THE WORK OF THE BIOLOGY DIVISION

CALIFORNIA INSTITUTE OF TECHNOLOGY

JULY 1, 1948 TO JUNE 30, 1949
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The Division of Biology of the Institute has now been in operation twenty-one years. Its steady growth and development during this period is a tribute to the imagination and foresight of those who planned and established it. Its first Chairman, the late Professor Thomas Hunt Morgan, built its foundations well and guided its growth wisely for thirteen years. During the past several years a number of his friends at the Institute have given consideration to the question of a suitable memorial to him. They have now commissioned the sculptor Albert Stewart of Scripps College to design a bas-relief likeness of him framed in a grill-work incorporating in its design various organisms on which he worked. Included as a part of the whole will be a shelf of the books written by him. A full scale working drawing of the proposed memorial has now been completed. From this a plaster pattern will be carved which in turn will be reproduced in cast bronze. Finally it will be placed in the Kerckhoff Memorial Library.

Some two hundred friends, associates and students of Doctor Morgan have contributed to the Morgan Memorial Fund. In addition to making possible the memorial described above, this Fund will help to continue the Morgan Scholarship for undergraduates at the Institute who express an interest in the Biological Sciences.
Financial Support

In addition to general Institute endowment funds and several endowment funds designated for various phases of the Biological Sciences -- Kerckhoff, Rockefeller, Robinson, Hixon, Gosney, Balch, and Holder Funds -- the work of the Division received financial support from a number of sources during the past year. These included: The Rockefeller Foundation, The National Foundation for Infantile Paralysis, The Earhart Research Foundation, American Cancer Society (three grants), U. S. Public Health Service (two grants), Herman Frasch Foundation, Eversole Research Fund, Loomis Institute for Scientific Research, Mr. and Mrs. F. S. Markham, John and Mary Markle Foundation, Merck and Company, Mr. Charles E. Merrill, The Nutrition Foundation, The Purdue University Corn Research Fund, Sunset Magazine, U. S. Rubber Company, The Williams-Waterman Fund for the Combat of Dietary Diseases -- the Research Corporation, and The Southern California Camellia Society.

Research in protein synthesis and radiation genetics has been supported through contracts with the U. S. Atomic Energy Commission, operating through the Office of Naval Research. An ecological survey of the marine organisms in the region of the Arctic Research Laboratory of the U. S. Navy at Point Barrow, Alaska was supported through contract with the Office of Naval Research. The U. S. Army Chemical Corps, Camp Detrick, has contracted for work on the biological properties of various herbicides and related compounds. The Division has cooperated with the Los Angeles County Air Pollution Control District in investigating eye-irritating substances in smog. Work on the flavoring components
of grapes has been continued under contract with the California Wine Advisory Board. Studies in maize cytogenetics, the mechanism of rubber biosynthesis and the physiology of seed germination were carried on in collaboration with the Bureau of Plant Industry, Soils and Agricultural Engineering and also with the Forest Service, both of the U. S. Department of Agriculture.

The Laurabelle Arms Robinson Endowment

and the Cancer Problem

Several years ago the Institute received from the estate of Mrs. Laurabelle Arms Robinson a bequest of more than two million dollars. It was the wish of the donor that the income from the fund and if necessary a certain fraction of the principal be used annually to support cancer investigations at the Institute. As a result of her deliberations and particularly after extended discussion with a counselor of unusual understanding, Mrs. Robinson was aware that the cancer problem is not an easy one to solve. She knew that there were two methods of approach, both essential -- a) the direct frontal attack such as is currently being made at Memorial Hospital and the closely associated Sloan-Kettering Institute in New York City, in which every cancer cure that appears to offer any hope whatever is empirically tested, and b) the long-range attack in which a deeper insight into the physics, chemistry and biology of living systems in general is sought as a basis for a rational understanding on the cancer problem. Mrs. Robinson was clearly aware that the second of these alternatives was the one consistent with the basic policy of the Institute and the one to which her gift would contribute.
The wisdom of attacking the cancer problem at a basic level has been recognized by the American Cancer Society, a national society that annually collects and disburses millions of dollars in combating cancer. A number of years ago this society enlisted the aid of the National Research Council in setting up the Committee on Growth. This is a committee of more than one hundred medical men, biologists, chemists, physicists and other scientists in fields that bear on the cancer problem. The committee is made up of five sections -- Biology, Chemistry, Chemotherapy, Clinical Investigations and Physics, each subdivided into a number of panels. These panels advise the general committee and the Society on specific research programs and in the awarding of research grants.

In surveying the joint Chemistry-Biology research program of the Institute as it bears on the cancer problem, it is of interest to see how closely it parallels that of the Committee on Growth. Of the three sections of this committee concerned with basic science, viz. those on Biology, Chemistry and Physics, there are fourteen panels as follows: Botany, Cellular Physiology, Experimental Genetics, Morphogenesis, Virology, Cytochemistry, Enzymes, Experimental Endocrine Physiology, Nutrition, Proteins, Synthesis and Metabolism of Steroids, Isotopes, Physics, Radiobiology. Of the fields represented by these panels, work is currently being carried on at the Institute in twelve.

In the postwar growth and strengthening of the Institute's long-range joint Chemistry-Biology program of research in the Biological Sciences the Laurabelle Arms Robinson Fund has been of great assistance. Without this
endowment it would hardly have been possible to add to the Institute's permanent staff such men as Kirkwood, Corey and Campbell in chemistry; Delbruck, Owen and Mitchell in biology.

In bridging the gap that often exists between pure and applied aspects of science it is important that students in basic fields be aware of practical problems. In addition to their direct help, American Cancer Society Research Grants and the Laurabelle Arms Robinson Fund have both had the highly desirable indirect effect of helping to make investigators at the Institute conscious of the cancer problem. An interesting example of this is found in the propositions recently submitted to his Ph. D. Degree examination committee by a graduate student. His major subject was organic chemistry and his minor, genetics. He had nothing directly to do with any project supported by funds designated for cancer work and so far as most faculty members knew had given no particular thought to the cancer problem. But this was evidently not true for there appeared among the eleven propositions he submitted as being prepared to defend, the following two:

"The discovery that peroxides produce mutations suggests that these compounds should be tested in the treatment of cancer. Not only might miscellaneous toxic effects be avoided in this treatment as compared with treatment with radiation or the mustards but also the large number of peroxides potentially available would permit search for particularly effective agents.

"The theory that certain plant tumors are caused by over-production of an enzyme converting tryptophane to indoleacetic acid might be tested with a
fluorotryptophane. On the basis of this theory, tumor tissue grown in a medium containing a suitably adjusted concentration of a fluorotryptophane might be expected to revert to normal growth habits."

While it is no doubt true that the probability is low that either of these specific suggestions will lead to significant advances, they are symptomatic of a trend that in the long run will surely increase our understanding of the problem.

The Physical Plant

As far as its physical facilities are concerned 1948-49 was an outstanding year in the history of biology at the Institute. Not only was the Biology Annex, a modern laboratory for experimental animals of several kinds, completed and occupied, but in addition the unique Earhart Plant Research Laboratory was constructed, formally dedicated and put into operation.

The Earhart Plant Research Laboratory, built at a cost of approximately $400,000 and made possible by a most generous gift of the Earhart Foundation of Ann Arbor, Michigan, is a laboratory of revolutionary design in which most of the environmental factors affecting plant growth are under strict control. Chambers with both natural and artificial light are available in which light, temperature, and humidity can be controlled. Special rooms are equipped to control gas-content of the air, air movement and water sprays simulating rain-storms. It was designed largely by Professor F. W. Went and Doctor H. O. Eversole assisted by the architect, Mr. Palmer Sabin, and an able staff of engineers.
The Earhart Laboratory will make it possible to investigate problems of plant growth, plant responses and plant functions that heretofore have been impossible to study. As a specific example of immediate and pressing local importance, the laboratory rooms designed for control of gas-content of the air will be used to study the effect of various smog components on plant growth and development. Without such laboratories it would be difficult to determine for certain whether or not local smog is injurious to plants and almost impossible to find out how and why it affects plants if it does so at all. Professor Went will be in charge of the research program of the Earhart Laboratory.

The Staff

During the year the work of the Division was carried on by eleven full professors, eight research associates, seven associate professors, eight senior fellows in research, twenty-two research fellows, thirty-two graduate students and seventy-six research technical and laboratory assistants. Doctor Herschel K. Mitchell was promoted from Senior Fellow in Research to Associate Professor. Doctor E. B. Lewis, who has been on leave as a Rockefeller Foundation Fellow at Cambridge University, was promoted from Assistant Professor to Associate Professor.

Associate Professor George E. MacGinitie, in charge of the Kerckhoff Marine Laboratory, has been given a year’s leave of absence to accept the important position of Scientific Director of the Arctic Research Laboratory of the United States Navy. Doctor H. Eugene Lehman of the University of North Carolina
was appointed to teach the summer term course in marine biology, usually taught by Professor MacGinitie.

An important part of the research work of the Division has been carried on by research fellows of various kinds. As is true in other Divisions of the Institute, the ratio of such research fellows to conventional faculty members is high in biology, a practice that combines in stimulating proportions investigators of different ages.

The Gosney Fund has continued to play a most significant role in bringing outstanding research fellows to the Division. During the year the following persons held Gosney Research Fellowships: Charles R. Burnham of the University of Minnesota, Joseph Ceithaml of the University of Chicago, John Laughnan of the University of Illinois, Werner K. Maas of the Naval Medical Research Institute, Donald F. Poulson of Yale University, Herschel L. Roman of the University of Washington, and Marshall R. Wheeler of the University of Texas. In addition to Gosney Research Fellows and other research fellows supported by Institute funds, research fellows were supported at the Division by the Rockefeller Foundation (two), The National Research Council, Merck Fellowship Board (three), the Guggenheim Foundation (one), the U. S. Public Health Service (two) and the American Cancer Society (one).

**Visiting Lecturers**

As in previous years staff and student seminars have played an important role in the intellectual life of the Division. Of more than fifty regularly scheduled
seminars, exclusive of undergraduate and graduate seminars open only to registered students, twenty-two were given by scientists visiting the Institute from other colleges, universities or research laboratories. Many of these persons were invited specifically to give seminar talks. This was made possible by the Eversole Lecture Fund which is used to reimburse visiting lecturers for travel and subsistence expenses.

New Fellowships and Scholarships

The year has seen the establishment of three significant new scholarships in the field of Biology. Miss Lucy Mason Clark has established an endowment fund the income of which is to be applied to a research fellowship or scholarship in the field of Plant Physiology. It is expected that the holder of the Lucy Mason Clark Fellowship will work in the Earhart Plant Research Laboratory.

Doctor Seeley G. Mudd has established a tuition scholarship to be known as the Seeley W. Mudd Scholarship in memory of his father. This scholarship is open to third and fourth year undergraduates who plan to go into medicine or do graduate work in some field of biology related to medicine. It is awarded on the basis of academic record, faculty recommendations and a competitive examination.

Friends of the late Professor Morgan have established a tuition scholarship known as the Thomas Hunt Morgan Scholarship, for Institute Freshmen who express an interest in the field of biology. While funds are now assured for only two awards of this scholarship, it is hoped that some way can be found
to put this scholarship on a continuing basis.

**Progress in Research**

Within the limits of a general report such as this, it is obviously not possible to describe in detail the research activities of all members of the biology staff. After briefly indicating the general nature of a number of investigations, three specific projects chosen as samples will be described in somewhat more detail.

At the Kerckhoff Marine Laboratory at Corona del Mar, Professor MacGinitie has continued his studies of life histories of various marine organisms. During the summer of 1948 he and Mrs. MacGinitie worked at the Arctic Research Laboratory of the U. S. Navy at Point Barrow, Alaska on a survey of the marine organisms of the region. On their return in the fall, many of the specimens collected during the summer were sorted and classified.

Working mainly with sea urchins collected at the Marine Laboratory Professor Albert Tyler has continued his studies of the process of fertilization. At least four chemical compounds have been shown to be specifically concerned with this process. Considerable progress has been made in isolating these and determining their chemical and biological properties.

Professor Wiersma has continued his investigations in neurophysiology. Professor van Harreveld has extended his work on the effects of narcotics and other drugs on the polarization state of nervous tissues. He has developed
a mathematical model of blood circulation which relates peripheral resistance, blood volume, capacity of the vascular system, blood pressure and blood flow. With Doctor Whieldon, he has made use of the electroencephalograph to investigate experimentally induced depression of cortical activity of the brain -- studies that may well contribute to our understanding of epilepsy and similar diseases.

In biochemistry, Professor Borsook, Professor Haagen-Smit, Doctor Keighley, Doctor Deasy and a number of associates have gone ahead with their studies of the key problem of protein synthesis using radioactive isotopes as markers for specific amino acid protein components. After being built into proteins in liver cells homogenates, bone marrow cells or rat diaphram tissue, the amino acids are recovered following digestion of proteins and separation by chromatographic techniques. This is one of the ways of learning more about protein synthesis, a process characteristic of all living cells, normal or diseased.

In connection with protein studies Professor Mitchell, Mr. Haskins and their associates have developed what appears to be an exceedingly useful modification of the method of filter paper chromatography. The new divide consists of a cylindrical stack of filter paper disks through which solutions are passed. Solute are differentially adsorbed and may be recovered quantitatively in pure form. In collaboration with Professor Owen, Professor Campbell, Doctor Gordon and others the "chromatopile" technique has been
used in the separation of protein mixtures. The preliminary results with various enzymes and with antibodies are encouraging enough to warrant pushing further along these lines.

Professor Bonner has continued to study various aspects of plant hormone physiology. With Doctor Wildman he has shown that the bulk of the growth hormone produced by oat coleoptiles is indoleacetic acid. For many years it has been a subject of dispute among plant physiologists whether this substance of auxin-A is the principal natural auxin of the oat plant. Doctor Henderson, working in collaboration with Professor Bonner, has shown that certain plant tumor tissue differs from normal tissue in possessing large amounts of an enzyme which favors the conversion of tryptophane into indoleacetic acid. This explains why the tumor tissue does not require exogenous auxin for growth while corresponding normal tissue does.

Doctor Galston has found that the vitamin riboflavin (vitamin B-2) sensitizes the photooxidation of many indole-containing compounds, including the plant growth hormone indoleacetic acid. The action spectrum of this reaction is sufficiently similar to the action spectrum of phototropic curvature of the oat plant to suggest that riboflavin, rather than carotene as has been generally thought, may be the photoreceptor for the phototropic responses of plants. Dr. Galston spent May and June in Beltsville, Maryland in the laboratory of Dr. Sterling Hendricks of the U. S. Department of Agriculture where he was able to make use of a unique monochromator as well as obtain valuable advice regarding the problems in which he is interested.
Professor Horowitz has investigated the production of amino acid oxidases in Neurospora following a difference in experimental finding between him and Krebs and Bender of England. This difference has now been found to result from strain differences and differences in culture media. L-amino acid oxidase is produced under certain conditions while D-amino acid oxidase only is found under other conditions.

A problem of considerable current interest in a number of connections involves the metabolism of the amino acid tryptophane. Professor Mitchell, Doctor Nyc, Doctor Weidel and Mr. Haskins have shown that hydroxykynurenine is an intermediate in its conversion to the vitamin nicotinic acid. Mr. Haskins and Professor Mitchell have presented evidence for the existence of a metabolic cycle involving anthranilic acid, indole, tryptophane, kynurenine and a compound as yet unidentified. Just as anthranilic acid accumulates in certain mutant strains of Neurospora, Professor Anderson and Doctor Teas have shown that this fluorescent substance accumulates in large amounts in certain mutant types in corn. The interrelations of tryptophane, indoleacetic acid and nicotinic acid in corn are being looked into by Doctor Teas, Doctor Wildman and Mr. Stehsel. Doctor Gordon and Professor Mitchell have investigated the enzymatic synthesis of tryptophane from indole and serine and have developed a sensitive chemical method for measuring small amounts of tryptophane.

Professor Horowitz and Doctor Fling have made progress in isolation and identification of a precursor of methionine in Neurospora. Mr.
Fincham has evidence indicating that in this mold aminohydroxyvaleric acid is a common precursor of ornithine and proline. Mrs. Houlahan and Professor Mitchell have isolated a precursor of the amino acid histidine in the same organism.

Doctor Zalokar and Professor Emerson have made gratifying further progress in understanding the mechanism by which sulfonamides act in inhibiting or stimulating growth of Neurospora strains.

Various problems in genetics are being investigated in three organisms: in Indian corn by Professor Anderson, Doctor Longley, Doctor Teas and associates; in Drosophila by Professor Sturtevant and Doctor Novitski; in the red bread mold Neurospora by Professor Beadle, Professor Horowitz, Professor Mitchell, Mrs. Houlahan and others.

Smog Investigations

To a person uninitiated in the strange ways of modern biology, a Division of Biology might seem to be the least promising of all places in which to learn about industrial air pollutants. But this is not necessarily so for the biologist has been forced to develop methods by which minute amounts of various chemical substances can be studied. Vitamins, hormones and other biologically active substances often produced significant changes in living things in amounts as low as one millionth of an ounce per individual per day. The result has been the development of laboratories of microanalysis in which routine analyses are made with incredibly small quantities of material. The Institute has in its
Biology Division such a laboratory -- under the supervision of Professor Haagen-Smit, a bioorganic chemist of international reputation. It was therefore not really remarkable at all that the Los Angeles County Air Pollution Control District should turn to Professor Haagen-Smit for assistance in determining just what are the dangerous and annoying eye-irritants in local smog. In an amazingly short time Professor Haagen-Smit had tracked down the offending substances and had identified them as organic peroxides -- carbon-containing compounds related to the familiar hydrogen peroxide of the corner drug store. These are known products of the burning of hydrocarbons. While the biology laboratories are not designed to do such purely public service work, the Division is proud to contribute to public welfare when its facilities are necessary because of uniqueness and when the problem is in obvious and urgent need of solution.

Chemically Induced Gene Mutations

In 1865 the Austrian monk Gregor Mendel postulated the existence of units of inheritance that we now know as genes. After lying dormant for 35 years his theory was revived and developed with great vigor in both Europe and America. After the rediscovery it was soon learned that genes are mutable, that is, that they suddenly become permanently modified so as to modify the character of the individuals of a plant or animal species that inherit the changed gene from its parents. But for many years -- until 1926 in fact -- it was thought
that gene mutations were just accidents which happened to a given gene once in a million or so generations and were beyond the control of man.

In 1926, Professor Herman J. Muller, then of the University of Texas and a former student of Thomas Hunt Morgan, made the important discovery that X-rays could increase the frequency of gene mutations a hundred fold or more. At once a new field of investigation was opened. How do X-rays produce this effect? What other high energy radiation will act similarly? Can mutations be produced by chemical treatments? Advances at first seemed rapid and spectacular. The so-called "direct hit" hypothesis of radiation-induced gene mutations was proposed and appeared to be supported by many experimental facts. It postulates that as a result of absorption of energy in a gene a direct chemical modification is produced.

No convincing progress in inducing mutations with chemical agents as distinguished from radiation was made until it was found by Auerbach in Scotland during the war that mustard gases are strongly mutagenic, i.e., produce mutations.

Within the past few years the growing doubts as to the correctness of the direct hit theory were strengthened when Stone, Wyss and Haas of the University of Texas found that certain types of mutations are induced in bacteria if a culture medium in which they are grown is irradiated with ultraviolet prior to adding the bacteria to the medium. For several reasons peroxide formation was suspected as a factor in this mutation production.
(Incidentally it is a strong possibility that some of the peroxides present in smog result from natural treatment of hydrocarbon air pollutants with ultraviolet components of radiation from the sun.)

At this point in the story two graduate students at the Institute entered. They were Frank H. Dickey and George Cleland, both at the time candidates for the Ph. D. degree with majors in organic chemistry and minors in genetics. During the war Mr. Dickey worked with organic peroxides and became an authority on them. On theoretical grounds he believed that induced mutations in general -- those produced by direct irradiations of the organism, those resulting from irradiated medium, as well as those resulting from mustard gases -- could be the result of organic peroxides as mutagenic intermediaries.

As graduate students, Dickey and Cleland carried out a series of experimental tests of the Dickey peroxide theory. The results were so promising that it was obviously highly desirable to push the work vigorously. Mr. Dickey, now Doctor Dickey, was awarded a Noyes Fellowship by the Division of Chemistry with the understanding that a part of his time would be devoted to studies on the mechanisms by which chemical mutagens produce their effects on genes. Technical assistance and laboratory facilities for this work are currently being supplied in Kerckhoff Laboratories by the Biology Division.

Dickey's peroxide theory of gene-mutation may well prove to be an outstanding example of progress in understanding living systems through collaboration.
of chemistry and biology. It is certainly an example of how the attack on an important biological problem can be assisted by collaboration such as is encouraged by the joint Chemistry-Biology research program at the Institute.

**Virus Research**

Viruses are important to man because they produce many serious diseases in him and in the plants and animals on which he depends directly or indirectly. Infantile paralysis is a disease in man produced by virus infection. The quick decline disease of oranges is an example of a plant virus disease that has become of great economic importance locally within recent years. But the fact that many viruses produce diseases of direct significance in man's existence is not the only reason for learning about them. They represent the simplest systems known to possess the properties of self-multiplication and mutations, two fundamentally significant characteristics of all things that live. Like genes, the units of self-multiplication and mutation of higher plants and animals, viruses are composed of giant nucleoprotein molecules.

At the Institute two viruses are being studied, tobacco mosaic virus, which is the first virus to be isolated in pure crystalline form (by Wendell Stanley in 1937), and a virus that attacks and kills the colon-bacillus. The latter is known as a bacteriophage or bacterial virus.

Doctor Samuel Wildman, Professor James Bonner, Professor Ray D. Owen and their associates are investigating tobacco mosaic virus with a view to finding out how its nucleoproteins are derived from normal constituents of
the tobacco plant cell. It has been known for many years that within a period of about two weeks a tobacco plant infected with this virus builds up a high concentration of virus nucleoprotein in its cells without appreciably altering its total protein content. Using a combination of chemical fractionation and electrophoresis (migration of charged protein molecules in solution in an electric field) techniques, Wildman and Bonner have found that as virus nucleoprotein is built up the normal soluble cytoplasmic nucleoproteins of the tobacco cell decrease in amount. Particulate nucleoproteins such as cell nuclei, plastids and mitochondria, on the other hand, remain relatively constant. The question then arises: Is a soluble cytoplasmic nucleoprotein of lower molecular weight than that of the virus nucleoprotein converted directly into virus through some process of molecular aggregation, or is cytoplasmic nucleoprotein first reduced to its constituent parts (amino acids, nucleotides, etc.) and then rebuilt into virus?

One of the methods of answering the above questions involves the techniques of serology. Professor Owen has produced rabbit antisera against normal tobacco cytoplasmic nucleoproteins and compared these with antisera against virus nucleoprotein. Such comparisons -- so far of a preliminary nature only -- suggest that virus and normal tobacco cell nucleoproteins are serologically related as though the virus were built up of whole cytoplasmic nucleoproteins or at least of fragments of them.

The bacterial viruses of the T series that infect the bacterium Escherichia coli have a life history as follows: Virus particles are adsorbed on the surface
of the bacteria, enter the cells and there multiply. A single virus may produce 300 descendants within 15 minutes. At the end of the multiplication phase of the virus, its bacterial host disintegrates and the daughter virus particles are released. Daughter viruses are then immediately able to infect additional host bacteria.

Several phenomena of significance in bacterial virology are currently being investigated at the Institute and elsewhere. One of these is the production of recombination types when two related viruses infect a single bacterial cell. This has been extensively studied by Doctor A. D. Hershey who spent the first half of 1948 at the Institute. It is found that permanent recombination types are found in definite proportions, indicating that the bacterial virus contains units like the genes of higher plants and animals and that there is some recombination mechanism, possibly involving a primitive form of sexual reproduction. A similar conclusion is reached by Dr. S. E. Luria of Indiana University who finds that viruses inactivated with ultraviolet radiation may be reactivated if two or more viruses, each inactive if adsorbed singly by a bacterium, simultaneously infect a single bacterial cell.

Professor Delbruck, following up some experiments by Doctors L. Szilard and A. Novick of the University of Chicago has studied what appears to be still another way in which some of the properties of two virus strains can be combined. If bacterial cells are simultaneously infected with viruses of the two types designated T2 and T4, both types may be recovered from a single host cell. But in addition to regular T2 viruses, a new type is found that in host
specificity behaves like T4 for one generation but thereafter is like T2 in its host specificity. This aberrant T2 type, which temporarily acquires some properties of T4, combines antigenic characters of both T2 and T4 as shown by serological tests. This phenomenon obviously needs to be investigated further.

Dr. Albert Kelner of the Carnegie Institution of Washington laboratory at Cold Spring Harbor, Long Island, New York discovered during the past year that certain bacterial spores inactivated with ultraviolet radiation can be reactivated with visible light. This remarkable finding was very soon extended to bacterial viruses by Doctor Renato Dulbecco of Indiana University, and to Neurospora asexual spores by Mr. Albert Siegel, a graduate student at the Institute. Doctor Dulbecco will continue his studies of photoreactivation of bacterial viruses during the academic year 1949-50 in the laboratories of Professor Delbruck. Such studies may well provide entirely new clues as to how living systems are constructed and how they operate.

Another aspect of bacterial virology currently being studied at the Institute involves the mechanism of adsorption of virus particles on bacterial cells. A number of years ago, Doctor T. F. Anderson of the Johnson Foundation of the University of Pennsylvania, who incidentally is an Institute alumnus (B.S. 1932, Ph. D. in chemistry, 1936), found that adsorption fails to occur in the absence of certain organic molecules, called cofactors, in the medium. The amino acid tryptophane, one of the commonly occurring building blocks of
proteins, is such a cofactor. The mechanism by which tryptophane acts in virus adsorption is being investigated in Professor Delbruck's laboratory by Doctor Gunther Stent, a Merck Research Fellow, and Dr. Eli Wollman, a Rockefeller Foundation Research Fellow on leave from the Pasteur Institute in Paris.

**Future Needs**

While the physical facilities of the Division of Biology proper are excellent at the moment, there is urgent need for additional space to take care of chemical aspects of the joint Chemistry-Biology program. The Division of Chemistry and Chemical Engineering is extremely crowded and it is no longer possible for the Division of Biology to appreciably ease the situation through the temporary loan of space. It is hoped that a Chemistry-Biology wing paralleling Kerckhoff and joining both Kerckhoff and Crellin Laboratories can be built in the near future.

One of the clearly recognized staff needs in biology at the Institute is a microbiologist. Such a person is needed not only as a part of the biology teaching and research programs, but also in connection with the development of a sound teaching program in Sanitary Engineering. It is highly desirable that students in Sanitary Engineering have a general course in bacteriology before specializing. There are a number of other branches in the Division of Biology that should be strengthened as soon as possible. Cytology is one, enzymology is another.
For a number of years it has been evident that serious thought should be given to the future of the Kerckhoff Marine Laboratory at Corona del Mar. The use made of it at the present time hardly justifies the capital investment and the annual operating budget. This facility should either be made a more important part of the program of the Division or the Institute's financial commitment in it somehow reduced.

Respectfully submitted,

G. W. Beadle