LABORATORY PROGRAM FORECAST
NATIONAL ACADEMY OF SCIENCES - NRC
ATOMIC BOMB CASUALTY COMMISSION

The Atomic Bomb Casualty Commission is a field installation of the National Academy of Sciences operated under contract with the Atomic Energy Commission, authorized by Presidential Directive dated November 18, 1946. The project is carried out at Hiroshima and Nagasaki, Japan and its facilities include a clinic and supporting laboratories and services (diagnostic ward, clinical, pathological, radiological, and isotope laboratories, IBM machines, Printing, photographic and electrical shops, and a motor pool).

In the staffing and scientific direction the Academy has cooperative agreements with the Ministry of Health and Welfare of Japan and with local Japanese authorities and institutions. In the U.S. it has the cooperation of many institutions and agencies in securing staff for service with ABCC. The chief of these are the Public Health Service, the Armed Forces, the Atomic Energy Commission, the Medical Schools of Yale University and of the University of California (UCLA), and the Oak Ridge National Laboratory.

The scientific results of the project are disseminated as reports through the Atomic Energy Commission in the U. S. and, in Japan, through the National Institute of Health of Japan. Many of the results are also published in the scientific literature of the U. S. and Japan.

The mission of the Atomic Bomb Casualty Commission continues to be a study of the late and delayed effects of nuclear radiation in the populations exposed at Hiroshima and Nagasaki in 1945 and in the children born of this parentage. The program has been reoriented as to scientific, procedural, and administrative direction during FY 1959 and FY 1960. New programs include a tumor registry, a study of Nagasaki survivors in cooperation with the Nagasaki A-Bomb Survivors registry, a study of morbidity in cooperation with several large industrial concerns employing A-bomb survivors, an investigation of cardiovascular defects, the occurrence of cervical cancer in survivors, and a study of diagnostic and therapeutic radiation exposure of the two populations. Increases in the rate of obtaining data in the leukemia survey and shielding studies will stabalize at about the FY 1960 level. Changes in the scope and magnitude of effort in the ABCC program are expected to be minimal and will continue at approximately present levels of effort for the indefinite future.

LABORATORY PROGRAM FORECAST

ARGONNE NATIONAL LABORATORY

Although the Argonne National Laboratory dates its official life from July 1, 1946, the Argonne program had its inception in 1942 as part of the Metallurgical Laboratory at the University of Chicago under the auspices of the Manhattan Engineering District. Early in 1942, when physicists became convinced that the nuclear chain reaction would be successful, concern arose about the radioactive hazards which would be involved. Consequently, a broad research program was initiated to determine the biological effects of radiation with the dual purposes of providing a basis for establishing permissible exposures to all forms of radiation and radioactive isotopes and the understanding of radiation sickness so as to devise preventive and therapeutic procedures. The continuing philosophy of the biological and medical research program at the Argonne Laboratory has been to study the health hazards of acute and chronic exposure to external radiation and to internally deposited radioisotopes.

As our knowledge of the acute effects of radiation has increased, greater emphasis has been placed on the chronic effects of low-level exposure to radiations, in anticipation of the increasingly important problem which will result from widespread use of nuclear reactions for power production. Consequently, a major program expansion on long-term biological effects of low-dose radiation is underway. Because of the low doses and dose rates involved, such studies require a considerable expansion of experimental animal facilities. In addition to studying the effects of fission neutrons, high-energy gamma radiation, and strontium-90 deposition, the program will undertake to evaluate the effects of a variety of mixed fission products, both short and long lived. Emphasis will be on the life shortening and carcinogenic effects.

The growing need for information concerning the chronic effects of low-level radiation exposures has already been mentioned. In addition to the large-scale laboratory animal studies with dogs and mice, a detailed epidemiological study on human populations is rapidly gaining impetus. Between 500,000 and 700,000 persons in Illinois are routinely drinking well water that contains above-average levels of radium: some waters contain levels near the maximum permissible content. Body radium burdens will be measured and correlated with estimates of the incidence of bone pathology and bone tumor mortality. These studies are integrated with the continuing follow-up of radium dial painters and other persons known to be carrying significant body burdens of radium. Basic biochemical and cell structure research programs could be shifted to universities or reduced in scope as the above programs expand. Studies on human biochemical genetics will increase. Certain projects in the plant sciences concerned with radioisotope labeling of compounds involved

in biosynthesis will be brought to completion. Studies of the biochemical factors which account for differences in the radiosensitivities of individual cells within a population will be expanded as they are required by the long-range neutron and gamma ray toxicity project. A comprehensive program of the biological effects of fission neutrons at dose rates varying from about .0001 to 10,000 rad per hour will be initiated upon the completion of a special biological research reactor facility in 1960.

Based upon the above statement of research objectives at Argonne National Laboratory, the level of support for the programs in the life sciences could be expected to undergo a substantial increase in ten years over the FY 1960 operating level of $4,100,000, with an estimated 115 scientific man years of effort. On the assumption that the general economic factors in the nation will remain relatively constant, an increase in the order of 40% in operating costs is indicated by FY 1970 to provide for the expansion in the studies of chronic effects of low-level radiation, neutron toxicity, and human biochemical genetics. An allowance has been made in this estimate for the completion of certain projects as stated above.

LABORATORY PROGRAM FORECAST

BROOKHAVEN NATIONAL LABORATORY

At the end of World War II, large government laboratories for nuclear research were in operation in all sections of the country, except in the Northeastern United States where many of the country's most active and distinguished scientists are located. Recognizing the need for a nuclear research center in this region, exploratory discussions between representatives of eastern universities and the Manhattan Engineering District led to the incorporation in 1946 of Associated Universities, Inc., a non-profit educational corporation. AUI contracted with the Manhattan Engineering District, and later with the Atomic Energy Commission, to establish and operate the Brookhaven National Laboratory.

Because of its close association from the beginning with the university community, the Brookhaven National Laboratory has emphasized basic approaches to research problems of Atomic Energy Commission interest and the education and training of research, student, and technical personnel. The training activity has been especially important at the post-doctoral level, where a large number of young scientists have served as temporary research associates for periods of from one to five years before taking permanent positions in the universities. In addition, a large proportion of the total research in the laboratory is done by visiting scientists, most of whom come from the regional universities, but many from other sections of the nation as well as from abroad. Thus, in the Biology Department which constitutes about 40% of the total research effort in the life sciences at Brookhaven, there are at present about 20 staff scientists, 10 research associates, and an average of 15 visiting scientists engaged in the research program. It is currently anticipated that the research program will continue to expand until an equilibrium level of 30-35 staff scientists, 25 research associates, and an average of 30 visitors is attained.

The biology research program emphasizes research in genetics, radiation biology, molecular biology, mammalian physiology, and cellular physiology.

This Laboratory provides our principal facility for the cooperative programs in the application of radiation for crop improvement. No further expansion in this effort is anticipated. The research program in plant radiobiology will be expanded following the recommendation of an ad hoc committee of botanical scientists who recently examined critically the entire plant science research program of the Commission. Since the existing program at Brookhaven is already strong in molecular level studies, the expansion will emphasize effects on tissues, whole plants, and plant communities.

It is anticipated that the general program in genetics will remain at about its present level of toxicity. Particular emphasis will be given to the effects of radioisotopes incorporated into the genetic materials.

Strontium-90 may present a special problem in this regard since it can partially replace calcium in the molecular structure of chromosomes.

The radiation biology program has emphasized mammalian studies. Although the numbers of animals employed in radiation toxicity studies will not be greatly increased, there will be an expansion of the basic studies at the molecular and cellular levels necessary for understanding whole body radiobiological effects. Estimates of cell renewal and turnover times are important in predicting radiation effects on specific tissues of importance in maintaining the physiological levels of activity consistent with survival. Efforts in theoretical biology will be considerably expanded to aid in the prediction of radiobiological damage.

The molecular biology program will be strengthened by expansion of studies in free radical chemistry, of protein and nucleic acid biosynthesis and their interrelationships, of protein structure, and of the mechanism of enzyme action.

A program of nuclear medicine is promoted by the Medical Department. It includes application of atomic components in the treatment and diagnosis of disease and in the elucidation of fundamental biological processes. During 1959 a medical reactor (the first designed for medical use only) was brought into operation. Rapidly, the research and service activities are being oriented around this special facility.

By utilizing radiation sources designed for other than medical purposes, preliminary studies have been carried out on newly developed irradiation methods. Central among the newer procedures has been the employment of sharply localized short-range and short half-life particle radiation made possible by neutron bombardment of localized isotopes with particular characteristics. Researches inherent in this field of activity necessarily involve investigations of precise isotope localization, kinetics of distribution and redistribution, metabolism of organic compounds, functions of inorganic compounds, and the effect of excited atoms on the stability of large molecular complexes. Advantage is sought of special situations applicable to medical practice, such as neutron-capture therapy of glioblastoma multiforma. For such purposes, advantage is taken of anatomical and physiological conditions such as the blood-brain barrier situation, as well as of particle range and rate of radioactive decay.

Associated with the neutron-capture therapy developments are studies of treatment procedures employing pure neutron and pure gamma radiations - also selected mixtures of these. Such refined RBE studies enable meaningful analyses of the mechanism of radiotherapeutic action. Other associated activity areas made special by availability of the medical reactor are activation (induced radioactivity) analyses and trace element (manganese, copper, and other) investigations.

Tritium-labeling studies (largely initiated at Brookhaven) have yielded basic information about DNA synthesis, chromosome replication,

tissue regeneration, durability of specialized cell types, and secretory function. The techniques (including use of carbon-14) have such remarkable possibilities that many other developments and discoveries are to be expected.

Because of interest, technical competence, and particular opportunities as well as special facilities, preliminary attention has been given to very high intensity (pulse-type) and very low intensity (environmental-type) irradiation. Within the scope of the first are unique treatment opportunities for dealing with cancer and other late effects, and within that of the latter (radioepidemiology) are opportunities to determine the influence of low-level irradiation exposure increments to population groups resulting from general atomic energy developments. Inherent are potentialities for analytical consideration and investigation of the nature of degenerative diseases of many types (arteriosclerosis, nephrosis, cirrhosis, neoplasia, sterility, anemia, and others).

Bearing in mind the unique facilities, the special competence, and the unusual associations available at the Brookhaven Laboratory, it appears necessary to take cognizance of the following:

1. That every effort will be made to discover, utilize, and test therapeutic advantages provided by a medical reactor.

2. That impressions about therapeutic advantages, based on clinical experience, will become advanced within the coming ten-year period.

3. That, despite the necessary remoteness, opportunities and advantages are provided at Brookhaven that cannot be duplicated at more than a few locations, even if unlimited funds were available.

Research in the life sciences at the Brookhaven National Laboratory is supported at an operating level of $4,715,000 in FY 1960; an estimated 103 scientific man years is devoted to projects in medicine, biology, environmental sciences and health physics. Planned expansion in plant radiobiology and in basic studies in molecular and cellular biology, along with a modest increase in a number of areas of nuclear medicine point to an overall increase approximating 30% during the next ten years.

LABORATORY PROGRAM FORECAST

OAK RIDGE NATIONAL LABORATORY

The wartime Clinton Laboratory, which ultimately gave rise to the Oak Ridge National Laboratory, was built in 1943 with two major objectives closely related to the nuclear weapons effort. First was the construction and operation of a production scale plant for the electromagnetic separation of uranium-235 from normal uranium. The second objective was the development on a pilot plant scale of methods for the production of plutonium-239 to be employed in the plutonium production plant under construction at Hanford. This involved construction of the Clinton pile and the development of methods and equipment for the chemical separation and purification of plutonium-239 from the fission products produced by neutron bombardment of uranium-238.

Following the war, the biological research effort, which previously had been concerned largely with health physics research to insure the safety of the operations, was expanded by the formation of the Biology Division. The underlying philosophy of the Biology Division is the study of the mechanisms of radiation effects in biological systems in an effort to design means of protection against radiation damage and of counteracting the damage after the radiation has been absorbed. The approach has been largely along genetical and cytological lines, with heavy emphasis on biochemistry and biophysics. Although much of the work has been concerned with cellular level effects, there is increasing emphasis on mammalian systems.

The Oak Ridge National Laboratory, in collaboration with the Oak Ridge Institute of Nuclear Studies, has emphasized education and training throughout the years. The program has had many facets, with heavy emphasis upon traveling lectureships in the southern universities, and an active research participation program whereby university staff members can work for periods from three months to several years at the Laboratory. An active program of post-doctoral training by means of temporary research associateships has been very successful, not only in training young scientists but also in recruiting scientific personnel. Since the establishment of the Laboratory, many senior personnel have left to accept university positions. This has not only strengthened the scientific programs of the regional universities but, in addition, has accomplished a transfer of certain research programs from the Laboratory to the universities, since in most cases these individuals transferred not only portions of their own research programs but also frequently some of their associated scientific personnel.

The research program of the Biology Division is organized into the following large subdivisions:

1. Cytology and Genetics.

This large project encompasses studies with a variety of organisms, including bacteriophages, bacteria, maize, Tradescantia, Vicia, Drosophila, and recently mammalian tissue culture cells. The emphasis is on basic studies of cellular structure and function, and of the action of radiation on the cell and especially on the genetic apparatus. This program will continue at the present high level.

2. Mammalian Genetics and Development.

The Oak Ridge National Laboratory is the site of the Commission's major program in mammalian genetics. Although many important results have been obtained throughout the years, the most exciting development is the recent finding that the induction of gene mutations occurs at a lower rate when the radiation exposure is protracted over a long period at a low dose rate. This is extremely significant to consideration of the genetic hazards of fallout and occupational exposures. The present level of activity will continue although new projects will be initiated as certain major studies are completed.

3. Microbial Protection and Recovery.

Bacterial and fungal cells have been employed as model systems for the study of basic mechanisms in chemical protection and recovery from radiation.

4. Mammalian Recovery.

Laboratory studies of protection by chemicals and by bone marrow transplantation in the mouse have been emphasized. The program has developed into a broader one concerned with tissue transplantation in general, with emphasis upon related immunological problems. No expansion of effort is planned.

5. Pathology-Physiology.

These studies have been concerned with the pathogenesis of early and delayed somatic radiation effects in mammals with emphasis on the induction of leukemia and neoplasia. This program will be expanded to encompass the life shortening and carcinogenic effects in mice of chronic low-level radiation.

6. Cell Physiology.

The major objective of this project is the determination of the molecular basis of cell function. The findings will provide a background to facilitate determination of the effects of radiation and other insults on cellular function. No major increase in this program is anticipated.

7. Biophysics.

The biophysics research is concerned with the understanding of the basic primary physical and chemical events which underlie and govern the action of radiation in biological systems. Significant advances have been made by the application of electron spin resonance methods to biological materials. It is anticipated that these studies will be expanded in conjunction with an overall increase in the Commission-supported effort in biophysics and bioenergetics.

8. Radiation Immunology.

These investigations are concerned with the fundamental immunological aspects of bone marrow and other tissue transplantation, and with fundamental immunological investigations. A modest expansion is planned, with emphasis on the immunogenetic aspects of the problem.

9. Biochemistry.

The biochemistry projects at the Oak Ridge National Laboratory have been concerned with three major problems: intermediary metabolism in bacteria and plants, nucleic acid biochemistry, and protein synthesis. Considerable expansion is planned with emphasis on the interrelationships and genetic control of nucleic acid and protein biosynthesis, biochemical studies of gene action, and studies of cellular differentiation at the molecular level.

While the projects in plant and mammalian genetics, which are two of the largest areas of research at Oak Ridge National Laboratory, will continue at existing levels of support, an expansion of programs in pathology-physiology, bioenergetics, radiation immunology and biochemistry indicate an increase during the next ten years of approximately 20% over the FY 1960 operating level of $5,420,000, with 166 scientific man years of effort.

LABORATORY PROGRAM FORECAST

LAWRENCE RADIATION LABORATORY - BERKELEY

The Lawrence Radiation Laboratory developed around the cyclotron devised by Ernest O. Lawrence. The basic designs and development of the instrument went forward between 1929 and 1936 to such a large extent it became necessary to establish the equivalent of a research institute to capitalize on the enormous potentialities of these instruments, for the University of California and the group working with Lawrence had become one of the three great centers of the now developing field of nuclear physics and chemistry. The 60" instrument built in the then newly organized Crocker Laboratory made available for the first time radioactive elements in amounts sufficient for medical use.

Small amounts of P^{32} had become available in 1936 from the small cyclotrons and John H. Lawrence at California and Artom and Hevesy in Europe had used P^{32} for tracer purposes in 1936. Lawrence, however, by virtue of his source of supply was the first to exploit the use of P^{32} to treat hematological diseases and this group therefore became the nucleus of the health physics-biomedical research organization formed under the Manhattan District to study the biological effects of radio-isotopes which might limit the concurrent developments in reactor technology and fissionable material production.

The position of such a biomedical group in a nuclear energy research complex was firmly established during the war years so that when the newly formed AEC undertook to support further developments in nuclear physics and chemistry at Berkeley, a biomedical group was also organized under Dr. John Lawrence and Joseph Hamilton to continue the excellent research programs of the war years. The Donner Foundation contributed to the further development of this group by providing funds for a modern biomedical research building and assisting in setting up a pavilion at the University Student Infirmary where research on patients could be carried on. An animal house with a few supporting laboratories was built with AEC funds.

At present about 60% of the personnel on the project have their laboratories in the Donner Laboratory or Donner Pavilion, the remaining being in the life sciences building, at the animal laboratories, or working in connection with one or another of the several accelerators.

In the case of the Donner Laboratory, it is anticipated that greater emphasis will be placed on the use of the particle-accelerators available at LRL to study the effects of heavy-particle radiation on cells and cell components. These studies at first will be basic but, no doubt, will have practical therapeutic applications. There is the possiblity that a particle accelerator specifically designed for deep X-ray therapy may be designed and built.

Research on the biological effects of deuterium will also be expanded.

The experiments concerned with photosynthesis and basic molecular radiation chemistry will continue to provide the major stimulus for many of the ideas responsible for the progress in understanding the effects of radiation on living tissue. It would not be improper to anticipate within the next 10 years a major breakthrough in this field on photosynthesis and energy accumulation in living tissues which would have major effects on the whole field of biochemistry.

The studies on the distribution of radioactive materials in the mammal will gradually be terminated as the animals die off. The space used for this program will be employed to develop a colony of pathogen-free animals which will be particularly useful for analyzing the role of stress from infectious diseases in the acute and chronic radiation syndrome. Other studies which may expand abruptly if a breakthrough develops are concerned with: the erythropoietic principle obtained from urine; the pinhole camera technique of scanning; the relation of fatty materials and foods to disease of the arteries and to the aging process; and the use of labeled hormones and biological compounds to study biological processes and diseases.

It is recommended that the role of the Lawrence Radiation Laboratory, as well as that of LASL and Sandia, include increased attention and expansion of theoretical and laboratory studies of weapons effects, phenomenology of blast, thermal, prompt radiation, and fallout.

The training effort at Berkeley is gaining greater reputation every year but there is a limit to the number of persons which can be accepted and adequately trained at the laboratory; in this case the limit is set by both space available and the permanent staff supported by the budget. On the whole, therefore, the Donner Research Laboratory should expand in a gradual well-controlled fashion to about 50% greater than its present size and activities. This will necessitate a rearrangement of the present facilities and quarters, but no predictions are possible until the university has decided a number of internal problems.

The FY 1960 operating level of support is $2,226,000, with an effort of 64 scientific man years.

LABORATORY PROGRAM FORECAST

LOS ALAMOS SCIENTIFIC LABORATORY

The Los Alamos Scientific Laboratory was officially established in April, 1943 for research and development concerned with nuclear weapons. Although weapons research remains one of the major objectives of the Laboratory today, the personnel and facilities make it a center of physics research and there are large programs in theoretical and experimental physics, chemistry and metallurgy in addition. Since from the outset, it was known that Los Alamos workers would be handling plutonium, a Biomedical Research Division was immediately organized to study the unique and difficult problems attendant thereto. From this beginning, the present biomedical research group of about 25 staff members and 30 supporting personnel has grown. While most of their activities have been directly related to weapons research development and testing, many of the problems encountered have necessitated basic research on radiation biology, biochemistry, biophysics, radiochemistry and instrumentation. The program of the Laboratory has been especially valuable in studying the physiology and effects of a variety of radioactive isotopes and fission products, and in the development and application of scintillation counting techniques including whole body counting methods. In addition, the Laboratory has been invaluable in radiation monitoring at weapons tests and in the fallout monitoring and surveillance project.

The total program will remain quite stable in the coming years. Continued emphasis will be placed on scintillation counting techniques for monitoring and whole body counting purposes. Attempts to recreate under laboratory conditions the exposure rates of a fresh fallout gamma field will expand slightly along with measures of changes in recovery mechanisms and resistance to stress. Smaller studies in cell injury and metabolism will provide data pertinent to the whole body effects of radiation under investigation. Some expansion in studies on the toxicity of tritium and tritiated compounds is anticipated though this will be offset by the completion of other studies of fission product metabolism and effects. The Los Alamos program on the long term effects of partial body and wole body irradiation will continue. No major expansions of program are anticipated. The close adherence of the Los Alamos Scientific Laboratory program to the programmatic needs of the Commission will continue.

Support of biomedical research may be expected to increase in the order of 15% from its FY 1960 operating level of $1,008,000, and 25 scientific man years of effort.

LABORATORY PROGRAM FORECAST

HANFORD ATOMIC PRODUCTS PLANT

The completion of the plutonium production facilities in 1944-45 necessitated a program of biological research to insure an adequate radiation protection program. This involved studies of fission product and especially plutonium metabolism and effects. In addition, since water was used to cool the reactors, investigation of possible effects on aquatic life in the Columbia River was initiated. The close association of the Hanford biological research program to a production facility has pointed the way towards many problems of importance to the Atomic Energy Commission. In recent years, the character of the research program has gradually changed towards a more basic approach to the problems being studied. In addition, a closer liaison between the northwestern universities and Hanford is developing which promises to be beneficial both to the university community and to the Commission.

Research endeavors concerning the hazard evaluation of internally deposited radioisotopes on organs and organ systems in small and large animals will be maintained and expanded where necessary, since little valid information is currently available to delineate dose-effect relationships and to permit acceptable extrapolation of effects and hazards to man. Chronic feeding experiments employing various fission products and reactor effluent radioisotopes have been emphasized. Particular attention is directed toward radiation effects on nucleic acid metabolism of the gastrointestinal tract. Projected studies over the next ten years will be expanded to include comprehensive metabolic and biologic response studies concerning Pu-239, Sr-90, Ca-45, Ra-226, Zn-65, P-32 and Ru-106.

Development of the use of miniature swine as an experimental animal will be emphasized. Studies concerning removal of internally deposited isotopes, such as plutonium, should be expanded. The addition of studies on the factors affecting the permeability and absorptive properties of cells toward radionuclides is urgently needed.

Biological and environmental sciences research at the Hanford Plant is being supported in FY 1960 at a level of $2,298,000, with 63 scientific man years of effort. On the assumption that national economic factors remain constant and that organizational relationships of the program are not altered, the current level of support could be expected to increase approximately 15%.

LABORATORY PROGRAM FORECAST

ARGONNE CANCER RESEARCH HOSPITAL

The Argonne Cancer Research Hospital, operated by the University of Chicago, was completed in early 1952 and made an integral part of the Billings Hospital, both of which are closely integrated with the Medical School. The establishment of this cancer hospital was authorized by the President for the primary purpose of exploring the therapeutic and diagnostic uses of radioisotopes in patients suffering from cancer. This facility provides an opportunity for competent medical scientists to conduct comprehensive studies in patients hospitalized with various types of malignancies. In particular, it also affords an opportunity to assess the therapeutic value of various teletherapy devices, including the cobalt-60 unit, the 2 Mev Van de Graaff, and the 50 Mev linear accelerator.

Though the program is oriented primarily toward metabolic studies and the therapeutic use of high energy particle accelerators, the group has been encouraged to pursue any promising leads, though peripheral, to the cancer problem. The encouragement of such research tends to attract better scientists into the program.

With the recently completed 50 Mev linear accelerator now in operation and being used in the treatment of patients, this cancer research facility has reached a stable operational level which should not increase to any great extent in the foreseeable future. The main mission of the Hospital will continue to be that of conducting extensive studies on hospitalized patients using radioisotopes therapeutically, diagnostically, and as tracers in metabolic experiments.

There should be little or no change in the tempo of studies directed toward detecting metabolic defects in both cancer and irradiated patients. With the available personnel interested in this phase of the research program, it is envisaged that there will be a continued interest in improvising new instrumentation, as well as the utilization of various isotopes and labeled compounds in studying metabolic defects.

The follow-up studies which have been carried out in the radium dial painters in cooperation with ANL should continue for several years, and in all probability the whole body counter at ACRH will prove useful in studying these patients and/or any other patients with similar conditions.

Both the immunological research and the research associated with recovery from radiation injury will continue at the same tempo for the ensuing three years. Also, the program directed toward an elucidation of factors which influence survival of transplanted tissues will be a continuing effort for at least a three-year period.

That portion of this program which requires some comment is the matter of erythropoietin studies. It is the expectation that in the very near future this substance will be isolated and characterized to such an extent that clinical trials will be feasible. If this becomes a reality within the next year, much of the current work in this area will terminate. Whether or not the costs involved with the clinical trials will be borne by the AEC is a matter which has not been resolved; if so, this would approximate $200,000.

It is well recognized that the decision to build and operate a cancer research hospital closely integrated with a first-class medical school has certain intangible benefits. An undertaking of this sort was not possible financially by a private institution, and in this case it has enabled a group of outstanding medical scientists to have available the facilities of the AEC to cope with most intricate and complicated problems. Though one might argue that such a facility might easily be supported by private enterprise, in reality its effectiveness would be greatly reduced under such an arrangement. The operation of this facility is costly on one hand, but it does permit careful and thorough study of cancer patients who otherwise would find it impossible to remain hospitalized for long periods of time. A considerable amount of knowledge is being accumulated in this Hospital, and it is important to note that a thorough study of selected patients yields considerable information to the research workers in contrast to the rather short-term type of study one would be forced to conduct in a private hospital where daily expenses are a concern to the patient.

It is difficult to predict results of this study during the next ten-year period, but in this particular instance it is considered that the operational level should be fairly well stabilized; and, barring any unforeseen problems, should not exceed the $2,500,000 figure, as compared to the FY 1960 level of $2,100,000, with an effort of 46 scientific man years.

The possibility of transferring funding and responsibility of this Hospital to another agency of Government was raised some time ago, and the justification for not doing so still holds.

In its basic legislation the AEC is authorized to engage in medical, biological, and health research involving the utilization of fissionable and radioactive materials. The Congress has made it clear that it wishes the Commission to engage in cancer research, as evidenced by specific language in the Appropriation Act for FY 1948 when $5,000,000 was made available for that purpose. The medical consultants to the Commission at that time considered the Argonne Cancer Research Hospital unit a proper part of the AEC cancer program. The Surgeon General of the Public Health Service carefully reviewed this project and reported that he and members of the staff of the National Cancer Institute considered it justified.

With time there has evolved some change in direction and emphasis in support of cancer research. In particular, the rapidly expanding uses of radiant energy, the increasing numbers of workers potentially exposed to radiation, the world-wide increase in radiation background secondary to atomic weapons testing, and the future problems yet to be solved in waste disposal from power and industrial uses all prompt the Commission to maintain an active supporting interest in cancer research and also in the relationship between radiation exposure and cancer induction.

The total budget for cancer research within the Division of Biology and Medicine is approximately eight per cent of the total budget, an amount which is considered minimal by our Advisory Committee for Biology and Medicine. The ACBM report of its January 1959 meeting recommends that the ACRH not be divorced from Commission responsibility.

LABORATORY PROGRAM FORECAST

UNIVERSITY OF ROCHESTER ATOMIC ENERGY PROJECT

The University of Rochester Atomic Energy Project had its beginning in 1943 under the Manhattan Engineering District. Its mission was to develop experimental data that would enable the establishment of safe levels of exposure to various chemicals and radioactive substances used in the development of the A-Bomb.

After the establishment of the Atomic Energy Commission, the biological and medical program at the University of Rochester was placed on a more permanent basis, and more closely associated with the University. The physical proximity of the AEC facilities to the Medical School has contributed to the closest association and integration with the parent university of any of the Commission-sponsored laboratories. The Project is administered by the Department of Radiation Biology, Which has full departmental status in the Medical School. Nine members of the Project staff hold the rank of full professor, and there are many more in the other faculty grades. The total scientific staff numbers about fifty.

An important educational and training program is operated by the Project. In addition to Commission-supported courses in Radiological Physics and Industrial Medicine, which supply many of the health physicists for Commission and contractor facilities, more than half of the graduate students enrolled in the life sciences in the University Graduate School are under the Department of Radiation Biology. These students may major in biophysics, radiation biology, pharmacology, or biochemistry. The graduates of these courses have filled many responsible positions in the Commission installations, both in research and in operations.

Program Forecast

Although the Rochester Project now has strong teaching and basic research programs, the Commission continues to rely on this laboratory for much of its toxicological data. The Division of Pharmacology and Toxicology has always cooperated in studying the toxicity, retention, excretion, and movement within the body of materials in the atomic energy industry suspected of chemical or radiological toxicity or other detrimental effects. Uranium, thorium, radium, radon, beryllium, polonium, thallium, indium, and mercury are examples. The alpha-inhalation laboratory is well equipped to study the relation of various particle sizes to the inhalation, retention and distribution of aerosols. The studies are expected to continue for many years and will be increased by the addition of strong programs in aerosol physics, pulmonary physiology, and instrumentation. Other programs in this division are devoted to bone metabolism and the study of the transport of ions across cellular membranes.

The Radiology and Biophysics Division is oriented primarily toward the study of biological processes by physical techniques and of certain aspects of chronic radiation damage and recovery. These programs are expected to continue for a number of years at the present level of effort. A relatively small program concerned with amino acid metabolism could be transferred to other University departments.

The Medical Division carries out metabolic studies in irradiated animals, and devises and tests various clinical procedures for promoting recovery from acute radiation damage. This program is expected to decrease in activity unless radically new anti-radiation drugs are developed. It is anticipated that the Medical Division will decrease the level of its experimental program with animals and pay increased attention to long-term effects as they may be observed in human populations occupationally exposed to radiation and radioactive materials.

A small but significant program, both basic and applied, on the production of burns by short, intense flashes of thermal radiation has supplied the Commission with most of its knowledge of the processes involved and possible methods for protection from burns caused by nuclear weapons. This work is essentially complete and will be phased out during the next two years. The basic program in physical measurements will probably be transferred to the Institute of Optics.

During the past few years the staff of the Project has paid increasing attention to the programs dealing with long-term, low-level effects of radiation in several species of laboratory animals. These studies are expected to continue for a number of years and may be further increased to meet specific needs of the Commission. However, no significant increase in the number of scientific personnel is planned, and it is expected that the level of operations will remain essentially constant during the next ten years.

The FY 1960 operating budget at the University of Rochester is $1,746,000.

LABORATORY PROGRAM FORECAST

OAK RIDGE INSTITUTE OF NUCLEAR STUDIES

MEDICAL DIVISION

The Oak Ridge Institute of Nuclear Studies is a non-profit corporation of 37 Southern universities and colleges which have the responsibility over the four Divisions of the Institute: Special Training, University Relations, Museum and Medical.

The Medical Division was formally organized in January 1949 as a research unit, the broad interests of which are directed toward the preliminary investigation of promising possibilities in the application of radioactive substances to the study of cancer and related disease. It was located in Oak Ridge with the expressed intent of developing a medical center peculiarly appropriate to the Oak Ridge location which would exploit for the benefit of medicine as a whole the special opportunities of an A. E. C. installation. The presence and personal interest of a large staff of outstanding electronic, nuclear instrumentation and isotope production specialists of the Oak Ridge National Laboratory has contributed greatly to the successful pioneer work in radioisotope therapy, teletherapy design and patient treatment.

A primary reason for establishing a clincial research program at Oak Ridge was the availability of short-lived isotopes from the reactors. The extensive clinical evaluation of gallium-72 with a half-life of fourteen hours is an example of a study carried out at ORINS that would have been impossible to undertake at a more distant location from an isotope producing reactor. Currently the efforts in the clinical program are directed toward the internal use of new isotopes plus studies involving external irradiation followed by bone marrow transplantation. Extensive basic and pre-clinical studies are being pursued in an effort to learn more about the distribution and metabolism of man in the diseased state. Thus far 1,002 patients have been admitted for treatment. One hundred and sixty-six articles have been published in medical and scientific journals.

A corollary feature of the ORINS' Medical Division is the close working relationship which has been developed between clinical and instrumentation services. In many institutions the patient program is administratively quite separated from the physics and electronic areas, and the close cooperation and intimate working relationships ORINS now enjoys naturally are not often possible. In the case of ORINS the clinical program continually calls attention to problems requiring new instrumentation; the instruments are developed on the spot with clinical and electronic specialists working together throughout; and when developed the instruments are tried out on patients by the same team of specialists.

An accompaniment of this program is the training of physicians and scientists from the United States and foreign countries. One hundred and forty-four American physicians and twenty-seven foreign ones have spent from three months to two years in the Medical Division. This was augmented by thirty-six scientists in the life sciences.

It is contemplated that the Medical Division will continue to operate at or near its present level of support for at least another ten years. The completion of the Whole-Body Irradiation facility will undoubtedly lead to an expanded fundamental study on the effects of whole body irradiation with perhaps less emphasis on the use of new isotopes. The new facilities will permit radiation to be directed at patients from several directions with a resulting more uniform dose distribution. Efforts will be continued to develop biological tests that will help in determining doses so that persons exposed to known or unknown amounts of radiation can be properly evaluated and treated. It is expected that the leukemia and bone-marrow transplantation will separate into two paths of investigation: One will be the evaluation of the treatment of acute leukemia by whole-body irradiation without the addition of bone marrow; the second will be further efforts to transplant bone marrow. It is hoped whole-body irradiation with bone-marrow transplantation may prove to be an effective form of treatment for certain cases of acute leukemia, and whole-body irradiation without bone-marrow transplantation may be used to good effect in other types of leukemia or widespread neoplasm without abnormality of hematopoiesis. Greater emphasis will be given to questions of distribution and metabolism of isotopes. Of secondary interests will be the continued training of physicians and scientists in the medical use of radioisotopes and teletherapy methods.

While, as stated above, no major expansion is anticipated, studies in whole body irradiation and bone marrow transplantation could result in a modest increase of 10% above the FY 1960 operating level of $1,150,000, with 40 scientific man years of effort.

LABORATORY PROGRAM FORECAST

UNIVERSITY OF CALIFORNIA - LOS ANGELES

The Atomic Energy Project at the University of California at Los Angeles was established in 1947 in conjunction with the appointment of Dr. Stafford Warren as Dean of the newly created School of Medicine on the Westwood Campus. Dr. Warren who had been one of the founders of the Medical Department of the Manhattan District was thus able to carry on his ideas of the position of nuclear medicine in the general field of medical research and teaching. Experience has proved his concepts to have been remarkably accurate.

With the assistance of the then recently formed Atomic Energy Commission, a few surplus wooden barrack buildings were converted into laboratories, offices and animal quarters, and by mid-1948 the laboratory was in operation. Many of the early staff members have subsequently become faculty members of the School of Medicine, while others have gone into numerous fields of practical medicine.

Program-wise, the AEC-UCLA has been concerned with three main lines of research: environmental contamination; effects of radiation on the mammal; and instrumentation for biologic research. The program typically has dealt with a broad examination of the various facets of each of the above categories rather than a detailed penetration of an academic field in its relation to radiation. In addition, the program has had a distinctly programmatic outlook and has consistently resulted in data, techniques and equipment of special value to many aspects of the AEC as a whole.

This project is currently in the process of a major reorganization under new leadership. The next few years should see a gradual reorganization and reorientation of its program, with special reference to studies in mammalian radiobiology with a more definite programmatic tone. The exact lines of development will be defined according to the programmatic needs of the Commission and the talents of the staff.

The FY 1960 operating level is $1,600,000. A substantial portion of the anticipated increase in support is represented by the indirect costs related to the occupancy of the new building.

LABORATORY PROGRAM FORECAST

UNIVERSITY OF TENNESSEE-AEC PROJECT

The exposure of a number of cattle to radiation from prompt radioactive fallout from the historic Alamogordo nuclear detonation focused attention on the need to evaluate the effects of both external and internal radiations on animals of economic value. Accordingly, the University of Tennessee-AEC Project was established in May, 1948 to investigate these problems and others affecting agriculture. A large proportion of the effort has been directed towards research on agriculturally beneficial applications of radiation and radioactive isotopes.

Current research concerns nutrition and metabolism of fission products, methods of removal or minimizing radiocontamination in farm animals and animal products, and effects of external radiations, both acute and chronic, with special emphasis on effects on physiology of reproduction. The need for more data concerning fission product metabolism and removal of isotopes such as strontium-90 from milk and perhaps other foods is paramount. There are great voids in present information on radiation effects on fertility and sterility. It is essential that these programs be expanded at both national laboratories and universities. A major expansion in plant science radiobiological research is planned, along with coordinated expansions in plant science research in the Biology and Health Physics Divisions at the Oak Ridge National Laboratory. This Laboratory serves as a center for all Southeastern Agricultural Experiment Stations in our program on beneficial applications of radiations to economic crop breeding. A relatively steady level of this activity is planned. **Perhaps a 15% increase above the FY 1960 level of $560,000 could be anticipated.**

LABORATORY PROGRAM FORECAST
AEC HEALTH AND SAFETY LABORATORY - NEW YORK

The Health and Safety Laboratory was organized in 1947 to advise the Commission on matters relating to the identification, evaluation and control of hazards arising from the processing and fabrication of nuclear and other toxic materials in atomic energy operations. Of particular significance during the first years of operation of the Laboratory were industrial hygiene and health physics studies of the use of beryllium, uranium and thorium in feed materials plants which led to standards of control for these hazardous elements. The Laboratory staff served as consultants in the establishment of the health physics programs at Fernald, Mallinkrodt, and elsewhere.

Following the fallout of "radioactive snow" over portions of New York State resulting from test operations in Nevada in the winter of 1952, the Laboratory was requested to monitor the area for radioactivity on an emergency basis. This led to the establishment of a network of fallout monitoring stations which was first extended throughout the United States, and then throughout the world in cooperation with other agencies of the United States government and with members of the United Nations Scientific Committee on the Effects of Atomic Radiation. The Laboratory continues to perform a key role in the Commission's program to estimate the amount and distribution of fallout from weapons tests.

The expanded program of construction and operation of high energy particle accelerators also presented problems of health and safety, and the Laboratory has engaged in research, development and field investigations of radiation hazards and their control in the vicinity of these vital research installations.

In more recent years the Health and Safety Laboratory has added to its competencies a research program in the measurement of extremely low levels of radiation in the natural background and in deposits of radioactive materials in the biosphere. The Health and Safety Laboratory remains one of two Commission laboratories operated directly by its own employees. From an initial staff numbering approximately 15, the Health and Safety Laboratory has developed to a staff of 85 employees at the end of FY 1959, of whom about one-half are professional personnel and the larger portion of the remainder are technicians.

The Health and Safety Laboratory program embraces:

(1) Studies to identify and evaluate existing and potential hazards found in AEC and Contractor installations, involving: (a) mining and subsequent production processing of nuclear materials, (b) storage and handling of nuclear materials, (c) fabrication of components containing nuclear materials.

(2) Research and development on the health and safety aspects of accelerator design and operation.

(3) Development and application of methods to estimate the amount and distribution of deposited debris from weapons tests.

(4) Development and application of methods for the measurement of radiation at low dose rates, such as from natural background, in order to implement, (a) epidemiological studies of large populations, (b) accumulation of data as a basis for evaluating degree of environmental contamination in the neighborhood of reactors and other installations involving the use of atomic energy.

The above program is pursued under the guidance of the Director, Division of Biology and Medicine for the primary purpose of contributing to the maintenance of adequately safe conditions in laboratories and industrial plants owned by the AEC, as well as in privately owned installations operated under contract to the AEC. A number of the large establishments are provided with health physics or safety divisions which contribute effectively to the immediate control of radiation and general safety in the specific locations. The role of the Health and Safety Laboratory does not encroach upon the activities of local safety groups operated by and for the individual contractors. Instead, the Health and Safety Laboratory, which is the only laboratory of its type operated directly by the AEC, exerts its efforts toward developing guide lines and techniques for maintenance of health and safety in the atomic energy enterprises so that the principles and techniques developed can be utilized not only by the large and small establishments existing at present but also by the numerous industrial establishments which are expected to come into existence within the relatively near future.

The only portion of the program described above which probably should be emphasized less intensely within the next ten years is that dealing with the fallout problem (weapons test debris). On the assumption that henceforth no Nation engages in the testing of nuclear weapons under conditions which will contaminate the atmosphere, there will be a diminishing need to conduct routine sampling and analysis of fallout samples for the purpose of defining the status of fission product deposition. While it is difficult to estimate just when this effort could be reduced virtually to the disappearance point, it may be estimated that an impressive reduction in effort would be appropriate at the end of another ~~three~~ five years. In this connection it should be emphasized that the techniques of collection and analysis of samples of fallout are applicable to those situations which would develop in the case of a severe reactor accident which resulted in the dissemination of fission products over a considerable portion of the landscape. As long as the Atomic Energy Commission maintains its preeminent position in the construction and operation of reactors it would appear that it will be the AEC's responsibility to maintain competence for evaluating the severity of reactor accidents.

At some time in the future other portions of the above program may become of more interest to private industry than to the Atomic Energy Commission. Just when this transition may occur is problematical, but probably industry's obligation and concern will not become preponderant with respect to that of the AEC within the next ten years.

If the assumptions stated above concerning the status of the fallout problem are correct, and a modest expansion is sustained for other HASL projects, the FY 1960 operating budget of $1,894,000 will not change materially.