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UNIVERSITY OF CALIFORNIA

PROGRAM

in

CANCER RESEARCH

Third Annual Report

January 1953

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School of Medicine
 University of California Medical Center
 San Francisco, California

Dr. Michael B. Shinkin, Consultant
 University of California
 San Francisco, California

Dr. Michael B. Shinkin, Consultant

Transmitted herewith to you is the Third Annual Report of the
 of California Program in Cancer Research.

The report is based on progress reports submitted by all
 of grants for cancer research made from the State of California
 for cancer research and other University of California
 sources, and by recipients of grants from national foundations, particularly
 the American Cancer Society, and from the Federal Government, through the
 United States Public Health Service.

The report has been read and approved by Doctors N. E. Nelson,
 acting for the Chairman of the Cancer Research Committee, Southern Section;
 D. M. Greenberg, Chairman of the Cancer Research Committee, Northern
 Section and the Cancer Research Coordinating Committee; and R. S. Stone,
 Chairman of the Cancer Board of the School of Medicine, University of
 California Medical Center, San Francisco. Their corrections and
 suggestions have been incorporated in the report.

The Addenda, upon which much of the body of the report is based
 and which contain detailed information regarding finances and related
 matters, were compiled by Miss Barbara Clark, the secretary of the Cancer
 Research Committee, Northern Section and the Cancer Research Coordinating
 Committee, from information made available from your office by Mr. Russell
 Barthell, and other sources.

Your attention is directed towards the section entitled,
 "Conclusions and Recommendations" (pages 32 to 34) which indicates some
 of the problems in regard to the future development of the cancer research
 program of the University of California.

Respectfully submitted,

Michael B. Shinkin

Michael B. Shinkin, M.D.
 Clinical Professor of Experimental
 Oncology, and
 Director, Laboratory of Experimental
 Oncology

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THE UNIVERSITY OF CALIFORNIA PROGRAM IN CANCER RESEARCH

Third Annual Report, January 1950

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INTRODUCTION

The third annual report on the University of California program in cancer research should be considered in relation to previous reports, submitted in 1947 and 1948. The first annual report in 1947 emphasized the administrative organization of the program. The second report in 1948 dealt chiefly with specific lines of investigation undertaken by individual scientists and groups engaged in the program. The report for this year attempts to outline the areas where advances are becoming apparent or can be anticipated within a reasonable future.

It is gratifying to note the steady development of this University-wide program, made possible by continued active support and sympathetic understanding. It should again be realized that many of the projects have been barely initiated; this is particularly true of investigations on the Los Angeles campus. It should also be noted that the full development of the program cannot be achieved until the projected physical facilities are completed and occupied on the San Francisco and Los Angeles campuses. Nevertheless, and in general, the organization and the pattern for the cancer research program have now been established, and the program is now entering the phase of natural growth and productivity.

The tree has been planted; the roots are taking hold.

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ADMINISTRATION

The total moneys for cancer research (exclusive of construction, fellowship, and teaching grants) allocated to the University of California in 1947 amounted to \$621,375; in 1948, \$618,053; and in 1949, \$1,072,740. The summary of sources and the amounts are detailed in Addendum I. Specific allocations made from the State appropriation and endowed funds to investigators within the University are listed in Addendum II.

Projects supported by the National Cancer Institute of the United States Public Health Service, and by the American Cancer Society, are itemized in Addenda III and IV, respectively.

As indicated in Figure 1, the financial support for cancer research at the University has risen by approximately \$200,000 each year since 1947. This rise is due to the increasingly larger grants from the U. S. Public Health Service and from the American Cancer Society. The funds available directly to the University, from its income on endowments and the State appropriation, remain at the same level. These funds form the permanent base of the program. For every dollar spent directly by the University for cancer research during 1949, \$2.70 was attracted from other sources. The present financial support is generous indeed (cf. Reynolds and Price, Amer. Scient., 37: 578, 1949).

These large sums, even so, do not include additional personnel for research programs paid through the medium of direct research fellowships. As given in Addendum V, the University during 1949 had 21 research fellowships, of which 9 were granted by the American Cancer Society (3 from the Damon Runyon Fund) and 12 were supported by the National Cancer Institute, involving a total expenditure of \$74,200.

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Figure 1

Financial support of the University of California program in cancer research during the calendar years 1947, 1948 and 1949, exclusive of support of research fellows, and teaching and construction grants.

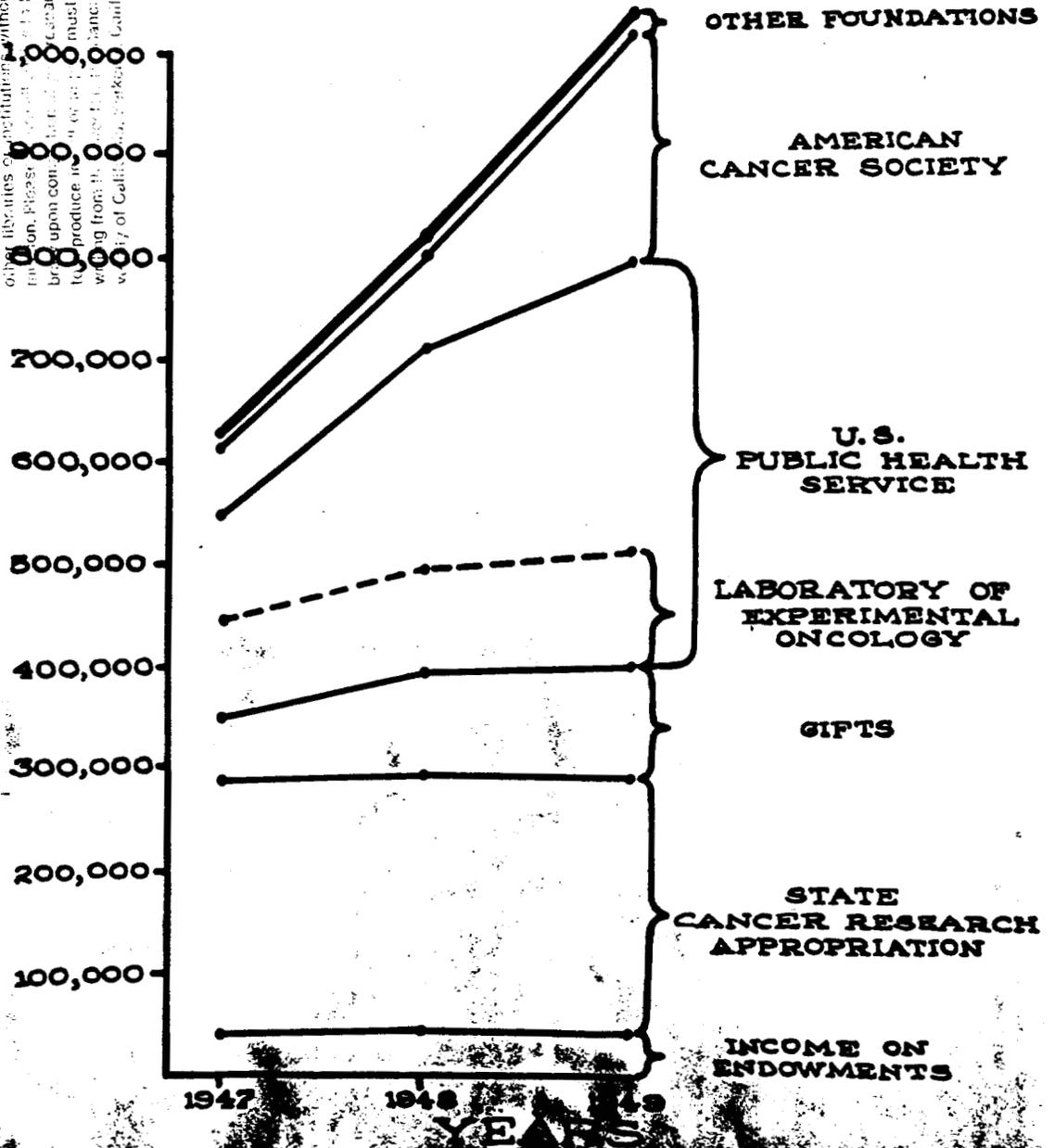
Figure 2

Construction grants for cancer research awarded to the University of California.

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 \$ 100,000
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 1948

BERKELEY
 SAN FRANCISCO

CANCER RESEARCH INSTITUTE
 \$1,000,000
 U.S. PUBLIC HEALTH SERVICE
 1948

INSTITUTE FOR CANCER RESEARCH
 \$700,000
 U.S. PUBLIC HEALTH SERVICE
 1949

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The School of Medicine in San Francisco receives \$25,000 per year from the National Cancer Institute for the purpose of improving cancer teaching. The School of Dentistry receives \$5,000 annually for the same purpose from the National Cancer Institute. These funds have obvious implications for cancer research as well as for teaching. In addition, a grant of \$13,000 is used for a national evaluation of teaching techniques and their effect upon cancer learning.

At the last meeting of the Cancer Research Coordinating Committee, held on May 12, 1949, in Los Angeles, the Committee formulated the policy that after a three-year period of support, all projects would be reviewed de novo on the basis of results or progress achieved. This, however, is not intended to imply that projects receiving support will be automatically renewed for any period beyond the grant for one year. The procedure will allow evaluation of endeavors and their priority in comparison with competing lines of investigations. It is apparent that advances will be made first in areas where the necessary techniques have already been developed, often for purposes distinct from cancer research. It would seem unprofitable to expand into many entirely new fields of exploration without first exploiting to the full the special talents of its staff and techniques in which the University has assumed the leadership and for which it is most renowned. Also, it has become obvious that continued progress is to be anticipated particularly in large areas of cooperative studies in which many disciplines are well represented and in which the study of cancer forms one of the main interests. At least five large groups of this type exist at the University: the Cancer Research Institute of the School of Medicine in San Francisco, of which the Laboratory of Experimental Oncology is a division; the Institute

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Research of the School of Medicine in Los Angeles; the Donner Laboratory of the Division of Medical Physics; and the Department of Biochemistry, on the Berkeley campus. Continued support of these large units is even more important than the support of individual projects. Decisions of the Cancer Research Coordinating Committee regarding its recommendations for the allocation of funds at its disposal are often difficult; and have to be made on the basis of many considerations. The total amount it can recommend for allocation is approximately \$290,000, of which \$250,000 comes from the State of California appropriation for cancer research; this amount has been approximately the same in 1947, 1948 and 1949. Each year, the total sums requested have amounted to approximately \$450,000. The number of separate project requests, however, has mounted steadily; 27 requests were made in 1947 and of these, 22 were granted; 40 requests were received in 1948 and 33 were approved; 51 requests, of which 34 were favorably considered, were made in 1949. These figures demonstrate an increase in ideas and in investigators who wish to work on problems related to cancer. The limitation of funds obviously implies that some projects, even if considered valuable, have to be rejected and asked to seek support elsewhere, or else the funds would become fragmented and much less effective.

The growth and development of the cancer research program can be gauged to some extent by the number of publications issuing from its workers. Last year, 28 separate reports from the University appeared in the scientific literature, while 20 additional papers were in press. This year, 105 separate contributions are listed in Volume VI, and at least 30 additional ones are in the process of publication.

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RESEARCH PROGRAM

The description of the research endeavors of the University of California investigators will be divided, as in the previous report, into five main topics: (a) carcinogenesis, (b) nature of the cancer cell, (c) cancer-host relationships, (d) diagnosis of cancer, and (e) therapy of cancer.

The financial support for specific lines of investigations or specific investigators is indicated in parentheses and refers to items in specific Addenda. References to published work are also given in parentheses, as listed in Addendum VI. For example, "Smith (II,3; III,5; 37)" would refer to Addendum II, item 3 and Addendum III, item 5, as sources of financial support for the investigation, whereas 37 would refer to the published work numbered 37 in Addendum VI. References to publications of authors from other institutions are indicated in the text.

Carcinogenesis

The mode of action of carcinogens is a crucial problem in the study of carcinogenesis. Among the most useful of tools for such studies are isotopically labeled carcinogenic compounds, which can be traced through the body and the tissues after administration.

The University of California (23,60) is in the forefront of applying the exact techniques necessary for the incorporation of isotopes in chemicals. Dr. W. G. Dauben (II,3; 12) has successfully labeled methylcholanthrene, 10-methyl-1,2-benzanthracene and estrone, and is proceeding with the work of labeling cholesterol with radioisotopes. Dr. W. Florsheim (II,18) is also working on the isotopic labeling of proteins. The tagging of chemical entities with radioisotopes often requires the

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long as a year of concentrated work to achieve and to verify the results of the synthesis of a single compound. These efforts make available to many other investigators instruments and materials for a wide variety of fundamental investigations.

Knowledge regarding carcinogenesis has been advanced by the demonstration by Strong (Proc. Nat. Acad. Sc., 31: 290, 1945), Demerec (Brit. J. Cancer, 8: 114, 1948) and others that many, if not all, of the carcinogenic compounds also possess the property of producing mutations. The further understanding of mutation and adaptation in lower organisms is of direct importance, therefore, to the study of neoplastic transformation. Drs. R. Y. Stanier and M. Doudoroff (II,9; IV,8; 21,22,27,92) are systematically studying many interesting aspects of growth, adaptation and mutation in bacteria.

In the line of specific carcinogenic compounds, several have attracted attention at the University of California. The distribution and excretion of methylcholanthrene and 1,2,5,6-dibenzanthracene in the mouse has been a fruitful study (51). Dr. H. Moon (III,13; 56) is investigating the possibility of inducing primary testicular tumors in mice with carcinogenic hydrocarbons. So far the work has not been successful, demonstrating a high resistance of this tissue to neoplastic conversion.

The thyroid gland has been the subject of intensive study in a number of laboratories. Dr. I. L. Chaikoff (II,6; III,2; IV,2) is investigating the induction of thyroid neoplasms with propylthiouracil, acetylaminofluorene and radioactive iodine. The introduction of aminofluorene directly to the gland in thiouracil-fed animals has produced neoplastic changes in the thyroid as early as one month after the start of the experiment. The regeneration of the thyroid and the uptake of radioactive iodine

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following incomplete extirpation of the organ have been studied by Dr. H. J. McCorkle (II,36) and his group. They have shown that the residual thyroid tissue takes up less radioactive iodine than the normal thyroid before operation, and that it takes up radio-iodine to a maximum level within the first 24 hours, while the normal thyroid has a maximum uptake at 48 hours after administration of the isotope.

Drs. N. I. Berlin and J. W. Gofman (II,5; III,6) studied cobalt-induced polycythemia in rats. It was shown that when histidine and cysteine complexes with cobalt were administered there was complete protection against development of polycythemia. A mixture of cobalt and histidine alone produced only partial protection against the hemopoietic action of cobalt.

In the laboratories of Dr. H. M. Evans (II,1; IV,3,4; 29) it has been verified that various neoplastic growths, benign and malignant, occur more frequently and at an earlier age in rats chronically injected with growth hormone than in untreated controls. There is no uniformity in the type of neoplasm produced, indicating some sort of general effect. Interestingly, hypophysectomized rats injected chronically with growth hormone do not show an increase in tumor incidence, indicating a complex interplay of pituitary and other hormones rather than a direct tumorigenic property of the growth hormone itself.

Drs. W. P. Longaire and S. W. Smith (II,15) are developing experiments on atypical cellular growth in chick embryos by means of homologous transplantation of wing buds from one 3-day old chick embryo to another. The technical difficulties in such transplants have largely been surmounted and work has started on skin transplantation between normal chickens of various ages to serve as controls for grafting between pairs of embryos.

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The role of viruses in some forms of neoplastic growth is being examined by Dr. W. L. Bostick (II,29; III,12; 15,16) who is continuing his investigations of the filterable lethal factor of Hodgkin's disease. Extracts of Hodgkin's disease tissue are lethal to fertile chick eggs and this factor is transmitted in serial passage from egg to egg. The studies have progressed to the exploration of the possible immunologic aspects in the disease, such as skin reaction tests in patients with Hodgkin's disease, and ultracentrifuge observations on Hodgkin's disease tissue.

Dr. Riojun Kinoshita, on a special research fellowship, has brought from Japan a sarcoma of white Japanese rats, which is apparently transmissible by cell-free material. This tumor is being studied and is being transmitted to American albino rats for further investigations.

Drs. J. F. Rinehart and L. D. Greenberg (II,26; 46,47,72,73) are continuing their long-term studies on chemical and morphological changes associated with vitamin deficiency states in the Rhesus monkey. Arteriosclerosis comparable to that of man was observed in 3 of 4 chronically pyridoxine-deficient monkeys. This represents the first experimental induction of arteriosclerosis in the primates; monkeys do not show arteriosclerosis upon chronic feeding of cholesterol as do rabbits. The work is of significance to the developing program in cardiovascular diseases now being undertaken on a national scale.

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11

Nature of the Cancer Cell

The most direct and probably the most significant approach in cancer is the study of cells, their biochemical and physical characteristics, and the differences between such cells and the abnormal cancer cells. More and more data are accumulating to indicate that the neoplastic transformation represents a transmissible change in the pattern of the nucleoproteins of the cell. Whether this alteration is nuclear or cytoplasmic is not certain (cf. Caspari, Adv. in Genetics, 2: 1, 1948). Recent developments of such technics as microchemistry, histochemistry, and the physical and chemical separation and analysis of various components of cells make increasingly feasible the exploration of this basic unit of living matter.

The studies may be divided according to several approaches, all of which complement and cross-fertilize each other. Work on cells is impossible without the development of exact reproducible methods of measurement of minute quantities of various constituents. The work of Dr. P. L. Kirk (III,4; IV,7; 54-57), extending over many years, has led to the application of numerous micro-methods which allow direct chemical observations on individual cells. During the past year a multiplier phototube attachment to the Beckman spectrophotometer has increased the sensitivity of the instrument by about 750 fold. A micro-Kjeldahl procedure has been developed which determines as little as 0.00001 mg. of nitrogen in the total sample. A microgram method for analysis of carbon in biological fractions, such as fat, is approaching completion. Amperometric titration for the sulphhydryl compounds in microgram quantities also has been achieved.

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12

The ideal material for study by micro-methods are cells grown in tissue culture. Many of the recent advances in this old technic have been made by Earle (J. Nat. Cancer Inst., 8: 103, 1946), who can now grow almost limitless quantities of the material and who is rapidly developing artificial media for maintenance of growth of such cultures. Dr. H. Harris (II,10) during the past year has established and put into operation a tissue culture laboratory which will meet many needs for collaborative efforts in problems at the very heart of the cancer problem.

The fractionization of cells and their components is proceeding in many laboratories. Drs. O. L. Sponser and J. D. Bath (II,22; 3,91), by x-ray diffraction, micro-electrophoresis and high-speed centrifugation are separating submicroscopic particles from cells of lower organisms such as Algae flies, for further clarification of their physical and chemical characteristics.

An ingenious and interesting method for the determination and analysis of minute amounts of trace elements in animal tissue has been developed by Drs. C. A. Tobias, R. Wolfe and R. W. Dunn (II,5; 77,96,105). This method allows the procurement of a wealth of data obtainable from the radio-activation analyses of tissues, including tumors.

The isotopic labeling of compounds has as an important place in cellular studies as in the investigations on carcinogenesis. Here again, Drs. W. G. Dauben, M. Calvia and many others (II,4; III,3; IV,6; 38-44) are tagging various compounds of interest for intermediate metabolism, for studies on their incorporation in normal and neoplastic tissues, both in vivo and in vitro.

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Dr. M. S. Dunn (II,21; III,11; IV,9; 17,24,25) has completed studies on the content of many amino acids in tumors and in normal tissues. It was found that fibrosarcomas in rats contain a markedly higher content of arginine and glycine and a lower content of histidine and methionine than normal tissues. Work is proceeding on microbiological methods for the determination of D-amino acids which would reveal the possible significance of these analogs in tumors and in normal tissues.

Dr. F. W. Allen (II,9; 2) is continuing his studies on the chemistry and properties of ribonucleic acids, an integral component of all nucleoproteins of the cells. By methods of histochemistry, Dr. H. A. Bern (II,11; 4-8) is delineating the presence and distribution of alkaline phosphatase in the prostate of various animal species before proceeding with the effects of carcinogens and of neoplastic transformation on this enzyme.

Immunological techniques have been applied by Dr. A. M. Schechtman (II,19) to the problem of differentiation of tissues. He found that there is antigenic specificity and difference between nuclear and cytoplasmic constituents derived from normal rat liver. The nature of the antigenic systems of nuclei is being explored further by various biochemical approaches. Drs. L. E. Melcher and M. B. Shiskin (II,25; III,17), also using immunological techniques for differentiation of tumor and normal tissues, have found in two human tumors a protein fraction obtained by 20 percent ethanol precipitation which produced reaction of sensitized guinea pig intestine after its desensitization to similar fractions from normal liver or spleen. The work would indicate that the problem of determining antigenic differences not only by the Schultze-Hale technique but also the absorption-precipitation between tumor and normal tissues by the antigenic specificities.

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The preparation of radio-iodinated immune globulin by Drs. S. P. Masouredis and L. R. Malcher (II,25,33) allows a technique for tracing immune globulins against various tumor fractions in the animal organism.

Certain specific enzyme systems of tissues and tumors are being investigated by Drs. J. J. Eiler and W. K. McEwen (III,15,16: 26), who are studying aerobic and anaerobic phosphorylation in slices of normal and tumor tissues; and by Drs. J. B. Biale and T. A. Geisman (II,23), who are interested in D-amino acid oxidase.

The rate of turnover and incorporation of various compounds by tumors and by normal tissues is a wide field which is being avidly pursued in several laboratories. Here again the use of radioactive tagged compounds offers opportunities that would have been impossible to realize before the introduction of these methods.

Dr. D. M. Greenberg and his co-workers (II,8; III,5; IV,5; 38-44,70) are studying the incorporation of isotopically labeled amino acids into the protein material in tissue slices and tissue homogenates. This process has been shown to be promoted by a complex enzyme system which is particularly active in mitochondria. The process is endergonic and normally requires the presence of oxygen and an oxidizable substrate in the media. The characteristics of the uptake of 5 labeled amino acids, glycine, alanine, phenylalanine, serine and methionine, have now been studied. There is evidence that the different amino acids may be taken up at different points in the protein material of the enzyme preparation. The reaction involves high energy phosphate compounds, requires the adenylic acid system and magnesium ion, and is inhibited by lack of oxygen.

Experiments are under way to determine if malignant tissues can utilize the energy of the high energy phosphate compounds formed during

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fermentation for protein synthesis or whether this is peculiarly coupled with aerobic oxidation. The accumulation and turnover of C14 labeled amino acids in animals with transplantable lymphosarcoma and sarcoma 37 are also being studied. The ability of such tumors in vivo to incorporate the isotope was found not to be as great as that of such metabolically active tissues as liver and kidney but was much greater than that of muscle. The uptake by muscle was consistently depressed in the presence of growing tumor.

Drs. F. Pierce and J. W. Gofman (II,5) are studying the metabolic properties of leukemic white blood cells as well as leukocytes from different types of leukemia. They have reviewed and established usable methods for the isolation of white blood cells with as little biochemical damage as possible; reproducible values for oxygen uptake are now obtained. The investigators are comparing the respiration of normal and leukemic white cells, and by means of paper chromatographic and microbiological assays are determining the amino acid patterns of normal and leukemic white cells as well as the radioactive phosphorus uptake and turnover rates.

Drs. N. Halliday and M. B. Shiskin (II,25; III,17; 26) have demonstrated that the histamine-like material which is markedly elevated in myelogenous leukemia granulocytes has the chemical characteristics of histamine. Miss P. L. Morrow, Dr. H. R. Bierman and Mr. R. Jenkins (II,25; III,17) have concluded studies demonstrating that leukemic white cells are considerably more resistant to destruction when exposed to ultrasonic vibration in the 650 kc range than are normal white blood cells of human origin.

Mr. M. Sable and others (II,25; III,17) have established that a considerable electric potential develops in growing chick eyes, particularly 3 days or later after the eyes have been isolated. The development of

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the electropotential is unequivocal, and there is a suggestion of a consistent pattern. This electric potential seems to be increased when tumor tissue is grown successfully on the chorioallantoic membrane.

Cancer-host Relationships

This line of investigation is devoted to the exploration of the effects of the presence of a tumor upon the host. It is upon the basis of further study of this aspect of cancer research, combined with additional knowledge regarding the nature of the cancer cell, that diagnostic tests for cancer may materialize. Increasing information is accumulating that the presence of a malignant neoplasm has marked generalized effects upon the host, although none of these effects can be stated to be unique for neoplastic growth. The studies in general orient themselves along two types of investigation: the exploration of urine, excreta, blood and various tissues of animals or human beings, with the hope that some specific constituents may be found; and the study of the dynamic phases of metabolism and differences in metabolism in cancer-bearing as contrasted with normal animals or patients.

Dr. P. M. West (III,9; 101, 102) has carried on the determinations of proteolytic enzyme inhibitors in blood. Methods have been developed for quantitative assays of anti-chymotrypsin and anti-rennin in human serum, and more than 20,000 determinations have been made. It has been found that the rennin inhibitor is higher than chymotrypsin inhibitor in normal blood serum, whereas in cancer, the chymotrypsin inhibitor values rise and there is a drop in the rennin inhibitor, producing reversal of the normal relationship. It is emphasized that similar enzyme disturbances occur in conditions other than cancer, and the procedure is being developed as diagnostic for

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malignant. The method may provide, however, an objective measure of the
 the cancer patient and of his response to therapy. Investigations
 are continuing on the analysis of the factors which are responsible for
 the alterations, including studies on the chemical nature of the anti-
 enzymes. Anti-rennin, for example, is a high-molecular-weight protein
 which can be concentrated by ultra-centrifugation of serum. Adrenal
 cortical activity has been found to be of importance in regulating the
 anti-enzymes.

Drs. S. L. Warren, R. M. Fink and K. F. Fink (II,13) are applying the
 paper chromatographic technique to human urine with accentuation on the
 urinary amino acid excretion. Four hundred urine specimens have been
 studied by this method, and may reveal interesting data of importance
 regarding metabolic factors involved in cancer and other disease conditions.
 Dr. H. B. Friedgood and co-workers (34) are also studying the phenolic-
 like urinary steroids in human urine by methods of paper chromatography.

Drs. L. A. Strait, R. R. Bierman and M. K. Hrenoff (II,23; III,17;
 IV,13; 10) are determining the excretion of coproporphyrin in urine and
 have found very high values in the presence of neoplastic disease and upon
 treatment with nitrogen mustard. These findings are tentatively ascribed
 to endogenous destruction of tissue, perhaps particularly of the hemato-
 poietic elements.

Physico-chemical and tracer studies of lipoprotein complexes of the
 blood, applying particularly ultracentrifugal techniques to the problem
 have been undertaken by Dr. J. W. Gofman (II,5; 37). The sedimentation
 properties of the low density lipoproteins in which the major occurrence
 of cholesterol and estrogen would be anticipated have been determined in a
 large number of normal human subjects. The major component is a molecule

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with the sedimentation constant of 5 to 7 Svedberg units; in a group of 20 sera, 8 showed appreciable concentration of components in the class of 12 to 20 Svedberg units. The significance of the presence of these molecules is not clear at present but is worthy of further investigation. Drs. B. Shacter and M. B. Shinkin (III,17) have studied the factor in human and other blood sera which inhibits catecholase activity. This inhibition is due to sulfhydryl and is markedly reduced in patients with carcinoma. The procedure has no specificity as the finding also occurs in tuberculosis, pregnancy, congestive heart failure and other conditions. The sulfhydryl content of the blood, as well as its protein components, as described by many authors, seems to be altered by the presence of neoplastic growth. Recently, direct amperometric methods have been applied to the problem.

Liver catalase activity and its effect on tumor growth has received the attention of Drs. D. Appleman and E. Skavinski (II,24). Liver catalase activity is reduced in the presence of tumor growth but seldom falls below 20 percent of normal. Rats implanted with sarcoma show enlargement of the liver and spleen and increase in blood volume, which may rise to 55 percent above normal. The results so far obtained suggest that the capacity of the liver to synthesize catalase is not affected, but the drop is probably due to shortage of precursor materials or an increased rate of destruction.

In the realm of metabolism several interesting lines of investigation which will add to our knowledge regarding many aspects of metabolism as well as having direct bearing on the cancer problem are well under way at the University.

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Dr. H. B. Jones (II,5) is continuing measurements of the rate of conversion of intravenously administered simple carbon compounds, such as acetate, pyruvate, formate, propionate, glucose, lactate, amino acids and short-chain fatty acids, in normal and tumor-bearing mice. The compounds are labeled with radioactive carbon (C^{14}). The fate of each carbon atom of the various compounds so far studied appears to be different from any labeled carbon in the same molecule or from homologous carbon atoms in related molecules, as far as the rate of conversion to carbon dioxide is concerned. Differences between normal and tumor-bearing mice have been encountered in the metabolism of methyl-labeled pyruvic acid and in carboxy-labeled propionic acids. Additionally, the metabolic pattern of beta labeled alanine has been shown to be greatly altered in the tumor-bearing animal.

The effect of neoplastic tissue on the turnover of deoxyribose nucleic acid is being studied by Dr. L. S. Kelly (II,5). Mice or rats with and without tumors were given tracer doses of radioactive sodium phosphate and its incorporation in deoxyribose nucleic acid from various tissues was determined. There was a significant increase in the specific activity of the nucleic acid in the livers, spleen and kidneys of tumor-bearing animals. The data suggest that the presence of tumors may influence the rate of cell division or at least the nucleic acid turnover rate in other tissues of the body far distant from the neoplasm itself.

Drs. W. Hall and A. White (II,16; III,10; IV,10) are studying the nucleic acid metabolism of various tissues of mice, including the concentration of ribonucleic and deoxyribonucleic acid in these tissues and how it is affected by adrenocorticotrophic hormone. Plans call for similar studies in mice with a transplantable carcinoma. An interesting study

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Dr. S. Roberts and A. White (72,73) showed that splenic tissue obtained from rats following a single intravenous injection of sheep erythrocytes released large amounts of hemolysin against this antigen on incubation in serum obtained from control animals. This antibody release by splenic tissue was much smaller when the animals were adrenalectomized. Primary evidence indicates that a transplantable mouse lymphosarcoma, after a single passage through mice hyperimmunized to sheep erythrocytes continues to elaborate antibodies to this antigen on successive passage through non-immunized animals. Antibody titers in extracts of successive transplants continued at the initial level for at least 7 passages.

Dr. S. Krichesky and, subsequent to his untimely death, Dr. Clara Szego Roberts (II,17,18; 19,33), investigated the metabolism of steroid hormones in normal and cancer-bearing animals. Methods for estrogen determinations on urine are not directly applicable to blood and tissues, and are being developed successfully. The liver plays a dual role in estrogen metabolism, being necessary both in activation and inactivation of the steroids. Drs. C. S. Roberts and T. A. Geisman are also continuing studies on possible alterations in the lipids of the liver in the presence of cancer, as originally suggested by Dr. H. S. Pean. The evidence so far militates against the suggestion that certain non-homogenous fluorescent compounds are identical with methylcholanthrene.

The application of induced radio-elements to cancer research is engaging the attention of a number of groups. Dr. D. M. Greenberg and his associates (II,8; III,8; IV,8; 22-44) determined the cholesterol metabolism of normal rats and of rats bearing a carcinoma of the liver, with C^{14} labeled acetate. The development of a method to measure the ability of the animals to incorporate radio-elements into their tissues is being

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Dr. C. A. Tobias and I. Rosenfeld (II,5) are studying the turnover of trace elements (cobalt, copper and zinc) in mice bearing transplanted primary carcinoma. With cobalt (Co^{60}) the cytoplasmic radioactivity per gram weight was higher than the nuclear activity. In the tumors, the ratio of nuclear to cytoplasmic activity was higher than in any other organ studied.

Dr. G. Scott (II,34; 81) is also investigating the deposition of radio-elements in animals bearing tumors. It has been determined that citrate and lactate complexes of the lanthanide series of carrier-free rare earths are deposited in tumors. Tumor-host studies are also being continued with compounds labeled with radioactive iodine (I^{131}), including thyroglobulin, monoiodotyrosine, diiodotyrosine and thyroxine. It was shown that the deposition of these related compounds is higher in the skins of tumor-bearing animals when compared to controls. The factor responsible for the high skin deposition of thyroglobulin appears to be a humeral one since extracts of tumors administered to otherwise normal rats also produce higher activity uptake by the skin. Injections of histamine phosphate duplicated the results observed when tumor homogenates are studied.

Dr. B. V. A. Low-Beer and his group (II,33,35) have studied differential uptake of radiophosphorus in 98 additional patients, with biopsy control in 38. Data on 180 breast cancers show an increase of 25 percent or more in 89.5 percent of the cases, whereas the uptake is less than this in 91 percent of patients with benign lesions. Selective localization of Zr^{95} and Ce^{95} has been done on 11 patients. Thirteen patients have received diiodofluorescein, without localization in brain tumors as claimed by other workers.

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The uptake of radioactive phosphorus (P^{32}) and other radioactive compounds in patients with neoplasms is being studied by Drs. S. P. Wasserdell, R. Palmer and others, in collaboration with Drs. B. V. A. Low-Beer and I. G. Scott (II,35). The uptake of such compounds by tumors is determined both by surface counting and by analysis of the tissue following biopsy shows interesting alterations upon treatment with nitrogen mustard, sex hormones and x-ray. The ability of the tumor tissue to take up radioactive phosphorus appears to have some correlation with the overall clinical response.

Drs. J. H. Lawrence and R. Huff (II,5; III,7; 53) are studying the metabolism of radioactive iron in human beings with various blood dyscrasias, as well as in normal individuals. The results indicate that the plasma iron turnover rate is high in diseases with a high rate of hemoglobin synthesis such as polycythemia, hemolytic anemia, and pernicious anemia. The turnover is also somewhat increased in leukemia, although not uniformly.

Dr. H. R. Bierman and others (II,25; III,17) have found that the lung is an important site for removal of white blood cells from the circulation. No increase in the peripheral white count in patients transfused with leukemic blood is achieved once such blood has circulated through the lungs. Data are accumulating to suggest that the removal mechanism in the lungs and perhaps other sites may be important in the leukemic and normal white blood cell levels of peripheral blood. In this mechanism, heparin appears to play a part.

Diagnosis of Cancer

The only acceptable method of diagnosing cancer in man remains the biopsy and its recent extension to the detection of circulating cells.

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Although the many interesting determinations on various biochemical alterations in the presence of cancer may some day yield tests of value, some of such tests can be even tentatively accepted at present. The National Cancer Institute, for this reason, has established a number of laboratories for the systematic investigation of various biochemical reactions suggested as possible aids in the diagnosis or evaluation of patients with cancer. One of these grants has been made to Dr. A. H. Dowdy (III,9) with particular reference of investigating the uses and limitations of procedures suggested by the serologic reactions with lipid fractions of the liver by Dr. H. S. Penn (67) and the proteolytic enzyme inhibitor systems of blood, by Dr. P. M. West (97,98). About 4,000 serological tests have been completed but the analysis of the results is so far not available. Approximately 20,000 blood specimens have been examined for anti-chymotrypsin and anti-rennin activity, as described previously.

The heparin clotting time has been studied by Drs. R. L. Rosenthal and J. H. Lawrence (II,5; III,7; 79) by electric resistance measurement of the clotting retraction rate. The coagulation defect is present in many cases of leukemia and the severity of this defect is closely related to the degree of hemorrhagic symptoms.

Drs. K. H. Kelly, H. R. Bierman and others (II,25; III,17) are systematically studying the cardiovascular and circulatory dynamic physiology of patients with cancer, performing determinations of blood volume, oxygen saturation, circulatory time, total body water, electrocardiograms, basal metabolic rates, as well as various blood chemistry determinations, during the course of progression of neoplastic disease, in order to gain further insight on the nature and causes of such alterations. Significant findings

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In these lines of investigations will allow better approaches toward
 to a point of abnormalities and complications incident to the course of
 clinical malignancy.
 Of utmost significance to the diagnosis and management of clinical
 cancer is the wide application of exfoliative cytological techniques. With
 made available by the National Cancer Institute, through the State
 California Department of Public Health, Dr. H. F. Traut, in collabora-
 tion with Drs. S. M. Farber, J. F. Rinehart and L. F. Morrison, established
 the University of California Cytological Laboratory with Dr. M. Rosenthal
 in immediate charge (III,14; IV,14; 30-32,67,68,76,99). This important
 area is of immediate impact not only on research but on clinical diagnosis,
 teaching, and services to the physicians of the State. The technique is
 widely applicable to all cavities of the body which may act as outlets
 for desquamating neoplastic cells. During the first 6 months of activity
 (July 1948 to January 1949), 1,354 cases were examined. During the next
 6 months, 3,068 cases were available for study. Particular emphasis has been
 placed not only on the examination of vaginal smears, which represent the
 majority of the specimens, but also on sputum, gastric aspirations, and
 specimens procured from the nasopharynx. The value of the vaginal smear
 technique is now well established and only needs a wide training program
 in order to make it available to all segments of the population. Noteworthy
 results are being achieved in the percentage of correct diagnoses with
 aspirations from the nasopharynx and the lung. The largest series of
 cytologic examinations of gastric washings in the world are available at
 the Laboratory. On the basis of 600 specimens, a 60 percent positive
 diagnosis in cancer of the stomach has been achieved. Higher accuracy is
 anticipated with additional facilities. Plans are being made for the installation
 of smears in the stomach and rectum.

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Therapy of Cancer

The search for chemical agents that may be effective against cancer growth continue in high gear throughout the world (cf. Shimkin and Bierman, 63). Interesting postulations will allow the systematic investigation of the species of compounds rather than depending almost entirely on the empirical approach. It is to be noted that almost all chemical or physical agents which have been demonstrated to have retarding effects on tumor growth in animals or in man also possess the property in inducing neoplastic growth. This would indicate that the biologic property of a chemical of being able to produce neoplastic alterations in the genic or cytoplasmic nucleoproteins is also required for retarding tumor growth. Another concept in the investigation of chemotherapy of cancer has led to the exploration of metabolic antagonists. Some degree of success was achieved with anti-folic compounds in acute leukemia of children. Recently anti-amino acid compounds are coming to the fore. Additional compounds which require further study are steroid and other hormones which change the hormonal substrate of the host, as exemplified by the androgen and estrogen treatment of advanced carcinoma of the breast (63).

An extensive program in the study of amino acid and other metabolite antagonists has been undertaken and is progressing under Dr. D. M. Greenberg, E. M. Gal and others (II,8; III,3,5; IV,5,6; 35,41). Experimental work on the nature of the action of ethionine, an antagonist of the amino acid methionine, was carried out by Dr. E. Farber. A considerable list of N-substituted amino acids and certain pteridines have now been tested. These compounds showed no anti-tumor activity in the screening tests. Tests are now under way on substituted amino acid analogs and a series of vitamin analogs.

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Because of the interesting effects on nerve protein by malononitrile reported by Hyden (Cold Spring Harbor Symp. Quant. Biol., 12: 104, 1947), a series of nitriles have been synthesized and are now being screened and subjected to other studies, particularly of their inhibiting effect on certain enzyme systems. These consist of malononitrile, ethoxymethylene malononitrile, ethylidene malononitrile and aminomalononitrile. Preliminary tests with ethoxymethylene malononitrile showed a significant decrease in the size of a transplantable carcinoma without loss of weight by the animals, but no inhibition of the growth of sarcoma 37.

Dr. H. Rapoport (II,3) is continuing work on colchicine and related compounds which inhibit cell division. Several compounds with the parent nucleus of colchicol methyl ether were synthesized. These showed low degree of activity in arresting mitosis.

Stilbamidine, which has analgesic effects upon multiple myeloma in man, was labeled with C^{14} and its deposition in mice studied by Dr. J. Weaver (II,5). Radioactivity does not appear in the pulmonary carbon dioxide indicating failure of the body to metabolize the compound. Largest concentrations of the material are reached in the kidney and liver. Clinically, stilbamidine has been shown by Drs. H. R. Bierman and M. Sokolow (II,25; III,17; 9) to have severe acute effects on the heart.

Drs. S. H. Bassett and W. S. Adams (IV,11) are examining the effect of urethane upon multiple myeloma and indicate that this compound has little if any effect on the Bence-Jones proteinuria seen in these cases.

Comparison of the relative effects of androgens, particularly in regard to their anabolic functions, is being carried out by Dr. G. S. Gordon on patients at the Laboratory of Experimental Oncology (II,25; III,17).

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Drs. A. White and E. Adams (III,10; IV,10) are determining the effects of endocrine factors on lymphoid tissue in mice with spontaneous leukemia and transplanted lymphosarcoma. Adrenal cortical hormone has been found to cause temporary regression of lymphosarcoma in man. Further knowledge regarding the influence of various hormonal factors to the responsiveness of lymphosarcoma and uninvolved lymphoid tissue in mice will provide basic information for the mode of action already observed clinically.

The effect of purified pituitary hormones on the growth of transplantable carcinoma in mice is being studied by Dr. P. A. Slattery (II,1; III,8; IV,3).

Dr. A. H. Dowdy (II,14) is interested in the effect of bacterial toxins upon cancer, particularly those of Clostridial bacteria which are adapted to growth in media containing freshly excised mice lymphosarcoma. It is hoped that such adaptation might produce selective localization of the material in experimental tumors.

On the basis of Dr. H. S. Penn's observations that regression of the Brown-Pearce tumor in rabbits is increased by anti-sera prepared against liver fractions from human subjects with cancer, Dr. E. M. Jacobsen (II, 17,18) reports that the incidence of metastases was reduced from 94 percent to 40 percent in rabbits injected with human liver lipid anti-serum, whereas the incidence of complete non-takes was increased from 2 percent to 60 percent. Further fractionization and purification of the sources of antigen material and the antisera are being undertaken.

Dr. M. B. Nelson (II,12) has initiated studies on the effect of temperature upon the growth of tumors in animals and upon the effects of radiation. The added insult of cold increases the mortality of mice exposed to irradiation whereas thiouracil, a metabolic rate inhibitor, does not alter the death rate.

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Many compounds described as having some effect on experimental tumors are also being studied on human patients. At the Laboratory of Experimental Oncology (II,25; III,17; 11,87,88) nitrogen mustard, urethane, guanozolo, benzimidazole, chymotrypsin, hydroquinone, the anti-folic compounds, and adrenocorticotrophic hormone are being tried on patients with neoplastic diseases. Guanozolo, a guanine antagonist, and benzimidazole, an adenine antagonist, have shown no effect upon four patients with carcinoma. Nitrogen mustard remains one of the most effective of chemical agents in the treatment of the lymphoma group of neoplastic diseases. Recently its use has been extended by Drs. H. R. Bierman, R. L. Byron, E. R. Miller, M. B. Shiskin, K. S. Dod and K. H. Kelly (II,25; III,17; IV, 13) by the use of intra-arterial catheterization of such arteries as the coeliac axis or the hepatic. Through catheters passed from the carotid or the femoral artery, nitrogen mustard is delivered in doses up to 1 mg. per kilogram body weight to the liver or other sites. Marked temporary effects have been observed in cases where previous intravenous therapy has been of but minimal benefit.

Other procedures are being evaluated from their possible therapeutic as well as physiological standpoint at the Laboratory of Experimental Oncology. These include the effect of various virus infections in patients with cancer. Hematologic and clinical remissions of acute leukemia in children have been observed following infection with chickenpox and with cat pancytopenia virus. Unfortunately such remissions are very temporary in nature. Lymphopathia venerea does not appear to have any retardative effects upon the growth of neoplasms in man.

On the basis of observations that melanoma is non-malignant before puberty, a series of patients has been started on heavy irradiation of the pituitary gland with the hope of altering the hormonal status, which may

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role in this mechanism. Three patients have received 8,500 r calculated to the pituitary gland by a multiple port technique devised and administered by Dr. B. V. A. Low-Bear. No retardation of tumor growth has been noted and the urinary excretion of 17-ketosteroid as well as biochemical determinations on the blood show disappointingly little change, demonstrating that at this dose of x-ray the effect upon the pituitary is minimal. Surgical extirpation of the pituitary has been attempted on two patients by Dr. E. C. Maffziger.

A technique of cross-circulation in man by which two patients are united artery to artery and their blood exchanged in amounts up to 150 liters has been developed by Drs. H. R. Bierman, R. L. Byron, K. S. Dod and K. H. Kally. The method has yielded interesting information regarding white blood cell levels in man. Hematocrit values, bilirubin, and other biochemical properties quickly equilibrate between the two individuals, but no such equilibration is obtained with the white blood cells. Similar experiments on rats by Dr. D. C. Van Dyke of the Anatomy Division indicate that this is attributable to the extremely rapid rate of destruction of white blood cells. The data provide additional evidence of the importance of the removal mechanism in the maintenance of white blood cell level in man and other animals.

In the field of ionizing radiations which represents, with surgery, the only curative method for cancer in man, several important areas are being explored from the experimental standpoint (cf. Stone, 93). The availability of the 184-inch cyclotron has led the Donner Laboratory (II, 5; 97) to apply the instrument as an experimental tool in cancer therapy. The circulating internal beam of the cyclotron is deflected into a tube and

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Colloids are exposed to the stream of deuterons thus obtained. Whether this type of ionizing irradiation has any advantages over x-ray sources or whether it has clinical application remains to be established. Dr. R. S. Stone and the staff of the Radiation Department are planning to undertake studies with the synchrotron and carefully controlled determinations of distribution and pathways of radiation by means of artificial models or phantoms. The initiation of this work is predicated upon development of proper facilities, and procurement of personnel not available at present. (II,32)

Dr. R. L. Dobson and others (II,5; 20,36) at the Donner Laboratory are evaluating the use of colloids containing radioactive yttrium, zirconium, columbium and lanthanum in the treatment of leukemia and polycythemia. On the basis of two years' experience, it appears that this agent is as useful as radioactive phosphorus, the effects of which have recently been evaluated (59,65). Whether there will be any advantages remains to be determined.

The validity of all clinical observations in cancer is predicated upon long and careful follow-ups of patients treated or managed by various forms of therapeutic or experimental procedures. The focal point of such follow-up is the General Tumor Registry. At the School of Medicine in San Francisco, Drs. R. S. Stone and E. L. Lucia (II,30; III,20; IV,16) have established this activity on a sound basis, fully coordinated with the reporting of the cases to the State of California Department of Public Health. To date, 4100 cases have been abstracted. Additional cancer material is being obtained from the Laguna Honda Home area through the Pathology Unit (II,57) which during the past year performed 171 autopsies.

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A total of 306 cases of chronic thyroiditis and 167 cases of thyroid carcinoma seen at the University of California Hospital have been reviewed by Dr. G. Lindsay (II,28). Drs. H. C. Naffziger and E. B. Boldrey (II,31) continuing their review of 30 years' experience with brain tumors at the Hospital. Such long-range examinations of surgical and pathological experiences allow sound modifications of techniques and a better understanding of their use and limitations (cf. 29,48,50,52,52,99). Dr. J. H. Lawrence and his staff also are continually reviewing and amplifying the clinical experience obtained in their observations (II,5; III,7; 59,61,65).

The evaluation of cancer teaching in medical schools, undertaken at the University of California in 1948 by Dr. H. R. Bierman and Mr. J. H. McClelland (12), has been extended to 32 other medical schools in the United States. Examinations showing internal validity were devised, given and analyzed. This evaluation, to be repeated annually for a period of 5 years, should reflect the improvement in cancer knowledge of graduates in medical schools and measure one of the effects of the moneys now being expended on cancer activities. The increased interest in cancer and its larger place in the curriculum undoubtedly will result in a generation of physicians increasingly capable of recognizing neoplastic disease in its early stages, thus providing a greater safeguard to the population and improving the adequate medical management of patients with cancer.

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CONCLUSIONS AND RECOMMENDATIONS

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Review of the accelerated cancer research program of the University of California, approximately three years after its initiation, leaves but that steady development and progress are being achieved. The University of California program compares favorably with similar programs in other outstanding institutions of this country, particularly considering the short period of its activities. The first phase of the University of California program in cancer research, namely, its organization and delineation of its patterns, is now completed. The financial support is still rising, and now amounts to over one million dollars per annum, not including the large construction grants which will eventually house many of the cancer activities.

The next phase upon which the University is entering is the harder one of careful nourishment, support, encouragement, and follow-through on a long-term basis of projects and areas of investigation until they yield results of value. This less dramatic phase requires careful supervision, particularly in reference to problems regarding finances and personnel. This "supervision" in no way implies any interference with the intellectual and scientific endeavors of the individual investigators. On the other hand, thoughtful liaison, cross-fertilization, and the anticipation and fulfillment of their needs is a real duty of the University if the program is to progress favorably and if the returns on the rich investment are to be harvested.

An increasing number of scientists of the University are exhibiting interest in cancer research by initiating investigations dealing with the subject, and several large areas have developed for the specific purpose of conducting cancer research. This has created a serious problem in

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... to personnel, the lack of positions with tenure for investigators who wish to make cancer research their career. The University of California has not created a single position of this type within its framework. ... which in cancer is being conducted in departments with other interests ... investigators with heavy teaching schedules, to which are added ... supported on year-to-year basis from various grants. This situation is incompatible with a long-term nature of the development implied in the University's interests in cancer. In terms of precedent, the creation of special units for the study of cancer with investigators on full tenure has been achieved at the University of Minnesota and at the University of Wisconsin. The University of California can do no less if it is to fulfill its obligations and its aims in cancer research. The ways and means of implementing this should receive careful and thoughtful study by the groups who have been made responsible by the President of the University for the guidance of the cancer research program and specially interested administrative units such as the Schools of Medicine.

The million dollar program in cancer research proceeding on three of the major campuses of the University and the multiple interrelationships thus occasioned also require a focus of full-time administration with some scientific background. This was found essential in the organization developed at the Yale University in connection with the Jane Coffin Childs Memorial Foundation for Cancer Research. It is becoming apparent, however, that the cancer research program of the University is functionally divided into the activities on the Northern campuses and those on the Southern campus. Although broad policy integration is desirable at the University level, proper functional organization requires separate grouping around the Cancer Research ... California Institute

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Research at Los Angeles. The thesis of autonomy of these two units allowed the procurement of construction funds for both Berkeley and Los Angeles. These two large areas need basic budgets and University sources that will integrate them more closely within the University patterns.

Progress in cancer research throughout the world is so unmistakable and high optimism toward its eventual solution is well justified. Cancer research is truly a sub-discipline of the broader field of cellular biology and pathology. Just as cancer research can go only as fast as the fundamental sciences in biology are pushed forward, so cancer research, in turn, makes its contribution to the wider areas of biology, biochemistry, genetics, biophysics, and related sciences. With proper tools and continued support, with imagination and patience both in the scientific and administrative aspects of the problem, the University of California can stand in the forefront of these inevitable achievements.

The tree has been planted; the roots are taking hold. The roots need careful, well-balanced, continuous nutriment if the branches are to bear the sweet fruit of achievement.

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ADDENDUM I
Financial Support, 1947, 1948, 1949

	1947-48	1948-49	1949-50	
I. Support for cancer research:				
California State appropriation	\$23,000	\$230,000	\$250,000	1/
University funds and gifts	39,510	40,000	37,081	2/
Income on endowed funds	57,965	100,531	107,976	3/
Donations and gifts				
Grants from other agencies and foundations				
1. U. S. Public Health Service	103,838	221,349	329,734	4/
2. Laboratory of Experimental Oncology	94,545	103,250	111,500	5/
3. American Cancer Society	69,322	90,778	219,532	6/
4. Other foundations	6,175	12,146	16,917	7/
Total, I.	\$621,375	\$818,054	\$1,072,740	8/
II. Construction and teaching grants:				
A. Cancer Research Genetics Laboratory, California State appropriation	---	160,000	---	
B. Construction Grant, U.S.P.H.S., San Francisco campus	---	1,000,000	---	
C. Construction Grant, U.S.P.H.S., Los Angeles campus	---	---	700,000	
D. Teaching Grants, U.S.P.H.S.	---	29,968	48,881	9/
Total, II.	---	1,189,968	748,881	
Total, I. and II.	\$621,375	\$2,008,022	\$1,821,621	
III. Cancer research fellowships:				
	---	---	74,300	10/
Total, I., II., and III.	\$621,375	\$2,008,022	\$1,895,921	

- 1/ Addendum II.
- 2/ George F. Baldwin Foundation; Lillie B. Matson Fund; Christine L. Webster Research Fund; Albert C. Hooper Fund; Emma B. Schutz Fund; Frank W. Lynch Memorial Cancer Fund; J. J. and Nettie Mack Memorial Foundation; Elsie H. Scott Fund; and Medical Research Fund for Cancer Research.

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ADDENDUM I, continued

6/ B. Andrews Donation; A. L. Hobson Memorial Donation; Blanche and Frank Wolfe Foundation Donation; W. E. Crocker Trust Donation; Eschnig Packing Company; J. E. Lawrence Medical Research Fund; Cooper Estate; California Institute for Cancer Research; Lederle Laboratories Division, Inc. of the American Cyanamid Co.; Louis D. Beaumont Trust; and miscellaneous donations.

7/ Addendum III, including grants through the California Department of Public Health.

8/ Direct allocation from the National Cancer Institute, National Institutes of Health, U. S. Public Health Service.

9/ Addendum IV, including the California Division of the American Cancer Society, the San Francisco County Branch of the American Cancer Society, and allocations by the Laura and Henry and Irene B. Darnhaas Trust Fund. Includes laboratory expenses of fellows from the American Cancer Society and the Damon Runyon Cancer Fund (identified in Addendum V).

10/ Donner Foundation; Rockefeller Foundation; John and Mary R. Markle Foundation; Nutrition Foundation; and National Research Council.

11/ Does not include research fellowships and traineeships.

12/ School of Medicine, San Francisco:	\$43,891.80
College of Dentistry, San Francisco:	4,989.80
	<u>\$48,880.60</u>

13/ Addendum V: American Cancer Society fellows; Damon Runyon Fund fellows; and U. S. Public Health Service fellows.

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APPENDIX II
State Appropriation Grants, 1949

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Title; Investigators; Division	Amount:
<u>BERKELEY</u>	
Study of tumors resulting from chronic administration of pure growth hormones EVANS, E. M. (Institute of Experimental Biology)	\$6,500
Synthesis of carcinogenic hydrocarbons with C ¹⁴ Study of chemical structure of colchicine Synthesis of high molecular weight fatty acids containing C ¹⁴ , and isolation of such acids from tumor-bearing animals CASON, J.; DAUBEN, W. G.; RAPOPORT, H. (Division of Chemistry)	7,000
5. Cancer program of the Division of Medical Physics LAWRENCE, J. H.; HAMILTON, J. G.; GOFMAN, J. W.; JONES, H. B.; TOBIAS, C. A.; DOBSON, R. L. (Division of Medical Physics)	55,000 (9,830)*
6. Experimental production of thyroid tumors CHAIKOFF, I. L. (Division of Physiology)	6,000
7. Growth, adaptation and mutation in bacteria STANIER, R. Y.; DOUDOROFF, M. (Division of Bacteriology)	1,150
8. Biochemical studies on the nature and regression of neoplastic growth GREENBERG, D. M.	12,000
9. Chemistry of nucleic acids ALLEN, F. W. (Division of Biochemistry)	5,000
10. Comparative study of growth-promoting factors in tissue cultures HARRIS, M.	4,000
11. Study of phosphatases and cancer of the male sex accessories BERN, H. A. (Division of Zoology)	2,500
Total:	\$99,150 (9,830)*

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APPENDIX II, continued

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Project Title; Investigators; Division	Amount:
<u>LOS ANGELES</u>	
12. Study of effects of temperature on the progress of malignancies NELSON, N. B. (Division of Medicine)	\$3,600
13. Chromatic search for specific substances excreted by cancer-bearing animals and patients WARREN, S. L.; FINK, R. M.; FINK, K. F. (Division of Biophysics)	7,000
14. Study of effect of bacterial toxins upon cancer DOWDY, A. H. (Division of Radiology)	11,000
15. Study of atypical cellular growth in chick embryos LONGMIRE, W. P. (Division of Surgery)	8,800
16. Studies of metabolism of normal and malignant lymphocytes, with particular reference to nucleic acid turnover in tissue culture as measured with the aid of radioactive phosphorus WHITE, A. (Division of Physiological Chemistry)	10,000
17. Study of lipoids of cancerous liver tissue ROBERTS, C. S. (for KRICHESKY, B.); GRISMAN, T. A.	6,000
18. Study of steroid hormones and fractions in cancer ROBERTS, C. S. (for KRICHESKY, B.)	6,150
19. Immunological studies of nuclear and cytoplasmic constituents of normal and neoplastic tissues SCHECHTMAN, A. M.	6,000
20. Study of glutamic acid metabolism of nervous tissue CRESCITELLI, F. (Division of Zoology)	3,600
21. Study of L- and D-amino acids in transplantable sarcomas and carcinomas DUMN, M. S. (Division of Chemistry)	7,500
22. Studies of structural aspects of protoplasm on molecular and lower colloidal levels SPONSLER, O. L.; BATH, J. (Division of Botany)	500

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ADDENDUM II, continued

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Project Title; Investigators; Division Amount:

LOS ANGELES, continued.

23. Study of the role of proteins as electron transfer systems in respiratory enzymes BIALE, J. B.; GEISSMAN, T. A.	\$5,000
24. Study of relationship of porphyrin-containing substances in tissues of normal and tumor animals APPLEMAN, D. (Department of Agriculture)	8,400
Total:	\$33,750

SAN FRANCISCO

25. Physiology and experimental therapy of cancer patients SHIMKIN, M. B. (Laboratory of Experimental Oncology)	15,000
26. Study of nutritional factors influencing aging and their relationship to cancer RINEHART, J. F.; GREENBERG, L. D.	6,500
27. Pathology Unit, Laguna Honda Home RINEHART, J. F.; SHIMKIN, M. B.	11,000
28. Study of pathologic processes of thyroid gland LINDSAY, S.	1,680
29. Serial passage of Hodgkin's disease extracts in embryonated chicken eggs BOSTICK, W. L. (Division of Pathology)	500 (500)*
30. General Tumor Registry STONE, R. S.; BYRON, R. L. (Cancer Research Institute)	7,500
31. Review of tumors of the nervous system HAFFZIGER, H. C.; BOLDEBY, E. B. (Division of Neurological Surgery)	4,200 (1,350)*
32. Physical measurement of ionizing radiations and health protective measures STONE, R. S.	9,000
33. Continuous metabolic studies on human patients using radioactive isotopes STONE, R. S.; LOW-MEER, S. V. A. SHIMKIN, M. B.	7,400

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ADDENDUM II, continued.

Project Title; Investigators; Division	Amount:
<u>SAN FRANCISCO, continued.</u>	
34. Study of the deposition of radioactive isotopes in experimental tumors SCOTT, K. G.	\$5,000
35. Study of the deposition of radioactive isotopes in human tumors LOW-BEER, B. V. A. (Division of Radiology)	5,800
36. Operative techniques and radioactive iodine studies McCORKLE, H. J. (Division of Surgery)	4,000
Total:	\$78,780 (1,350)*

CENTRAL ITEMS
CANCER RESEARCH COMMITTEES

a. Secretariat, Cancer Research Coordinating Committee and Cancer Research Committee, Northern Section SHIMKIN, M. B.	3,500*
b. Secretariat, Cancer Research Committee, Southern Section NELSON, H. B.	4,490*
c. Research Travel, Northern SHIMKIN, M. B.	1,500*
d. Research Travel, Southern NELSON, H. B.	1,000*
e. Administrative Travel, Statewide SHIMKIN, M. B.	1,000*
Total:	\$11,490*

	State:	Other:*	Total:
Berkeley:	\$89,320	\$ 9,830	\$99,150
Los Angeles:	83,750	---	83,750
San Francisco:	78,930	1,800	78,780
Central Items:	---	11,490	11,490
	\$250,000	\$43,170	\$293,170

*From the Hooper and Sebaste Funds and Elizabeth L. Parsons F.

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ADDENDUM III
U. S. Public Health Service grants

Amount: 21

Project Title; Investigators; Division

BERKELEY

- | | |
|---|------------------|
| 1. Radioactive iodine and radioactive carbon as indicators of metabolism and thyroid function
CHAIKOFF, I. L. | \$20,466 |
| 2. Synthesis of cholesterol from acetate by normal and neoplastic tissues
CHAIKOFF, I. L.
(Division of Physiology) | 7,560 |
| 3. Incorporation of labeled amino acids into protein <u>in vitro</u>
TARVER, H. | 6,500 |
| 4. Quantitative cytological chemistry
KIRK, P. L. | 3,240 |
| 5. Isotopic tracer studies of tissue synthesis and reactions of metabolite antagonists
GREENBERG, D. M.
(Division of Biochemistry) | 28,200 |
| 6. Distribution and mechanism of polycythemia produced in rats by cobalt
BERLIN, N. I. | 540 |
| 7. Pathologic physiology of polycythemia
LAWRENCE, J. H.
(Division of Medical Physics) | 10,476 |
| 8. Biological nature and physicochemical properties of pure growth and adrenocorticotrophic hormones
EVANS, H. M.
(Institute of Experimental Biology) | 45,286 |
| Total: | \$120,268 |

LOS ANGELES

- | | |
|---|--------|
| 9. Evaluation of cancer diagnostic tests
DOWDY, A. H.
(Division of Radiology) | 10,000 |
| 10. Influence of endocrine secretions on the nitrogen lipid and water metabolism of tissues
WHITE, A.
(Division of Physiological Chemistry) | 10,260 |

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Project Title; Investigators; Division Amount: 2/

LOS ANGELES, continued.

- | | | |
|--------|--|----------|
| 11. | Requirements of micro-organisms for amino acids and other nutrients and the determination of amino acids in plant and animal materials
DANN, M. S.
(Division of Chemistry) | \$2,844 |
| Total: | | \$30,104 |

SAN FRANCISCO

- | | | |
|--------|--|-----------|
| 12. | Serial passage of Hodgkin's disease extracts in embryonated chicken eggs
BOSTICK, W. L. | 7,981 |
| 13. | Induction of teratoid tumors in mammals
MOON, H. D.
(Division of Pathology) | 3,078 |
| 14. | Cancer cell morphology in body excreta for determination of malignant cell characteristics, diagnosis of cancer, and relation of nucleic acid
TRAUF, H. F.
(Cytology Laboratory) | 60,384 |
| 15. | Efficiency of aerobic and anaerobic phosphorylation in surviving alices of normal and tumor-bearing tissues
EILER, J. J. | 6,723 |
| 16. | Influence of hypnotics and metabolic stimulants on the rate and efficiency of aerobic phosphorylation in preparation of rat heart and brain
EILER, J. J.
(College of Pharmacy) | 3,010 |
| 17. | Study on physiology of patients with cancer; experimental chemotherapy of cancer
SHIMKIN, M. B.
(Laboratory of Experimental Oncology) | 85,064 |
| 18. | Metabolism of basic amines of therapeutic interest
WAY, E. L.
(Division of Pharmacology) | 6,378 |
| Total: | | \$172,612 |

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ADDENDUM III, continued.

Project Title; Investigators; Division Amount: ^{1/}

SAN FRANCISCO, continued.

From the U.S.P.H.S., State of California

19. Study of pulmonary cytology (Cytology Laboratory)	\$4,350
20. General Tumor Registry (Cancer Research Institute)	2,400
Total:	\$6,750

Berkeley:	\$120,268
Los Angeles:	30,104
San Francisco:	172,612
San Francisco:	<u>6,750</u> (from U.S.P.H.S., State of California)
Total:	\$329,734

^{1/} Paid or pledged during 1949.

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ADDENDUM IV
American Cancer Society grants

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Project Title, Investigators, Division Amount

<u>BERKELEY</u>	
1. Study of certain syntheses in animal body with radioactive isotopes CHAIKOFF, I. L.	\$11,230
2. Study of synthetic processes in diabetic animals CHAIKOFF, I. L. (Division of Physiology)	9,450
3. Studies on relation of growth hormones to neoplasms EVANS, H. M.	20,265
4. Studies on nature and function of growth hormone EVANS, H. M. (Institute of Experimental Biology)	15,750
5. Isotopic tracer studies on enzymes and mechanisms of protein synthesis GREENBERG, D. M.	7,560
6. Studies on protein turnover and on <u>in vitro</u> protein synthesis with radioactive isotopes of sulfur TARVER, H.	7,560
7. Standardization of tissue culture media KIRK, P. L. (Division of Biochemistry)	12,250
8. Enzymatic adaptation and mutation STANIER, R. Y.; DOUDOROFF, M. (Division of Bacteriology)	7,020
Laboratory expenses (3 research fellows) (See Addendum V)	1,750
Total:	\$92,835

LOS ANGELES

9. Studies on relation of D-amino acids to growth DURN, M. S. (Division of Chemistry)	7,000
10. Studies on biochemistry of the lymphocyte WHITE, A. (Division of Physiological Chemistry)	7,200

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ADDENDUM IV, continued.

Project Title, Investigators, Division	Amount:
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LOS ANGELES, continued.

11. Effect of steroids on human metabolism BASSETT, S. H., under the direction of LAWRENCE, J. S. (Division of Medicine)	\$10,048
Laboratory expenses (1 research fellow) (See Addendum V)	500
Total:	\$24,748

SAN FRANCISCO

12. Cancer Research, San Francisco	4,050
13. Cancer Research Institute, for cancer research beds, radiation physics, new equipment and x-ray apparatus	63,000
14. Production of color plates for a teaching monograph on cytological diagnosis of early carcinoma of the lung FARRER, S. M. (Cytology Laboratory)	3,070
Laboratory expenses (5 research fellows) (See Addendum V)	1,500
Total:	\$71,620

From the A.C.S., California Division

16. Cancer Research Institute	2,700
17. Training of Fellows in Pathology	6,250
18. Cancer Research; follow-up secretaries	1,649

From the Laura and Henry and Irene B. Dornham Trust Fund:

19. Relationship between cancer growth and its host, studied with radioactive isotopes SCOTT, E. G. (Division of Radiology)	15,680
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**ADDENDUM V
Cancer Research Fellowships**

Campus; Fellow; Under direction of: _____ Amount: _____

AMERICAN CANCER SOCIETY FELLOWS:

Berkeley:

E. C. Dougherty	C. Stern	\$3,600
W. D. Fraser	W. M. Stanley	3,600
E. P. Kennedy	H. A. Barker	3,600

Los Angeles:

E. Adams	A. White	3,000
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San Francisco:

K. S. Dod	M. B. Shinkin	3,600
L. H. Arnstein	E. B. Boldrey	3,600

Total: \$21,000

DAMON RUNYON FUND FELLOWS:

Berkeley:

S. Margon	L. W. Kinzell	3,500
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San Francisco:

K. H. Kelly	M. B. Shinkin	3,500
P. O. Mustacchi	J. F. Rinehart	2,400

Total: \$9,400

Campus; Fellow; Type of fellowship: _____ Amount: _____

U. S. PUBLIC HEALTH SERVICE FELLOWS:

Berkeley:

M. I. Berlin	Postdoctorate	3,600
T. Burbridge	Postdoctorate	3,600
B. Davis	Predocoratorate (Bachelor)	2,400
D. Feller	Predocoratorate (Master)	2,400
E. M. Gal	Special	4,500
W. Pierce	Postdoctorate	3,600
L. Walker	Postdoctorate	3,600

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Campus; Fellow; Type of fellowship:	Amount:
Los Angeles:	
L. Birzis	Predoctorate (Master) \$2,400
R. Kinosita	Special 10,000
E. Kosower	Predoctorate (Bachelor) 2,400
M. Lipsett	Postdoctorate 3,600
G. Nace	Predoctorate (Master) 2,400
Total:	\$43,900

A.C.S.:	\$21,000
Runyon:	9,400
U.S.P.H.S.:	43,900
Total:	\$74,300

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1. BAKER, C. G. and D. M. GREENBERG, Studies with radioactive carbon-labeled acetate on cholesterol metabolism in rats fed p-Dimethylaminobenzene. *Cancer Research*, 9: 701-706, December 1949.
2. BACHER, J. E. and F. W. ALLEN, Action of ribonuclease on ribonucleic acid. *Fed. Proc.*, March 1949.
3. BATH, J. D. and O. L. SPONSLER, An alternative method for the culture of *Sciara* larvae. *Science*, 109: 235, March 11, 1949.
4. BERN, H. A., The distribution of alkaline phosphatase in the genital tract of male mammals. *Anat. Rec.*, 104: 361-378, July 1949.
5. BERN, H. A., The effects of sex steroids on the sex accessories in the male Dutch rabbit. *Am. J. Anat.*, 84: 231-278, March 1949.
6. BERN, H. A., A note on epithelial metaplasia in the male genital tract. *Endocrinology*, 44: 555-558, June 1949.
7. BERN, H. A., Some effects of long-continued estrogen treatment on male Dutch rabbits. *Cancer Research*, 9: 65-73, February 1949.
8. BERN, H. A., Urinary and genital tract phosphatases of the male Dutch rabbit. *Am. J. Phys.*, 156: 396-404, March 1949.
9. BIERMAN, H. R. and M. SOELOW, Cardiovascular effects produced by stilbanidins in patients with multiple myeloma. *J. Nat. Cancer Inst.*, 10: 279-289, October 1949.
10. BIERMAN, H. R., L. A. STRAIT and M. K. RHENOFF, Excretion of urinary coproporphyrins in patients with neoplastic diseases treated with methyl-bis (Beta-chloroethyl)amine hydrochloride (HM2). *J. Nat. Cancer Inst.*, 10: 93-104, August 1949.
11. BIERMAN, H. R., M. B. SHIMKIN, S. R. METTLER, J. WEAVER, W. C. BERRY, and S. P. WISE, Methyl-bis (Beta-chloroethyl)amine in large doses in the treatment of neoplastic diseases. *Calif. Med.*, 71: 117-125, August 1949.
12. BIERMAN, H. R. and J. N. McCLELLAND, A study of methods for the improvement of cancer learning in the medical school: First annual report. *J. of Assoc. Am. Med. Colleges*, November 1949.
13. BIERMAN, H. R., The value of blood oxygen determinations. *Calif. Med.*, 71: 230-234, October 1949.
14. BORTICK, W. L. and S. P. LUCIA, Nonparasitic, nonneoplastic cystic tumors of the spleen. *Arch. Path.*, 47: 215-222, March 1949.

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ADDENDUM VI, continued.

15. BOSTICK, W. L., Hodgkin's disease: clinical correlations. *Arizona Med.*, 6: 19-24, 1949.
16. BOSTICK, W. L., Hodgkin's disease: a review of 150 cases. *Calif. Med.*, 70: 87-92, February 1949.
17. CAMDEN, K. N. and M. S. DUNN, The utilization of D-glutamic acid by *Lactobacillus Arabinosus* 17-5. *J. Biol. Chem.*, 179: 935-941, June 1949.
18. DAUBEN, W. G. and D. MAREE. Abstract. The distribution of radioactivity and the metabolic degradation in the mouse of 20-methylcholanthrene-11-C¹⁴. *Cancer Research*, 9: 612, October 1949.
19. DAVIS, C. T., C. R. SLATER and B. ERICHESKY, Androgen: ketosteroid ratios of rabbit urine. *Endocrinology*, 44: 83-87, 1949.
20. DOBSON, E. L., J. W. GOPMAN, H. B. JONES, L. S. KELLY and L. A. WALKER, Studies with colloids containing radioisotopes of yttrium, zirconium, columbium, and lanthamum. II. The controlled selective localization of radioisotopes of yttrium, zirconium, and columbium in the bone marrow, liver and spleen. *J. Lab. & Clin. Med.*, 34: 305-312, March 1949.
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22. DOUDOROFF, M., J. M. WIAME, and H. WOLOCHOW, Phosphorolysis of sucrose by *Pseudomonas Putrefaciens*. *J. Bact.*, 57: 423-427, April 1949.
23. DOUGHERTY, E. C. and J. H. LAWRENCE, Isotopes in clinical and experimental medicine. Part I. *Calif. Med.*, 69: 58-73, July 1948. Part II. *Calif. Med.*, 69: 148-153, August 1948.
24. DUNN, M. S., E. R. FEAVER and E. A. MURPHY, The amino acid composition of a fibrosarcoma and its normal homologous tissue in the rat. *Cancer Research*, 9: 306-313, May 1949.
25. DUNN, M. S., Determination of amino acids by microbiological assay. *Physiological Reviews*, 29: 219-259, July 1949.
26. KILKER, J. J. and W. K. McEVEN, The effect of pentobarbital on aerobic phosphorylation in brain homogenates. *Arch. Biochem.*, 20: 163-165, January 1949.
27. ENGLEBERG, E. and R. Y. STAMLER, The relationship between growth and mutation in *Pseudomonas Fluorescens*. *J. Bact.*, 56: 171-180, August 1949.

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APPENDUM VI, continued.

28. EVANS, H. M., M. E. SIMPSON, and C. B. LI, The gigantism produced in normal rats by injection of the pituitary growth hormone. I. Body growth and organ changes. *Growth*, XII: 15-32, 1948.
29. FALCONER, E. H. and M. E. LEONARD, Skeletal lesions in Hodgkin's disease. *Ann. Int. Med.*, 29: 1115-1131, December 1948.
30. FARBER, S. M., G. TOBIAS, and A. McGRATH, Jr., Co-existent pulmonary tuberculosis and bronchogenic carcinoma. *Revista Panamericana de Medicina y Cirugia del Thorax*, 2: 1, 1949.
31. FARBER, S. M., M. A. BENIOFF, J. K. FROST, M. ROSENTEAL, and G. TOBIAS, Cytologic studies of sputum and bronchial secretions in primary carcinoma of the lung. *Dis. of Chest*, 14: 633-664, September/October 1948.
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33. FURLONG, E., B. KRICHESKY, and S. J. GLASS, Effect of carbon tetrachloride feeding on estrogen excretion in the normal female guinea pig. *Endocrinology*, 45: 1-9, July 1949.
34. GARST, J. B. and H. B. FRIEDGOOD, Physical and chemical properties of emulsifying agents in urine. *Fed. Proc.*, 8: 1949.
35. GAL, E. M., Preparation of some N-substituted amino acid analogs. *J. Am. Chem. Soc.*, 71: 2253 (1949).
36. GOPMAN, J. W., Studies with colloids containing radioisotopes of yttrium, zirconium, columbium, and lanthanum. I. The chemical principles and methods involved in preparation of colloids of yttrium, zirconium, columbium, and lanthanum. *J. Lab. and Clin. Med.*, 34: 297-304, March 1949.
37. GOPMAN, J. W., F. T. LINDGREN, and H. ELLIOTT, Ultracentrifugal studies of lipoproteins of human serum. *J. Biol. Chem.*, 179: 973-979, June 1949.
38. GREENBERG, D. M. and P. SIEKIVITZ, The biological formation of serine from glycine. *J. Biol. Chem.*, 180: 845-856, 1949.
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40. GREENBERG, D. M. and D. SAO SAMADI, The effect of amino acid deficiencies on the incorporation of radioactive carbon-labeled amino acids into plasma proteins. *Proc. Soc. Exp. Biol. and Med.*, 89: 111-112, October 1948.

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41. GREENBERG, D. M. and E. M. GAL, Paper chromatographic identification of some N-substituted amino acids. Proc. Soc. Exp. Biol. and Med., 71: 88-89, 1949.
42. GREENBERG, D. M. and T. WINNICK, Studies in protein metabolism with compounds labeled with radioactive carbon. II. The metabolism of glycine in the rat. J. Biol. Chem., 173: 199-204, March 1949.
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45. GREENBERG, L. D. and J. F. RINEHART. Abstract. Xanthurenic acid excretion in pyridoxine deficient Rhesus monkeys. Fed. Proc., 7: 157, March 1948.
46. GREENBERG, L. D. and J. F. RINEHART, Studies on the blood pyridoxine of Vitamin B₆ deficient monkeys. Proc. Soc. Exp. Biol. and Med., 70: 20-25, 1949.
47. GREENBERG, L. D., D. F. BOHR, H. McGRATH, and J. F. RINEHART, Xanthurenic acid excretion in the human subject on a pyridoxine-deficient diet. Arch. Biochem., 21: 237-239, March 1949.
48. GRIMES, O. F. and H. G. BELL, Carcinoid tumors of the intestine. Surg., Gynec. and Obst., 88: 317-325, March 1949.
49. GRIMES, O. F. and S. H. BRODIE, Adamantinoma of the maxilla metastatic to the lung. Case report. Ann. Surg., 128: 999-1005, November 1948.
50. GRIMES, O. F. and H. G. BELL, Carcinosarcoma. Calif. Med., 69: 282-284, October 1948.
51. HEIDELBERGER, C. and H. B. JONES, The distribution of radioactivity in the mouse following administration of dibenzanthracene labeled in the 9 and 10 position with carbon¹⁴. Cancer, 1: 252-260, July 1948.
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- 53. HUFF, R., T. HENNESSEY, and J. H. LAWRENCE. Abstract. Iron metabolism studies in normal subjects and in patients having blood dyscrasias. J. Clin. Invest., 28: 790, July 1949.
- 54. KIRK, P. L. and M. DANIELSON, A liquid-liquid microextractor for solvents lighter than water. Anal. Chem., 20: 1122, 1948.
- 55. KIRK, P. L. and F. L. SCHAFFER, Construction and special uses of quartz helix balances. Rev. Sci. Instruments, 19: 785, 1948.
- 56. KIRK, P. L. and H. STERN, Microgram analysis. Further studies of determination of glucose and its application to the determination of sucrose. J. Biol. Chem., 177: 37, 1949.
- 57. KIRK, P. L. and H. STERN, Microgram analysis. A solid-liquid extractor and its application to extraction of sugars from plant materials. J. Biol. Chem., 177: 45, 1949.
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- 59. LAWRENCE, J. H., B. V. A. LOW-BEER and J. W. J. CARPENTER, Chronic lymphatic leukemia; a study of 100 patients treated with radioactive phosphorus. J. Am. Med. Assoc., 140: 585-588, June 18, 1949.
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APPENDUM VII
University of California Cancer Committees*

Member	Department	Cancer Research Committee, Northern Section	Cancer Research Committee, Southern Section	Cancer Research Coordinating Committee
Berkeley:				
DeCms, K. B.	Veterinary Science	X		
Greenberg, D. M.	Biochemistry	Chairman		Chairman
Harris, M.	Zoology	X		
Lawrence, J. H.	Medical Physics	X		X
Stanley, W. M.	Virus Laboratory	X		
Stewart, M. A.	Graduate Division	X		X
Los Angeles:				
Bellamy, A.W.	Zoology		X	X
Dick, H. G.	Research Committee		X	
Dowdy, A. H.	Radiology		X	
Dunn, M.	Chemistry		X	X
Knudsen, V. O.	Graduate Division		Chairman	X
Nelson, M. B.	Medicine		X	
Warren, S. L.	Biophysics		X	X
San Francisco:				
Rinehart, J. F.	Pathology	X		
Shiskin, M. B.	Oncology	X		X
Stone, R. S.	Radiology	X		X
Traut, H. F.	Obstetrics	X		
Barthell, R. W.	President's Office	Administrative Secretary to the Cancer Research Committees		

*Appointed by the President of the University

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