CARBONYLS.

Johns Hopkins Univ., Baltimore

B1A508 MODIFICATION BY SUPPLEMENTARY AGENTS OF THE RATES OF INDUCED CHROMOSOME AND GENE CHANGES.



B1A543 THE ACTION OF RADIATION AND OTHER MUTAGENIC AGENTS (1) IN INDUCING MUTATION IN DROSOPHILA FEMALES, AND (2) IN CONTROLLING THE ACTION OF SPECIFIC SUPPRESSOR GENES.

Johns Hopkins Univ., Baltimore.  
School of Engineering

B1C544 THE EFFECTS OF IONIZING RADIATIONS ON GENE AND CHROMOSOME MUTATION RATES IN NORMAL HUMAN CELLS IN TISSUE CULTURE.

E1C546 SILT ADSORPTION OF RADIOACTIVE ZINC AND IRON.

D1A431 STUDIES ON BIOLUMINESCENCE AND ENERGY TRANSFER MECHANISMS.

Johns Hopkins Univ., Baltimore.  
School of Hygiene

D1B499 PATHWAYS OF METABOLISM IN EMBRYONIC DEVELOPMENT.

D1B519 STUDIES OF VITAMIN B-12 ABSORPTION.

D1C413 THE ORGANIZATION OF BACTERIOPHAGE DNA.

D1D518 ENDOCRINE GLANDS AND ABSORPTION OF Fe, Ca, AND Sr.

D1E411 CELL MEMBRANE PERMEABILITY AND ACCUMULATION OF IONS.

Johns Hopkins Univ., Baltimore.  
School of Hygiene and Public Health

E3A410 FUNDAMENTAL INVESTIGATIONS OF THE BEHAVIOR OF AEROSOLS.

B1A412 GENETIC EFFECTS OF IRRADIATION ON CERTAIN PARASITIC HELMINTHS.

Johns Hopkins Univ., Baltimore.  
McCullum-Pratt Inst.

D1A414 CHEMICAL STUDIES ON THE EFFECT OF ULTRAVIOLET IRRADIATION OF NUCLEIC ACIDS AND RELATED COMPOUNDS.

D1A520 A STUDY OF BIOLUMINESCENT MATERIALS.

D1C542 A. THE TRANSFORMATION OF E. COLI B FROM VIRUS SENSITIVE TO VIRUS RESISTANT OR VICE VERSA. B. CHEMICAL AND NUTRITIONAL STUDIES OF BACTERIAL VIRUSES.

Johns Hopkins Univ., Baltimore.  
School of Medicine

A1E550 BLOOD COAGULATION, HEMOR-  
RHAGIC DISEASE.

Kaiser Foundation Research Inst.,  
Richmond, Calif.

D1A334 ENERGY TRANSFER IN PHOTOCHEMI-  
CAL REACTIONS.

Kansas State Univ., Manhattan

K1B361 CARBON-14 DIOXIDE FIXATION BY  
LUPINUS LUTEUS POLLEN.

K1C548 X-RADIATION EFFECTS ON THE BIOL-  
OGY OF HETERAKIS GALLINARUM, CECAL WORM  
OF FOWL, AND A PATHOGENIC PROTOZOAN, HIS-  
TOMONAS MELEAGRIS.

Kansas. Univ., Kansas City.  
School of Medicine.

A1K240 A PILOT STUDY TO INVESTIGATE THE  
EFFECTS OF X-IRRADIATION ON THE COURSE  
OF PATHOGENESIS OF VIRAL DISEASES, AS  
STUDIED BY IMMUNOFLUORESCENCE.

Kansas. Univ., Lawrence

A1A241 IMMUNOCHEMICAL STUDIES OF  
RADIATION-INDUCED DAMAGE TO BIOLOGICAL  
SYSTEMS.

Kentucky. Univ., Lexington. Agri-  
cultural Experiment Station.

E1B89 EFFECT OF CALCIUM LEVEL AND  
PLACEMENT IN THE SOIL ON ITS UPTAKE BY  
PLANTS AND ON THE SOURCE OF THE CALCIUM  
TAKEN UP BY PLANTS.

Knoxville Coll., Tenn.

A1A342 NITROGEN BALANCE, O<sub>2</sub> CONSUMP-  
TION, AND CO<sub>2</sub> PRODUCTION IN MICE GIVEN  
FOREIGN BONE MARROW.

Kresge Eye Inst., Detroit.

A1H114 EFFECT OF NEUTRONS AND OTHER  
RADIATIONS ON OCULAR LENS.

Linfield Coll., McMinnville, Ore.  
Linfield Research Inst.

K1A336 "RESEARCH AND DEVELOPMENT OF A  
HIGH-INTENSITY PULSED X-RAY SYSTEM FOR  
BIOLOGICAL STUDIES."

Loma Linda Univ., Los Angeles.

A1A90 IRRADIATION AND INFLUENZA INFEC-  
TIONS IN MICE: CONSEQUENCES OF THE DUAL  
ACTION.

Loma Linda Univ., Los Angeles.  
School of Medicine.

C1B335 A STUDY OF LEUKOPOIETIC FACTORS  
IN BLOOD.

London. Royal Cancer Hospital.  
Inst. of Cancer Research

K1A582 TISSUE THERAPY AFTER IRRADIATION.

Longwood Coll., Farmville, Va.

B1B266 CYTOLOGICAL, PHYSIOLOGICAL AND  
GENETIC STUDIES OF CERTAIN STRAINS OF  
TETRAHYMENA PYRIFORMIS.

Louisiana State Univ., Baton  
Rouge.

D1A375 A PHYSICO CHEMICAL INVESTIGATION  
OF SOME AREAS OF FUNDAMENTAL SIGNIFICANCE  
TO BIOPHYSICS.

Louisville, Ky. Univ.

C1A384 DERIVATIVES OF SOME FIVE-  
MEMBERED HETEROCYCLES AS POSSIBLE  
PROTECTIVE AGENTS AGAINST IONIZING RADI-  
ATIONS.

E1C108 A RADIOLOGICAL STUDY OF THE  
BIOTA OF DOE RUN, MEADE COUNTY, KENTUCKY.

Lovelace Foundation for Medical  
Education and Research, Albu-  
querque, N. Mex.

A2A168 THE BIOLOGICAL EFFECTS OF EX-  
POSURE TO FISSION PRODUCTS.

H174 "SELECTED ASPECTS OF WEAPONS EFFECTS."

Loyola Univ., Chicago

D1B372 THE EFFECT OF PARATHYROID HORMONE ON CARBOHYDRATE METABOLISM.

Loyola Univ., Chicago. Stritch School of Medicine

D1E68 "METABOLISM AND REMOVAL OF Sr-90 IN MAN."

Marine Biological Lab., Woods Hole, Mass.

D1D488 STUDIES ON THE PHYSIOLOGY OF MARINE ORGANISMS USING RADIO ISOTOPES.

Marquette Univ., Milwaukee. School of Medicine

A1A547 RELATION OF RICKETTSIAL AND VIRAL INFECTIONS TO RADIATION INJURY.

D1B438 NUCLEOLYTIC ENZYME.

Mary Imogene Bassett Hospital, Cooperstown, N. Y.

C1B355 THE COLLECTION, STORAGE AND FATE FOLLOWING TRANSFUSION OF HEMOPOIETIC CELLS.

Maryland. Univ., Baltimore. School of Medicine

D1D347 ACTIVE TRANSPORT OF IONS IN NITELLA.

Massachusetts General Hospital, Boston

A1F132 EFFECTS OF IONIZING RADIATION ON NERVE CELL ULTRASTRUCTURE. (Studies of the effects of ionizing radiation on the ultrastructure of developing nervous tissue as revealed by electron microscopy).

A1H502 EFFECTS OF RADIOACTIVE IODINE ON BIOLOGY OF THE THYROID GLAND.

A2B558 MECHANISM OF DESTRUCTION OF BONE.

C1B322 THE STUDY OF ANOMALIES OF HUMAN CHROMOSOMES ASSOCIATED WITH IRRADIATION, LEUKEMIA AND CONGENITAL DEFECTS.

Massachusetts Inst. of Tech., Cambridge. Radioactivity Center.

J1D323 EXTERNAL LOCALIZATION OF BRAIN TUMORS EMPLOYING POSITRON-EMITTING ISOTOPES.

A2A452 RADIUM AND MESOTHORIUM POISONING AND DOSIMETRY AND INSTRUMENTATION TECHNIQUES IN APPLIED RADIOACTIVITY.

J1D415 THE USE OF THERMAL AND EPITHERMAL NEUTRONS IN THE TREATMENT OF NEOPLASMS.

Massachusetts Univ., Amherst

Massachusetts Inst. of Tech.,  
Cambridge

B1B392 BIOCHEMICAL MUTANTS OF HIGHER PLANTS.

A1F131 AUTORADIOGRAPHIC INVESTIGATION OF BRAIN METABOLISM UNDER NORMAL, EXPERIMENTAL AND PATHOLOGICAL CONDITIONS.

Max-Planck-Institut für Züchtungsforschung, Cologne

G1B575 BERYLLIUM CASE REGISTRY.

B1F574 DEVELOPMENT OF SELECTION METHODS FOR INDUCED SMALL MUTATIONS IN HIGHER PLANTS (WITH SPECIAL REGARD TO MUTATIONS OF YIELDING CAPACITY).

Massachusetts Inst. of Tech., Cambridge. Dept. of Meteorology.

Medical Coll. of Virginia, Richmond

E3B560 PLANETARY TRANSPORT PROCESSES IN THE STRATOSPHERE.

A1F64 ACUTE BRAIN DAMAGE INDUCED BY X-IRRADIATION.

A1H416 "A STUDY OF THE COMPARATIVE EFFECTS OF IONIZING RADIATION AND AGING ON THE MAMMALIAN LENS OF THE EYE."

C1B467 THE HOMOTRANSPLANTATION OF  
FETAL BLOOD CELLS AND TISSUES IN ANIMALS  
RECEIVING WHOLE BODY RADIATION.

Miami, Fla. Univ. Marine Lab.

Meharry Medical Coll., Nashville.

E2B107 THE GEOCHEMISTRY OF RADIOACTIVE  
ELEMENTS IN THE MARINE ENVIRONMENT.

J1B417 DEVELOPMENT IN EXPERIMENTAL ANI-  
MALS OF NEW METHODS FOR RADIOISOTOPES  
APPLICATION IN CAVITARY CARCINOSIS AND IN  
PARTICULAR AGAINST TRANSCOELOMIC METAS-  
TASES.

Miami Valley Hospital, Dayton, Ohio

Meteorology Research, Inc., Alta-  
dena, Calif.

J1B399 THE POTENTIAL OF P-32-LABELED  
POLYPHOSPHATES IN THE THERAPY OF CANCER.

E3B83 TURBULENCE FORECASTING STUDY.

Michigan State Univ., East Lansing.

Miami, Fla. Univ. Coral Gables  
School of Medicine

B1F189 BASIC FERTILIZATION PHENOMENA  
AND GAMETIC LETHALITY IN DROSOPHILA.

A2B466 A STUDY OF FACTORS CONCERNED  
IN THE UPTAKE, PHYSIOLOGY AND RETENTION  
OF Zn-65 IN THE MALE REPRODUCTIVE SYSTEM  
OF THE RAT.

D1A448 PHYSICAL MECHANISMS IN THE INAC-  
TIVATION OF PROTEINS BY RADIATION.

Miami, Fla., Univ. Inst. of Marine  
Science.

D1B188 AN INVESTIGATION OF THE BIOSYN-  
THESIS OF ORGANO SULFUR COMPOUNDS IN  
PLANTS.

E2A94 UPTAKE OF RADIONUCLIDES BY MA-  
RINE FUNGI.

D1B440 TRACER STUDIES OF CARBOHYDRATE  
INTERCONVERSIONS BY MICROBIAL ENZYMES.

E1B164 MECHANISMS OF UPTAKE OF IONS BY ABOVE GROUND PLANT PARTS AND THEIR SUBSEQUENT TRANSPORT AND REDISTRIBUTION WITHIN THE PLANT.

E1C118 STUDY OF PRODUCTIVITY IN A STREAM ECOSYSTEM USING A RADIOACTIVE TRACER.

Michigan. Univ., Ann Arbor.

A1A243 EFFECT OF IRRADIATION ON THE LOCALIZING RESPONSE (TO ANTIGEN) OF DIFFERENT TISSUES IN IMMUNITY.

A1F446 "BRAIN FUNCTION, BEHAVIOR AND IRRADIATION."

A1F503 THE EFFECTS OF IONIZING RADIATION AND RELATED FACTORS ON THE DEVELOPING AND ADULT NERVOUS SYSTEM.

B1C194 STUDIES ON HUMAN POPULATION GENETICS.

B1D193 STUDIES ON CONSANGUINITY EFFECTS.

D1A192 LEARNING AND REGENERATION IN PLANARIA.

D1A451 EFFECTS OF MONOENERGETIC SOFT X-RAYS.

D1D191 EFFECTS OF IONIZING RADIATION ON SUBMICROSCOPIC STRUCTURE AND RESULTING ALTERATIONS IN METABOLIC FUNCTION.

E1C165 FATES AND EFFECTS OF RADIOISOTOPES IN AQUATIC FOOD CHAINS.

E3B157 RAIN SCAVENGING OF PARTICULATE MATTER FROM THE ATMOSPHERE.

J1C244 CLINICAL EVALUATION OF CESIUM-137 TELETHERAPY.

K1A242 DEVELOPMENT OF SCINTILLATION SCANNING OF THE MYOCARDIUM AND PANCREAS.

L-190 A STUDY OF THE EFFECT OF IONIZING RADIATION ON RESISTANCE, GERMINATION AND TOXIN SYNTHESIS OF CLOSTRIDIUM BOTULINUM SPORES, TYPES A, B AND E.

Michigan Univ., Ann Arbor. Medical School.

A2B450 EFFECT OF I-131 ON THE FETUS.

Milan. Università.

D1D602 EFFECT OF IONIZING RADIATIONS ON THE CONTROL MECHANISMS OF LIPID TRANSPORT.

Milan. Università. Istituto di Patologia Generale.

D1A430 ENERGETICS TRANSFER IN THE PHOTODYNAMIC REACTION.

Minnesota. Univ., Minneapolis.

C1C195 PHYSIOLOGICAL SITES OF DISCRIMINATION BETWEEN STRONTIUM AND CALCIUM AND REMOVAL OF STRONTIUM RADIOISOTOPES FROM MILK.

D1A196 A PHYSIOCHEMICAL APPROACH TO THE STUDY OF THE PRIMARY ACTS IN PHOTOBIOLOGICAL PROCESSES.

D1A198 ENERGY TRANSFER AND UTILIZATION IN THE PHOTOSYNTHETIC PROCESS.

D1D197 MECHANISMS OF LETHAL RADIATION DAMAGE AND RECOVERY IN ALGAL FLAGELLATES.

D1D246 A COMBINED IN VITRO RADIOAUTOGRAFIC, RADIOANALYTIC AND HISTOCHEMICAL STUDY OF SYNTHETIC PATTERNS IN NORMAL, BENIGN PROLIFERATIVE AND MALIGNANT TISSUES.

J1B245 DEVISING TECHNIQUES UTILIZING THE DIFFERENTIAL UPTAKE OF RADIOACTIVE PHOSPHORUS FOR IN VIVO DETECTION OF OCCULT OR SILENT GASTRIC CANCER AND FOR MULTIPLE ORGAN SCRUTINY.

K1A400 "ACTIVATION ANALYSIS: A NEW STABLE ISOTOPE METHOD FOR HUMAN BIOLOGICAL TRACER STUDIES."

Minnesota. Univ., Minneapolis.  
Museum of Natural History.

E1A72 RADIATION AND OTHER FACTORS INFLUENCING THE DISTRIBUTION OF ANIMALS.

Minnesota. Univ., St. Paul.

B1B199 GENETIC CONTROL OF PHYSIOLOGICAL PROCESSES IN HIGHER PLANTS.

B1F487 THE GENETIC BASIS AND PRACTICAL SIGNIFICANCE OF MUTATIONS INDUCED IN OATS AND BARLEY WITH IONIZING RADIATIONS.



Minnesota. Univ., St. Paul. Coll.  
of Veterinary Medicine.

A1E445 BOVINE LEUKEMIA: STUDIES OF OC-  
CURRENCE AND DISTRIBUTION INCLUDING IN-  
VESTIGATION OF FAMILIAL AND ENVIRONMEN-  
TAL FACTORS WITH SUPPORTING CLINICAL,  
HEMATOLOGIC AND PATHOLOGIC STUDIES.

Minnesota. Univ., St. Paul. Inst. of  
Agriculture

D1C200 INTERACTIONS BETWEEN A NEW  
SULFUR MUSTARD AND E. COLI.

Missouri. Univ., Columbia.

D1D439 THE MECHANISM OF THE ABSORPTION  
OF RADIOISOTOPES BY PLANTS.

E1B163 EFFECT OF SOIL COLLOID, TYPE AND  
GROWTH RATE OF PLANTS ON THE UPTAKE OF  
RADIONUCLIDES BY PLANTS.

K1B247 RADIOACTIVE ISOTOPES STUDIES OF  
BODY COMPOSITION, BODY FUNCTION, SOILS AND  
FOOD SUPPLY.

K1C201 STUDY OF THE INHERITANCE OF  
PRODUCTIVE PROCESSES IN DOMESTIC ANIMALS  
BY ENDOCRINE METHODS USING RADIOACTIVE  
ISOTOPES AS TRACERS.

Montana State Coll., Bozeman.

B1D480 THEORETICAL AND EXPERIMENTAL  
WORK ON THE DYNAMICS OF HOST-PATHOGEN  
SYSTEMS.

B1D510 THEORETICAL AND EXPERIMENTAL  
WORK ON THE DYNAMICS OF HOST-PATHOGEN  
SYSTEMS.

Montana State Univ., Missoula.

A1B473 THE USE OF HYDROGEN ISOTOPES IN  
THE STUDY OF PLANT MORPHOGENESIS.

Montefiore Hospital, Pittsburgh

D1C348 PATHWAYS OF NUCLEIC ACID SYNTHE-  
SIS.

Morehead State Coll., Ky.

E1A81 ECOLOGICAL EFFECTS OF FAST NEU-  
TRONS AND GAMMA RADIATIONS ON DORMANT  
AND PHYSIOLOGICALLY ACTIVE SEED OF TREE  
SPECIES NATIVE TO THE EASTERN DECIDUOUS  
FOREST AREA.

F2C213 INSTRUMENTATION FOR NUCLEAR APPLICATIONS.

Muhlenberg Hospital, Plainfield, N. J.

J1B580 THE LOCALIZATION OF TUMORS WITH LABELED POLYSACCHARIDE ANTIGENS.

F2C214 FAST NEUTRON SPECTROSCOPY.

F2C215 ELECTRON SCATTERING.

National Academy of Sciences.

A1B49 MORTALITY AND MORBIDITY IN RADIOLOGISTS.

F2C365 HIGH TEMPERATURE STRAIN SENSITIVE FILMS.

National Bureau of Standards,  
Washington, D. C.

National Research Council. Inst. of  
Lab. Animal Resources.

F2C209 ASSISTANCE TO THE NATIONAL COMMITTEE ON RADIATION PROTECTION AND MEASUREMENTS.

K1C364 INSTITUTE OF LABORATORY ANIMAL RESOURCES.

F2C210 ENERGY AND ABSORBED DOSE MEASUREMENTS.

Naval Radiological Defense Lab.,  
San Francisco

F2C211 MEASUREMENTS OF LOW-LEVEL RADIOACTIVITY.

E3C216 ANALYSIS AND EVALUATION OF THE BIOLOGICAL AND ENVIRONMENTAL CONSEQUENCES OF NUCLEAR WAR.

F2C212 (F2) EVALUATION AND TESTING OF RADIATION INSTRUMENTS.

C1B557 BONE MARROW PRESERVATION AND  
TRANSPLANTATION.

Naval Research Lab., Washington,  
D. C.

F2A223 RADIATION EFFECTS IN DIELECTRIC  
SOLIDS.

F2B553 DEVELOPMENT OF SMALL IN VIVO  
DETECTORS.

E3A207 80TH MERIDIAN AIR SAMPLING  
PROGRAM.

New England Deaconess Hospital.  
Cancer Research Inst., Boston

Nebraska. Univ., Lincoln.

A1-324 ACUTE AND CHRONIC RADIATION IN-  
JURY.

A1F113 PSYCHOLOGICAL EFFECTS OF CRA-  
NIAL X-IRRADIATION ON PSYCHOLOGICAL  
PROCESSES IN RATS.

New Hampshire. Univ., Durham

Nevada Univ., Reno.

B1D302 RADIATION INDUCED VIABILITY MUTA-  
TIONS IN THE HONEY BEE.

A2B25 PART A. THE RELATION OF FALLOUT  
AND OTHER FACTORS TO PLANT CONTAMINATION  
AND THE ASSIMILATION OF FISSION PRODUCTS.  
PART B. RADIOCHEMICAL ANALYSES ASSO-  
CIATED WITH PART A.

New Jersey State Dept. of Health.  
Radium Research Project, West  
Orange.

New England Center Hospital, Boston

A2A505 EPIDEMIOLOGICAL INVESTIGATION OF  
THE RADIUM DIAL PAINTERS.

C1B551 PHYSIO-PATHOLOGY OF PLATELETS  
AND THE DEVELOPMENT OF PLATELET EX-  
TRACTS.

New Mexico. Univ., Albuquerque

D1A433 MONTE CARLO COMPUTATIONS OF  
TISSUE CELL GROWTH.

F2A169 THE SYNTHESIS AND PROPERTIES OF  
COMPOUNDS WHICH MAY BE USED AS SCINTIL-  
LATORS.

D1D350 A STUDY OF LETHALITY AND PERME-  
ABILITY CHANGES IN IRRADIATED MICROOR-  
GANISMS.

New York Botanical Garden, New  
York

New York. State Univ., New York.  
Downstate Medical Center

D1D349 MECHANISMS OF ACTION OF X-  
IRRADIATION ON PLANTS.

A1E130 ACTION OF TRITIATED TETANUS TOXIN  
AND TOXOID UPON THE ANTIBODY FORMING  
MECHANISM.

New York. State Univ. Brooklyn.  
Downstate Medical Center

New York State Univ. Veterinary  
Coll., Ithaca.

A1A504 ACTION OF TRITIATED TETANUS  
TOXIN AND TOXOID UPON THE ANTIBODY  
FORMING MECHANISM.

A2B390 FISSION PRODUCT METABOLISM AND  
RESPONSE IN LABORATORY AND DOMESTIC ANI-  
MALS AND PLANNING STUDY FOR EVALUATION  
OF RADIOACTIVE CONTAMINATION OF THE FOOD  
CHAIN.

A1H434 RADIOAUTOGRAPHIC, HISTOCHEMICAL,  
AND BIOCHEMICAL STUDIES OF THE EFFECTS  
OF IRRADIATION ON CARTILAGE AND BONE.

New York Univ. New York

New York. State Univ. Buffalo

A2A506 DOSIMETRIC ASPECTS OF THE EPIDE-  
MIOLOGY OF RADIUM POISONING.

A1A351 IONIZING RADIATION AND REGENERA-  
TION IN SALAMANDERS.

F1A486 THE STUDY OF ENVIRONMENTAL RADI-  
ATION.

New York. Univ., New York. Medical  
Center

A1E129 HISTOCHEMICAL AND BIOLOGICAL ALTERATIONS FOLLOWING WHOLE BODY X-IRRADIATION.

A2B460 DISTRIBUTION OF RADIONUCLIDES IN HUMAN TISSUES.

D1D303 EFFECTS OF H-3 THYMIDINE AS A DNA LABEL IN THE RAT LIVER.

E3A418 STATISTICAL ANALYSIS OF ENVIRONMENTAL GAMMA-RAY SCINTILLATION SPECTRA.

J1A597 THE TUMORGENIC ACTION OF BETA RADIATION ON THE RAT SKIN; THE EFFECT OF VARYING THE SIZE AND CONTINUITY OF THE AREA OF THE IRRADIATED SKIN ON THE INCIDENCE OF EPIDERMAL TUMORS.

North Carolina. Agricultural and  
Technical Coll., Greensboro

A1A343 AN INVESTIGATION OF THE THERAPEUTIC POTENTIAL OF HETEROLOGOUS (BEEF) BONE MARROW FOLLOWING RADIATION INJURY IN MICE.

North Carolina State Coll., Raleigh.

B1B376 THE LOCALIZATION, PERSISTENCE AND RESULTANT GENETIC EFFECTS IN INVERTEBRATES OF INGESTED FOURTH PERIOD METALS IN STABLE AND RADIOACTIVE FORMS.

B1D267 RADIATION GENETICS AND RADIATION RESISTANCE IN PEANUTS.

B1D269 POPULATION DYNAMICS IN THE EVOLUTION OF MUTANT GENES.

B1D270 COMBINING ABILITY AND THE EFFECT OF IRRADIATION UPON HETEROSIS AMONG DIVERSE POLYGENIC SYSTEMS IN OATS.

E1B16 THE EFFECTS OF FORM OF NITROGEN ON THE MECHANISMS OF ABSORPTION AND TRANSPORT OF MONO- AND DIVALENT CATIONS, WITH PARTICULAR EMPHASIS ON Cs AND Sr.

E1C106 STUDIES IN THE ECOLOGY OF FRESH-WATER ALGAE IN NORTH CAROLINA.

K1B268 THE NORTHWARD MIGRATION OF CITRUS BY MEANS OF RADIATION-INDUCED MUTATION.

North Carolina. Univ., Chapel Hill.

B1B271 BIOCHEMICAL AND GENETICAL STUDIES ON CHRONIC ANEMICS.

North Dakota. Univ., Grand Forks. School of Medicine.

D1B362 PHOSPHOLIPID AND SULFATIDE METABOLISM.

North Georgia Coll., Dahlonega

E1C74 UPTAKE OF METALLIC IONS BY THE FRESHWATER SNAIL, AUSTRALORBIS GLABRATUS.

North Texas State Univ., Denton

A1F82 EFFECTS OF X-IRRADIATION ON THE NERVOUS SYSTEM.

Northern Illinois Univ., Dekalb

B1B330 STUDIES OF CHEMICAL PROTECTION AGAINST RADIATION INDUCED MUTATIONS.

Northwestern Univ., Chicago. Medical School

A1D401 AN ELECTRON MICROSCOPIC AND AUTORADIOGRAPHIC STUDY OF INTESTINAL RADIATION DEATH IN THE MOUSE.

D1B202 THE EFFECT OF X-IRRADIATION ON CERTAIN ASPECTS OF SALT AND SULFUR METABOLISM IN ADRENALECTOMIZED RATS.

D1D449 A STUDY OF NUCLEOPROTEIN METABOLISM IN NORMAL, DEGENERATING, REGENERATING AND STIMULATED NERVE CELLS WITH RADIOISOTOPIC TRACERS.

J1A249 AN INVESTIGATION OF TUMOR-INDUCTION IN MICE FROM INTRANUCLEAR IRRADIATION WITH THYMIDINE LABELED WITH TRITIUM AND CARBON-14.

Nuclear Science and Engineering Corp., Pittsburgh.

A2A507 SURVEY OF IODINE-129 CONCENTRATIONS IN AND RADIATION DOSAGE TO HUMAN THYROID GLANDS.

E3A533 THE CHEMICAL AND PHYSICAL STATES  
OF FISSION-PRODUCTS IODINE IN FALLOUT.

Ohio. Agricultural Experiment Station,  
Wooster.

E1A117 CONTINUING BIOCLIMATIC AND SOILS  
INVESTIGATIONS IN FOREST ENVIRONMENTS.

E1B145 MAPPING AND FIELD AND LABORA-  
TORY CHARACTERIZATION OF SOILS OF THE  
PROJECT CHARIOT AREA, ALASKA.

Ohio State Univ. Inst. of Polar  
Studies, Columbus

E1A76 SLOPE MOVEMENT AND MICRO-  
ENVIRONMENT AT CAPE THOMPSON, ALASKA.

Ohio State Univ. Research Foundation,  
Columbus.

E1A116 NEW TRACER TECHNIQUES FOR  
EVALUATING THE EFFECTS OF AN INSECTI-  
CIDE ON THE ECOLOGY OF A FOREST FAUNA.

Ohio Univ., Athens

D1C203 THE NATURE OF CHEMICAL BONDING  
IN THE CHROMOSOME.

Oklahoma. Univ., Norman. Re-  
search Inst.

D1D272 AN INVESTIGATION OF PHOTOPRO-  
TECTION AND OTHER VISIBLE LIGHT INDUCED  
EFFECTS IN MICROORGANISMS.

E3B419 SEVERE CONVECTIVE STORMS AND THE  
STRATOSPHERIC SCAVENGING OF RADIOACTIVE  
PARTICLES.

Oklahoma. Univ., Norman. Re-  
search Inst. and Oklahoma. Univ.,  
Norman.

A1A65 A HISTOLOGICAL STUDY OF THE MOR-  
PHOGENESIS OF ANOMALIES INDUCED IN THE  
LIMBS OF CHICK EMBRYOS BY X-RAYS AT DIF-  
FERENT STAGES IN DEVELOPMENT.

Oregon. Fish Commission, Portland

E2D95 THE OFFSHORE-INSHORE EXCHANGE  
OF GROUND FISH STOCKS OFF NORTHERN ORE-  
GON AND SOUTHERN WASHINGTON.

Oregon State Univ., Corvallis

D1B475 RADIOTRACER STUDIES OF BIOSYN-  
THETIC AND RESPIRATORY PATHWAYS.

E1B52 A STUDY OF THE MECHANISM OF  
DIVALENT CATION UPTAKE BY PLANTS.

E1B56 RELATIONSHIP OF SOIL PROPERTIES  
TO CHEMICAL REACTIONS AND OTHER PHE-  
NOMENA INVOLVING SULFUR.

E2A60 ECOLOGICAL AND RADIOLOGICAL  
STUDY OF THE BENTHOS IN THE PACIFIC OCEAN  
OFF OREGON.

E2A61 BASIC FOOD WEB RELATIONSHIPS  
AND ENERGY CONVERSION IN LOWER TROPHIC  
LEVELS IN THE MARINE ENVIRONMENT.

E2A62 RADIOANALYSIS OF OCEANIC ORGAN-  
ISMS IN THE PACIFIC OCEAN OFF OREGON.

E2A63 SPECIES COMPOSITION AND DISTRIBU-  
TION OF MARINE NEKTON IN THE PACIFIC OCEAN  
OFF OREGON.

K1B420 RADIOACTIVE TRACER STUDIES OF  
INTERMEDIARY METABOLISM IN FRUIT.

K1C476 THE STUDY OF NORMAL AND ALTERED  
RUMINANT LIVER METABOLISM UTILIZING RADIO-  
ISOTOPIC TECHNIQUES.

Oregon. Univ., Eugene

A1A421 SOMATIC MUTATIONS AND MORPHO-  
GENETIC EFFECTS OF RADIATION.

A1G221 EFFECTS OF RADIATION ON AGING  
AND REPRODUCTION IN THE FEMALE GOLDEN  
HAMSTER.

Oregon. Univ., Portland. Medical  
School

A1E220 STUDIES OF GENETIC ALTERATIONS  
IN HUMAN CELLS AND MOLECULES AND FAC-  
TORS INFLUENCING THEM.

A1F219 "THE EFFECTS OF IONIZING RADIA-  
TION ON SYNAPTIC ACTIVITY AND SINGLE  
NEURONAL POTENTIALS."

D1C481 EFFECT OF RADIATION UPON MEM-  
BRANE METABOLISM AND ACTIVE TRANSPORT.

J1B368 INTRACELLULAR PICKUP OF RADIO-  
ACTIVE PHOSPHORUS BY PROSTATIC EPITHE-  
LIAL CELLS.



B1D578 INVESTIGATIONS ON MUTABILITY OF  
POLYGENES.

Ottawa. Univ.

D1D396 ALPHARADIOGRAPHY WITH POLONIUM  
AND PLUTONIUM SOURCES.

Pennsylvania State Univ., University  
Park

Palo Alto Medical Research Founda-  
tion, Calif.

B1B305 THE INHERITANCE AND CHARACTER-  
ISTICS OF DIFFERENTIAL ELEMENT ACCUMULA-  
TION BY MAIZE WITH PARTICULAR EMPHASIS ON  
STRONTIUM AND CALCIUM.

D1C86 THE ISOLATION OF MACROMOLECU-  
LAR DEOXYRIBONUCLEIC ACID OF MICROBIAL  
ORIGIN.

D1A521 RADIATION STUDIES ON TRANSFORM-  
ING DNA, ON TNV-RNA AND  $\phi$  X174-DNA.

K1A87 RADIOACTIVE COLLOIDS IN MEDICAL  
RESEARCH.

D1A522 BASIC ASPECTS OF THE ACTION OF  
IONIZING RADIATION ON MICROORGANISMS.

Parma, Italy. Università.

E2A572 ECOLOGY OF ACANTHARIA (RADIO-  
LARIA) IN RELATION TO THE CIRCULATION OF  
Sr IN THE SEA.

D1D304 PATHWAYS OF METABOLISM IN BO-  
VINE GERM CELLS.

Pennsylvania. Univ., Philadelphia

Pavia, Italy, Università Istituto di  
Genetica

B1F496 MUTATION RATES IN MORMONIELLA.

B1C561 MUTABILITY AND MUTATIONAL LOADS  
IN MAN.

K1A422 NEW APPROACHES TO IMAGE FORMA-  
TION IN RADIOISOTOPE SCANNING.

Peter Bent Brigham Hospital, Boston.

E1A112 RADIO-ECOLOGY OF SMALL VERTEBRATE SPECIES UNDER NATURAL ENVIRONMENTS.

C1B325 "A PROGRAM FOR THE STUDY OF TRANSPLANTATION OF BONE MARROW, TISSUES, AND WHOLE ORGANS AND OF RELATED TOPICS IN SURGICAL RESEARCH."

E1A601 STUDIES ON THE PRODUCTIVITY OF VASCULAR HYDROPHYTES AND THEIR ROLE IN MINERAL CYCLING IN AQUATIC ECOSYSTEMS.

Philadelphia General Hospital

Pontificia Universidade Catolica,  
Rio de Janeiro. Instituto de Fisica.

D1B307 THE EFFECT OF X-RAY IRRADIATION ON THE LIPIDS OF THE SKIN.

E3D99 A STUDY OF ARTIFICIAL AND NATURAL CONTAMINATION IN BRAZIL.

D1C306 THE EFFECT OF X-RAY IRRADIATION ON THE DESOXYRIBONUCLEIC ACIDS OF THE SPLEEN AND RADIOSENSITIVE TISSUE.

Presbyterian--St. Luke's Hospital,  
Chicago.

Pisa, Italy. Università. Centro  
di Medicina Nucleare

C1C250 MOBILIZATION OF RADIOACTIVE EMITTERS FROM BONE.

A1E576 STUDY OF THE HEMODYNAMIC CHARACTERISTICS OF THE PULMONARY CIRCULATION AND THE LEFT HEART BY MEANS OF RADIOCARDIOGRAPHY.

Princeton Univ. N. J.

Pittsburgh. Univ.

B1B423 BIOCHEMISTRY OF GAMETOGENESIS AND FERTILIZATION IN ALGAE.

B1D555 GENETIC POTENTIAL OF CERTAIN POPULATIONS OF DROSOPHILA PERSIMILIS FROM THE SIERRA NEVADA OF CALIFORNIA.

Public Health Service, Washington,  
D. C.

A1B482 ATOMIC BOMB CASUALTY COMMISSION, NATIONAL ACADEMY OF SCIENCES-ATOMIC ENERGY COMMISSION-UNITED STATES PUBLIC HEALTH SERVICE COOPERATIVE STUDIES ON LONG RANGE RADIATION EFFECTS ON HUMAN BEINGS.

Public Health Service, Bureau of  
State Services, Washington, D. C.

E1A525 ECOLOGY OF TERRESTRIAL BIRDS.

Puerto Rico Univ., Rio Piedras.  
Agricultural Experiment Station.

E2A91 RADIOACTIVE IRON STUDIES WITH  
SOILS AND CROPS OF PUERTO RICO.

Puerto Rico. Univ., San Juan.  
School of Medicine.

D1B273 A STUDY OF THE PHYSIOLOGY OF  
THIAMINE AND THIAMINE ANALOGUES.

Purdue Research Foundation, Lafayette,  
Ind.

B1A205 THE RELATIONSHIP BETWEEN SOMATIC AND GENETIC RESPONSE OF TOMATO SEED AND POLLEN TO X-IRRADIATION USING "WATER PROTECTION" AND MUTATIONS AT SPECIFIC LOCI.

Purdue Univ., Lafayette, Ind.

B1D204 THE EFFECTS OF X-RADIATION ON PLATEAUED POPULATIONS OF TRIBOLIUM CASTANEUM IN REGARDS TO REPRODUCTIVE FITNESS AND RESPONSE TO SELECTION.

D1B363 CARBOHYDRATE CATABOLISM IN PLANTS.

K1B373 THE CONSTRUCTION, INSTALLATION AND OPERATION OF A 2 PI LARGE VOLUME LIQUID SCINTILLATION COUNTER.

Quinnipiac Coll., Hamden, Conn.

D1C501 SEPARATION AND IDENTIFICATION OF PEPTIDES IN BACTERIA USING CARBON 14 AND SULFUR 35.

Radio Corp. of America. Electron  
Tube Div., Lancaster, Penn.

F2B537 DEVELOPMENT OF A PHOTOMULTI-  
PLIER HAVING A PULSE RISE TIME LESS THAN  
 $0.5 \times 10^{-9}$  SECOND.

Rand Corp., Santa Monica, Calif.

E3-48 STUDY OF POST-ATTACK ENVIRON-  
MENT RESULTING FROM THERMONUCLEAR WAR.

Reed Coll., Portland, Ore.

G1A477 COMPARATIVE STUDY OF TRACE  
METAL CONTENT OF NORMAL AND PATHOLOGI-  
CAL TISSUE BY MEANS OF ACTIVATION ANALYSIS.

Research Triangle Inst., Durham,  
N. C.

E3A424 DEVELOPMENT OF A TECHNIQUE FOR  
THE RAPID ANALYSIS OF FALLOUT ACTIVITIES  
IN NATURAL WATERS.

F2C7 DEVELOPMENT OF A SENSITIVE TRIT-  
IUM MONITOR.

Rhode Island. Univ., Kingston. Gradu-  
ate School of Oceanography

E2A429 CONCENTRATION PROCESSES IN THE  
CHESAPEAKE ESTUARY.

Rice Univ., Houston, Tex.

D1B462 ENDOCRINE AND METABOLIC STUDIES  
UTILIZING RADIOISOTOPES AND LABELED HOR-  
MONES.

Rochester, N. Y. Univ.

B1A425 SOMATIC MUTATIONS IN THE MOTH  
EPHESTIA.

B1B308 GENETICS OF BLUE-GREEN ALGAE -II.

B1D393 A STUDY OF MATHEMATICAL MODELS  
OF MUTATION AND SELECTION IN MULTI-LOCUS  
SYSTEMS.

C1A514 AN INVESTIGATION INTO THE PHAR-  
MACOLOGICAL PROPERTIES OF ANTI-IRRADI-  
ATION DRUGS.

Rochester, N. Y. Univ. School of  
Medicine and Dentistry

C1C556 METABOLISM OF BONE SODIUM.

D1B552 MECHANISMS OF BIOLOGICAL DAMAGE  
OF THE MOLECULAR, CELLULAR, AND TISSUE  
LEVELS.

Rockefeller Inst. for Medical Research  
New York

B1D495 GENETIC STRUCTURE OF NATURAL  
POPULATIONS.

Roscoe B. Jackson Memorial Lab.,  
Bar Harbor, Me.

A1B311 REPAIR RATE AND LIFE SPAN IN RA-  
DIATION DAMAGED MICE.

B1A309 THE OCCURRENCE OF CHROMOSOMAL  
ABERRATIONS IN PRE-SPERMATOCYTIC CELLS  
OF IRRADIATED MALE MICE.

B1C310 ATTEMPTS TO DELINEATE INBORN  
ANEMIAS IN MICE.

B1C541 QUANTITATIVE POPULATION GENET-  
ICS OF MICE UNDER IRRADIATION.

Roswell Park Memorial Inst. Buffalo

C1B397 THE ROLE OF SERUM ERYTHROPOI-  
ETIN FACTOR IN ANEMIA OF MALIGNANCY.

J1A326 LOCALIZATION OF ANTIBODIES IN  
SPONTANEOUS AND INDUCED TUMORS.

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- Branson, Herman AT(30-1) 892  
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Carr, Edward A., Jr. AT(11-1)1208  
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Casida, John E. AT(11-1)1187  
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Caspari, Ernst W. AT(30-1)2902  
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Castleman, Benjamin AT(30-1) 2031  
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Caswell, R. S. AT(49-2)1165  
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Caveness, William F. AT(30-1) 3014  
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Cepellini, Ruggero AT(30-1)-2959  
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Cerecedo, Leopold R. AT(40-1)2914  
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Chadwick, Donald R. AT(49-7)1298  
A1B482 ATOMIC BOMB CASUALTY COMMIS-  
SION, NATIONAL ACADEMY OF SCIENCES-  
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Chaikoff, I. L. AT(11-1)34-11  
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Chang, M. C. AT(30-1)1943  
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Chase, Herman B. AT(30-1)2018  
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Chidester, John L. AT(11-1)1150  
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Chow, B. F. AT(30-1)-2992  
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Chow, B. F. AT(30-1)-1203  
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Christensen, John A. AT(11-1)1038  
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Christian, J. E. AT(11-1)876  
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Conger, Alan D. AT(40-1) 2579  
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Clark, Irwin AT(30-1) 2530  
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Conley, C. Lockard AT(30-1)1208  
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Clark, J. Bennett AT(40-1)2956  
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Cope, Oliver AT(30-1)-667  
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Clemente, Carmine D. AT(11-1)34-68  
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Cochran, George W. AT(11-1)1150  
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Cormier, M. J. AT(40-1)2741  
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Cohn, Norman S. AT(11-1)826  
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Cornatzer, W. E. AT(11-1)479  
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Coleman, N. T. AT(11-1)34-92  
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Costrell, L AT(49-2)1165  
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Colter, John S. AT(30-1)2967  
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Cowan, Clyde L. AT(30-1) 2419  
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Comar, C. L. AT(30-1)2147  
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Crafts, A. S. AT(11-1)34-38  
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Creager, Joe S. AT(45-1)1752  
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SHELF, AT(45-1)-1752.

Curl, Herbert C., Jr. AT(45-1)1751  
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Dameshek, William AT(30-1) 1276  
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Dameshek, William AT(30-1) 2032  
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Darby, William J. AT(40-1)1033  
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Daub, Guido H. AT(29-2)915  
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Dawson, William A. AT(45-1)1734  
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Day, C. Godfrey AT(30-1) 2998  
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Dean, L. A. AT(49-7)-1  
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De Bernard, B. AT(30-1)-2632  
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DeBusk, A. Gib AT(40-1)2788  
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Dent, J. N. AT(40-1) 2978  
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Dewar, Michael J. S. AT(11-1)889  
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Dickman, Sherman R. AT(11-1)-305  
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Dieckert, Julius W. AT(40-1) 3015  
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Di Giovanni, H. J. AT(30-1)-2363  
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Dingle, A. Nelson AT(11-1)739  
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DiStefano, Victor AT(30-1)-2192  
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Dixon, Frank J. AT(04-3)410  
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Dobyns, Brown M. AT(30-1) 1243  
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Dobzhansky, T. AT(30-1)3096  
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Dollar, A. M. AT(45-1)1730  
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Doudney, C. O. AT(40-1)2139  
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Douglas, Lee T. AT(30-1)-3113  
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Ducoff, Howard S. AT(11-1)878  
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Dudley, Robert A. AT(30-1)2819  
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Dunavant, B. G. AT(40-1)2892  
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Dunn, L. C. AT(30-1)1804  
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Edington, Charles AT(40-1)2417  
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Edmondson, L. F. AT(49-7)1774  
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Edwards, H. M., Jr. AT(40-1)2395  
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Edwards, R. R. AT(30-1)-3049  
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Edwards, R. R. AT(30-1)-3082  
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Edwardson, J. R. AT(40-1) 2583  
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Ehrlich, M. AT(49-2)1165  
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Eisenbud, Merril AT(30-1)-2896  
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Eisenbud, Merril AT(30-1)3086  
A2B460 DISTRIBUTION OF RADIONUCLIDES IN HUMAN TISSUES.

Eisenbud, Merril AT(301)2577  
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Ely, Ralph L., Jr. AT(40-1)2513  
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Emery, Donald A. AT(40-1)1747  
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Emmert, Fred H. AT(30-1)2117  
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Engstrom, R. W. AT(30-1)-3032  
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Eno, Charles F. AT(40-1) 2754  
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Erdtman, O. G. E. AT(30-1)-3119  
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Evans, R. D. AT(30-1)952  
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Evans, Titus C. AT(11-1)291  
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Everett, Keye R. AT(11-1)1157  
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Everett, Newton B. AT(45-1)1377  
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Ewing, Maurice AT(30-1)2663  
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Farber, Sidney AT(30-1)1753  
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Fernandez-Moran, H. AT(30-1)2278  
A1F132 EFFECTS OF IONIZING RADIATION ON NERVE CELL ULTRASTRUCTURE. (Studies of the effects of ionizing radiation on the ultrastructure of developing nervous tissue as revealed by electron microscopy).

C1B355	Ferrebee, J. W.	AT(30-1)2005	C1B409	Freter, Rolf	AT(30-1)-2628
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D1D304	Flipse, Robert J.	AT(30-1)1849	D1A97	Friedell, Hymer L.	W-31-109-Eng-78
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K1A336	Floyd, Ross	AT(45-1)1379	E3A410	Friedlander, S. K.	AT(30-1)-2165
	"RESEARCH AND DEVELOPMENT OF A			FUNDAMENTAL INVESTIGATIONS OF	
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B1A217	Foard, Donald E.	AT(11-1)34-94	D1B259	Fritz, George J.	AT(40-1)2834
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E2C28	Folsom, Theodore R.	AT(11-1)34-71	D1A598	Fuller, R. C.	AT(30-1) 2801
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				THETIC BACTERIA.	
C1C556	Forbes, Gilbert B.	AT(30-1) 1827	E1B172	Fuller, Wallace H.	AT(11-1)947
	METABOLISM OF BONE SODIUM.			THE UPTAKE OF STRONTIUM BY	
				VARIOUS TYPE CROPS AND FACTORS AFFECTING	
				UPTAKE AND TRANSLOCATION OF STRONTIUM	
				AND CALCIUM NATIVE TO SOIL.	
B1B308	Forest, Herman S.	AT(30-1)3046	D1A261	Gaffron, H.	AT(40-1)-2687
	GENETICS OF BLUE-GREEN ALGAE -II.			RESEARCH IN PHOTOSYNTHESIS.	
D1B290	Foster, J. M.	AT(30-1)1845	E1B54	Gardner, Walter H.	AT(45-1) 1543
	ENZYMOLGY OF THE FORMED ELE-			UNSATURATED FLOW OF WATER IN	
	MENTS OF HUMAN BLOOD.			POROUS MEDIA AS INFERRED FROM NEUTRON	
				ABSORPTION.	

Gaul, Horst AT(30-1)2619  
B1F574 DEVELOPMENT OF SELECTION METHODS FOR INDUCED SMALL MUTATIONS IN HIGHER PLANTS (WITH SPECIAL REGARD TO MUTATIONS OF YIELDING CAPACITY).

Gershowitz, Henry AT(11-1)405  
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Gilbert, Gareth E. AT(11-1)552  
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Giles, N. H. AT(30-1)-3098  
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Ginoza, William AT(30-1)-3116  
D1A521 RADIATION STUDIES ON TRANSFORMING DNA, ON TNV-RNA AND  $\phi$  X174-DNA.

Glass, H. Bentley AT(30-1)-1939  
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Glass, H. Bentley AT(30-1)1472  
B1A543 THE ACTION OF RADIATION AND OTHER MUTAGENIC AGENTS (1) IN INDUCING MUTATION IN DROSOPHILA FEMALES, AND (2) IN CONTROLLING THE ACTION OF SPECIFIC SUPPRESSOR GENES.

Glass, Laurel E. AT(11-1)34-53  
A1J42 IMMUNOCYTOLOGICAL STUDIES OF X-IRRADIATED MOUSE EMBRYOS.

Glassman, Edward AT(40-1)3013  
B1B271 BIOCHEMICAL AND GENETICAL STUDIES ON CHRONIC ANEMICS.

Gleit, Chester E. AT(04-3)453  
E3C38 PHYSICAL, CHEMICAL AND RADIO-CHEMICAL ANALYSIS OF FILTER DEBRIS.

Goff, Richard A. AT(40-1)2850  
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Goldberg, Edward D. AT(11-1)34-84  
E2B29 MARINE GEOCHEMISTRY RESEARCH.

Goldie, Horace AT(40-1)3089  
J1B417 DEVELOPMENT IN EXPERIMENTAL ANIMALS OF NEW METHODS FOR RADIOISOTOPES APPLICATION IN CAVITARY CARCINOMA AND IN PARTICULAR AGAINST TRANSCOELOMIC METASTASES.

Gorbman, Aubrey AT(30-1)-3037  
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Goss, James A. AT(11-1)1015  
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Gowen, John W. AT(11-1)1225  
B1C186 A QUANTITATIVE STUDY OF LIFETIME SICKNESS AND MORTALITY AND PROGENY EFFECTS RESULTING FROM EXPOSURE OF ANIMALS TO PENETRATING IRRADIATION.

Graham, Ellis R. AT(11-1)1064  
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Graham, Ellis R. AT(11-1)1014  
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- Graikoski, John T. AT(11-1)1095  
L-190 A STUDY OF THE EFFECT OF IONIZING RADIATION ON RESISTANCE, GERMINATION AND TOXIN SYNTHESIS OF CLOSTRIDIUM BOTULINUM SPORES, TYPES A, B AND E.
- Green, David E. AT(11-1)1151  
D1D233 STUDIES ON INTEGRATED ENZYME ACTIVITY IN ANIMAL TISSUE.
- Green, Earl L. AT(30-1)1979  
B1C541 QUANTITATIVE POPULATION GENETICS OF MICE UNDER IRRADIATION.
- Gregor, H. P. AT(30-1)2279  
D1A292 DETERMINATION OF ACTIVITY OF ALKALINE EARTH CATIONS IN BIOLOGICAL AND OTHER AQUEOUS MEDIA BY MEANS OF MULTI-LAYER MEMBRANE ELECTRODE.
- Gregory, Walton C. AT(40-1)2909  
K1B268 THE NORTHWARD MIGRATION OF CITRUS BY MEANS OF RADIATION-INDUCED MUTATION.
- Greiff, Donald AT(11-1) 596  
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- Griffen, Allen B. AT(30-1)2113  
B1A309 THE OCCURRENCE OF CHROMOSOMAL ABERRATIONS IN PRE-SPERMATOCYtic CELLS OF IRRADIATED MALE MICE.
- Grosch, D. S. AT(40-1)2836  
B1B376 THE LOCALIZATION, PERSISTENCE AND RESULTANT GENETIC EFFECTS IN INVERTEBRATES OF INGESTED FOURTH PERIOD METALS IN STABLE AND RADIOACTIVE FORMS.
- Gunn, Samuel A. AT(40-1)2023  
A2B466 A STUDY OF FACTORS CONCERNED IN THE UPTAKE, PHYSIOLOGY AND RETENTION OF Zn-65 IN THE MALE REPRODUCTIVE SYSTEM OF THE RAT.
- Gunsalus, I. C. AT(11-1)903  
D1B444 MECHANISM OF BIOCATALYSIS AND OF METABOLIC CONTROL.
- Hale, William M. AT(40-1) 1631  
A1A463 A STUDY OF THE EFFECTS OF COBALT-60 GAMMA IRRADIATION ON INFECTION AND IMMUNITY.
- Hall, H. P. AT(49-7)-1773  
E3A528 ASH CAN OPERATIONS—GOODFELLOW AFB, TEXAS.
- Halpern, B. D. AT(30-1)-1931  
F2A535 PROPOSAL FOR PLASTIC SCINTILLATORS.
- Ham, William T., Jr. AT(40-1)2452  
A1H416 "A STUDY OF THE COMPARATIVE EFFECTS OF IONIZING RADIATION AND AGING ON THE MAMMALIAN LENS OF THE EYE."
- Hampton, James C. AT(11-1)1244  
A1D401 AN ELECTRON MICROSCOPIC AND AUTORADIOGRAPHIC STUDY OF INTESTINAL RADIATION DEATH IN THE MOUSE.
- Hanawalt, Philip C. AT(04-3)-326-7  
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- Hand, Cadet AT(11-1)34-96  
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- Hannah-Alava, Aloha AT(30-1)2690  
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- Hansen, M. F. AT(11-1)1209  
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- Hanson, J. B. AT(11-1)790  
D1D358 THE ROLE OF RIBONUCLEIC ACID IN THE ACCUMULATION OF IONS BY PLANT CELLS.
- Hanson, J. B. AT(11-1)791  
D1D442 THE ROLE OF RIBONUCLEIC ACID IN THE ACCUMULATION OF IONS BY PLANT CELLS.
- Hanunian, N. A. AT(04-3)414-3  
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- Harding, Clifford V. AT(30-1)2456  
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- Hardy, Harriet L. AT(30-1)2629  
G1B575 BERYLLIUM CASE REGISTRY.
- Hartman, Richard T. AT(30-1)3018  
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- Harward, M. E. AT(45-1)1063  
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- Haurowitz, Felix AT(11-1)209  
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- Heaney, Robert P. AT(11-1)587  
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- Heaslip, Margaret B. AT(40-1)2066  
E1A81 ECOLOGICAL EFFECTS OF FAST NEUTRONS AND GAMMA RADIATIONS ON DORMANT AND PHYSIOLOGICALLY ACTIVE SEED OF TREE SPECIES NATIVE TO THE EASTERN DECIDUOUS FOREST AREA.
- Hempelmann, L. H. AT(30-1)1286  
D1B552 MECHANISMS OF BIOLOGICAL DAMAGE OF THE MOLECULAR, CELLULAR, AND TISSUE LEVELS.
- Herriott, Roger M. AT(30-1)-1371  
D1C542 A. THE TRANSFORMATION OF E. COLI B FROM VIRUS SENSITIVE TO VIRUS RESISTANT OR VICE VERSA. B. CHEMICAL AND NUTRITIONAL STUDIES OF BACTERIAL VIRUSES.
- Herrmann, Robert L. AT(30-1)3093  
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- Herranen, Ailene AT(30-1)2565  
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- Herskowitz, I. H. AT(11-1)633  
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- Heyssel, R. M. AT(40-1)2401  
K1A286 UTILIZATION OF A LOW LEVEL WHOLE BODY COUNTING FACILITY IN THE MEASUREMENT OF ELECTROLYTE COMPOSITION AND METABOLISM IN MAN.
- Hiatt, Robert W. AT(04-3)226  
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Hicks, S. P.	AT(11-1)-1201	Holowaychuk, N.	AT(11-1)414
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Hill, Berton F.	AT(49-1)643	Hood, Donald W.	AT(40-1)2799
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Hirschman, Albert	AT(30-1)2960	Hsiao, Sidney C.	AT(04-3)330
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Hamilton, J. R.	AT(40-1)2905	Hueter, F. G.	AT(45-1)1441
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Hodges, Clarence V.	AT(45-1)1089	Huffman, Joan L.	AT(40-1)1749
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C1B565	AN IMMUNOGENETIC STUDY OF THE MECHANISM OF PROTECTION AGAINST RADIATION DEATH BY TREATMENT WITH HAEMOPOIETIC TISSUES.	E1B524	EQUIPMENT AND METHODS FOR DECONTAMINATION OF AGRICULTURAL LANDS CONTAMINATED BY RADIOACTIVE FALLOUT.
Hoffman, Joseph G.	AT(30-1)2462	Hume, David M.	AT(40-1)2459
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Hollingsworth, J. W.	AT(30-1)1926	Hutchinson, Franklin	AT(30-1)2653
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Holmes, W. N.	AT(45-1)1381	Isaacs, John D.	AT(11-1)34-97
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Ives, Philip T. AT(30-1)2467  
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Johnson, J. W. AT(11-1)34-78  
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Jackson, W. A. AT(40-1)2410  
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Johnson, Noye M. AT(30-1)2982  
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Jacobson, Baruch S. AT(11-1)1117  
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Johnson, Ralph G. AT(11-1)1019  
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Jacobson, L. AT(11-1)34-5  
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Johnston, P. M. AT(40-1)1775  
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James, W. T. AT(40-1)2787  
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Jones, Arthur W. AT(40-1)1749  
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Jenkins, James H. AT(38-1)293  
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Jones, Raymond F. AT(30-1)-3105  
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Jenny, Hans AT(11-1)34-55  
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Joham, H. E. AT(40-1)2859  
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Kahn, Reuben L. AT(11-1)1172  
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Johnson, George T. AT(40-1)3021  
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Kasha, Michael AT(40-1)-2696  
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Kasimer, Philip R. AT(30-1)2480  
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Kaufman, Warren J. AT(11-1)34-100  
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Kemp, Norman E. AT(11-1)1050  
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Ketchum, B. H. AT(30-1)3140  
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Ketchum, Bostwick H. AT(301)1918  
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Kinoshita, Jin H. AT(30-1)1368  
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Kinsey, V. Everett AT(11-1)152  
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Kirkham, Don AT(11-1)1269  
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Kittrick, J. A. AT(45-1)1756  
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Klein, Richard M. AT(30-1)2587  
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Klein, William H. AT(30-1)2373  
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Kobayashi, Yutaka AT(30-1)2085  
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Koczy, F. F. AT(40-1)2411  
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Koenig, Harold AT(11-1)1180  
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Kojima, Ken-ichi AT(40-1)2798  
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Koller, P. C. AT(30-1)2702  
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Koolla, Werner P. AT(30-1)2548  
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Korkisch, Johann AT(301)2623  
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Kramer, Paul J. AT(40-1) 1827  
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Krampitz, L. O. AT(11-1)1252  
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Krane, Stephen M. AT(30-1) 2183  
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Krise, George M. AT(40-1)2849  
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Krivot, William AT(11-1)1274  
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Kroll, Harry AT(30-1)2710  
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Kruger, Paul AT(04-3)457  
E3B70 METEOROLOGICAL EVALUATION OF  
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Krumholz, Louis A. AT(40-1)-2595  
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Kuhl, David E. AT(30-1)3175  
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Kundin, William D. AT(11-1) 1179  
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Kurnick, N. B. AT(11-1)34-87  
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Kuroda, P. K. AT(401)2529  
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Lackey, James B. AT(40-1)2137  
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Lampe, Isadore AT(11-1)245  
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Larsen, Wesley P. AT(11-1) 1030  
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Laskowski, M., Sr. AT(11-1)293  
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Laties, George G. AT(11-1)34-61  
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Laughlin, J. S. AT(301)1451  
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Layrisse, Miguel AT(30-1)2694  
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Loevinger, Robert AT(04-3)326-04  
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Lee, William R. AT(30-1)2315  
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Looney, W. B. AT(40-1) 2889  
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Leone, Charles A. AT(11-1)1073  
A1A241 IMMUNOCHEMICAL STUDIES OF  
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Lott, James R. AT(40-1)2419  
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Levitt, J. AT(11-1)683  
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Luick, J. R. AT(11-1)34-69  
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Rice, T. R. AT(49-7) 5  
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Sastry, B. V. Rama AT(40-1)3066  
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Ceppellini, Ruggero AT(30-1)-2959  
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Hale, William M. AT(40-1) 1631  
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Overman, Richard R. AT(40-1)1642  
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Emery, Donald A. AT(40-1)1747  
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Jones, Arthur W. AT(40-1)1749  
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Blair, W. Frank AT(40-1)1751  
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Johnston, P. M. AT(40-1)1775  
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Kramer, Paul J. AT(40-1) 1827  
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