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BACTERIOLOGY, GENETICS, AND DNA—A FRONTIER IN RESEARCH

MOST BIOCHEMISTS and geneticists today agree that deoxyribonucleic acid, or DNA, is an essential part of the mechanism of heredity. Outstanding contributions to our understanding of the importance of DNA have been made by scientists of the Rockefeller Institute during the past 50 years, which we will describe briefly here.

Before much can be said about the significance of DNA, however, we must go back about 90 years in the history of biological science to the time of the monk, Gregor Mendel, and the dawn of the science of genetics. Mendel, an extraordinarily perceptive gardener, concluded from experiments with pea plants in his cloister garden that whatever carries the traits of the parent plants to their offspring must be composed of discrete units that do not lose their identity in the mating process. Tall plants mated with dwarf plants do not produce middle-sized plants, but some tall ones and some dwarfs, the traits being distributed among the offspring in a statistically predictable way.

When more of the process was understood, the discrete units controlling individual traits were called genes and they were found to be arranged in a specific order along rod-like bodies that can be seen in the nucleus of cells at certain stages in their lives. These objects in the nucleus were called "chromosomes" because they become colored when the cell is stained with certain dyes. It is astounding to reflect that the chromosomes within one single cell (barely visible to the naked eye in the case of the human ovum, for example) contain all the information necessary to enable it to elaborate itself into a mature organism capable of carrying on the species. A central problem in genetics research today is the attempt to discover how this information is contained within the cell nucleus, how it is passed from one generation to the next, and how it is able to control the character of the subsequent development of the individual cell and the organism of which it may be a part. DNA is believed to play the key role in this process.

More than 50 years ago Dr. P. A. Levene at the Rockefeller Institute took up the task of determining the chemical nature of the nucleic acids, one of which, DNA, exists in the nucleus of cells. Thanks to Dr. Levene's work and what has followed from it we now know DNA to be an immensely large and elaborate molecule composed of only a few relatively simple sub-structures called nucleotides. These are arranged on a backbone of a sugar-like character strewn with phosphate groups. DNA is believed to be a double molecule in which the phosphate-sugar backbones of the two halves are coiled around each other in a long helix. Dr. Levene established many years ago that the sugar-like backbone of DNA consists of deoxyribose. It was not until 1954, however, that J. D. Watson at the California Institute of Technology and F. H. C. Crick, his British colleague at the Cavendish Laboratory in Cambridge, recognized its double helical structure.

Strangely enough, a bacteriologist at the Rockefeller Institute who was absorbed in studying pneumonia made the most significant step in discovering the key role of DNA in the regulation of living organisms. The late Dr. O. T. Avery found that DNA extracted from the cells of one strain of pneumococci can transform another strain into the first. But most important—the change is passed from generation to generation. Avery was assisted by Dr. Colin MacLeod, who later left the Institute, and Dr. Maclyn McCarty, then a National Research Council Fellow, now studying the relationship of streptococci to rheumatic fever.

Dr. Avery had become interested in this question after a British pathologist, F. Griffith, reported in 1928 that when he inoculated mice with a mixture of a harmless strain of pneumococci and the dead remains of a harmful strain, the mice died from *live* pneumococci of the harmful strain! Either the dead bacteria were brought to life or something in them was able to transform a harmless strain into a virulent one. It was 18 years later that Avery, MacLeod and McCarty published their classic paper which concluded that the agent causing the transformation is DNA. Somehow molecules of this nucleic acid are able to transfer genetic information from one kind of cell to another kind and cause the revision to be inherited indefinitely.

Mendel's genetic studies were based on observations of differences in plants such as their size or the color of their flowers. The change produced in pneumococci by transformation is less obvious, but it is observable. The original strain of pneumococci in the transformation experiment

grew in small, irregular colonies, but when transformed they formed large, smooth, glistening colonies. We have included here a photograph of colonies of the two kinds of cell, magnified 3.5 times. This is, in fact, the photograph with which Avery, MacLeod, and McCarty illustrated their paper in 1944.

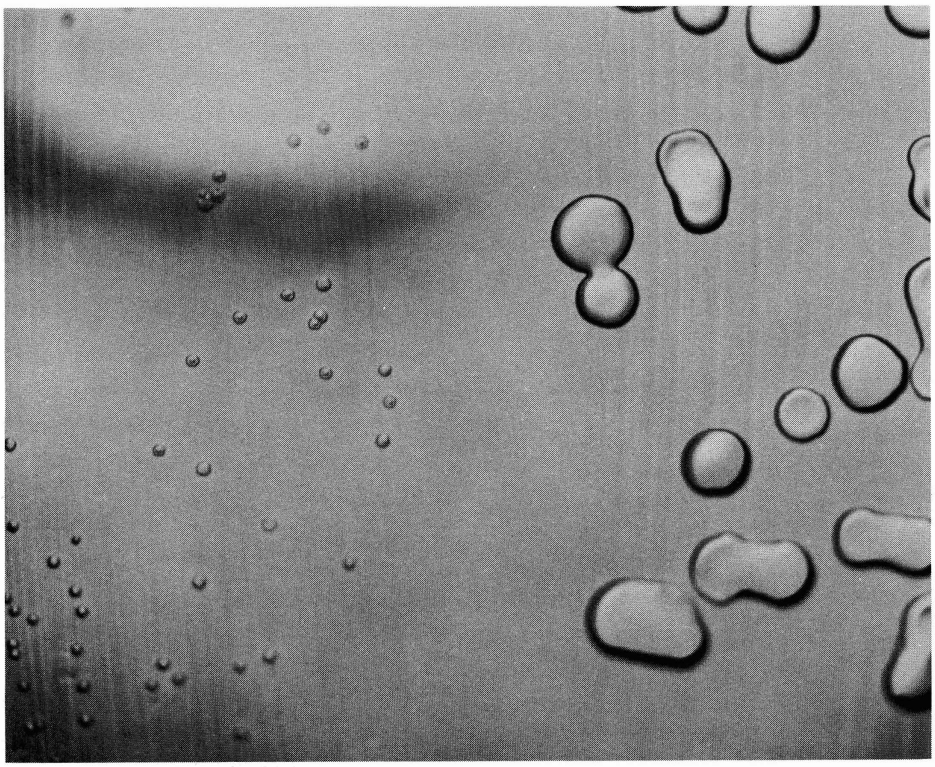
During these 18 years some of Dr. Avery's younger colleagues provided essential clues to the subsequent identification of DNA's role in the transformation of pneumococci. In 1930 Dr. Martin H. Dawson, also a National Research Council Fellow, who had begun to study this problem while at the Institute, and Dr. Richard P. Sia, on a leave of absence from the Peiping Union Medical College, succeeded in causing dead pneumococci to transform live cells just as in Griffith's experiment, but in laboratory glassware instead of in a mouse. In the following year Dr. J. Lionel Alloway, another NRC Fellow at the Institute, reported his success in discarding not only the mouse but even the intact dead cells themselves. Instead, Alloway used only cell-free extracts of the dead cells to carry out the transformation. Avery, MacLeod, and McCarty continued this process of eliminating components from the transforming systems until like the Cheshire cat in *Through the Looking Glass* there was "nothing left but the grin" and the grin was the nucleic acid, DNA.

Some doubted this however. They argued that Avery could not be certain that his DNA extracts really were free of protein contaminants that might be the true transforming agent. It was revolutionary enough to conclude that any specific, identifiable, chemical compound could produce inheritable changes in bacteria. It was still more revolutionary to propose that the compound was not even a protein, as are all the enzymes that play so fundamental a role in the regulation of biochemical processes. DNA, as Levene had shown, is a kind of complicated sugar-like molecule! Avery and McCarty continued to study this question, particularly that of possible protein contamination of their transforming DNA extracts. They pushed their estimates of the maximum possible contamination closer and closer to zero and the transformation continued unaffected. Yet until the level of zero was reached doubt remained. Taking a different approach Avery and McCarty decided to try to prepare an enzyme that would destroy DNA, but leave proteins untouched. They reasoned that if the activity of transforming extracts was destroyed by such a selectively DNA-destroying enzyme, they would be justified in assuming that DNA and not a protein contaminant is responsible for the transforming effect in pneumococci. Relatively pure DNA-destroying enzyme, termed DNA-ase, was prepared, and it completely destroyed the transforming power of the cell extracts.

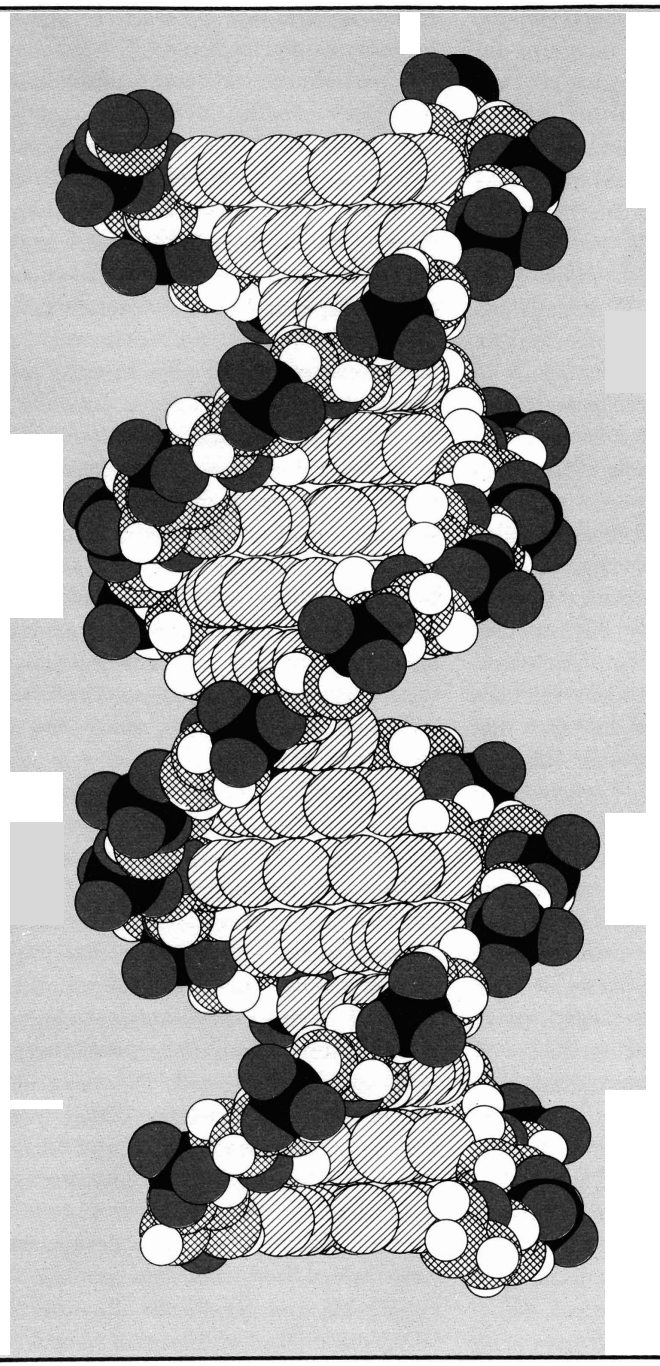
McCarty's DNA-ase was extremely pure, thus making it very unlikely that transformation was stopped by DNA-ase only because protein-destroying impurities in the enzyme were inactivating traces of protein that were really the effective component of the transforming extracts. Ultimately Dr. Moses Kunitz, now Member Emeritus at the Institute, long renowned for his work in crystallizing biologically active proteins, after long and difficult attempts, succeeded in preparing extremely pure crystalline DNA-ase. McCarty found this to be even more effective than his own. Pure DNA-ase has proved to be one of the most significant research tools available for the study of DNA and related problems.

It is one thing, however, to show that DNA can cause heritable changes to occur; it is something else again to show that DNA is part of the germinal material in which these changes occur. But Dr. Alfred Mirsky, working with Dr. Hans Ris, found much to suggest that DNA is actually part of the chromosome material, perhaps even its sole constituent. They showed, for example, that the amount of DNA in all the different cells in an organism is the same, even though the cells vary enormously in other respects. This was suggestive because all of the cells in a given organism also contain the same number of chromosomes. More striking, however, Mirsky and Ris demonstrated that when sex cells have halved their number of chromosomes, in preparation for sexual reproduction, the amount of DNA they contain is also halved. They concluded that the amount of DNA in each set of chromosomes of the same organism is the same and that DNA must be an essential part of the germinal material of the chromosomes.

Dr. Rollin D. Hotchkiss, a biochemist, who began to work with Avery in 1947, has continued his interest in the role of DNA in transformation and its genetic implications. In particular, he has developed methods for quantitative study of the process. Recently, with Dr. Muriel Roger, he has been studying the mechanism by which DNA reaches and enters the cell. It



Colonies of pneumococci before one type of transformation LEFT *and after* RIGHT, 3.5×



WE SHOW HERE a drawing of a model of a short segment of DNA made available through the kindness of Dr. L. D. Hamilton at the Sloan-Kettering Institute nearby, who is engaged in collaborative studies of the structure of DNA with Dr. M. H. F. Wilkins and his associates at King's College, London.

The black and red spheres (representing phosphorus and oxygen, respectively) mark out clearly the double-helix along which the nucleotides are arranged, each of which is linked with a corresponding partner on the opposite coil. These cross-linked groups constitute the dense core of shaded atoms shown in the drawing.

A complete molecule of DNA would be thousands of times longer than the segment in the drawing, consisting of the same few nucleotides arranged in varying sequences along the helixes one after the other. In spite of this apparent simplicity, however, the DNA molecule can exist in billions of similar but unique forms depending on the exact sequence of its nucleotides. It is now supposed that this varying sequence is a kind of code that contains the genetic information of the individual and the species. Moreover, it appears that DNA, in addition to being the repository of genetic information, the file of blueprints, so to speak, also participates in the construction and the operation of a cell. Some believe that the DNA molecule serves as a kind of template upon which many of the biologically active molecules synthesized by the cell are constructed.

appears that only relatively intact DNA molecules are effective in bringing about transformation, for after various physical and chemical assaults which break the molecule into pieces, its transforming efficiency is reduced. We may remark parenthetically that mild heat treatment, which seems to collapse the double helix structure of DNA without changing its composition, seriously impairs its transforming capacity. Evidently the shape of the molecule and the precise spacing of the nucleotides along its axis are important determinants of its biological properties.

Using DNA whose phosphorus is radioactive, Hotchkiss and his colleague, Dr. Maurice Fox, have been able to keep track of DNA during transformation. They find that in some way DNA from the transforming extracts becomes fastened onto the cells prior to its being fixed in their genetic material. Actual transformation, if it happens at all to a particular cell, seems to occur sometime after the DNA becomes fixed in the cell. For example, if the new DNA includes a capacity to resist streptomycin, a colony of cells exposed to it may absorb the DNA more or less at once, but streptomycin-resistant cells will not begin to appear among them until twenty minutes or so later. In the interim it appears that even the cells that have fixed the new DNA on themselves and that will later be transformed to streptomycin resistance are still sensitive to the antibiotic.

While it seems to be necessary that DNA be essentially intact in order to enter the cell, evidently only fragments of a molecule are usually incorporated into the cell's genetic apparatus. Hotchkiss has shown this by a double transformation experi-

ment. First a colony of cells that can use the alcohol, mannitol, as a food is established; then the rare cell among billions of these that is also resistant to streptomycin is selected. A new colony is then grown from this rare cell, all members of which will include both characteristics, e.g., they can consume mannitol and resist streptomycin. The DNA from these doubly-marked cells is then used to transform unmarked cells. If the entire DNA molecule is involved in the transforming event one would expect any cell transformed to show both characteristics. In fact this happens; but more often the transformed cells show only one or the other characteristic, indicating that in these cases, only fragments of DNA entered the cell's genetic material.

An interesting extension of this work is the discovery that one form of sulfanilamide resistance appears to involve at least three separate fragments of DNA. For when DNA from such cells is used for transformation the transformed cells show different degrees of sulfanilamide resistance corresponding to each fragment of DNA. In fact the result is more complicated because the fragments seem to lie close to each other on the DNA molecule, and as a result two may be incorporated together, as well as one at a time or all three at once. Six or seven genetically different transformants may therefore be found. The biochemical difference in the several transformed strains seems to consist of the fact that they elaborate different forms of a single protein which have different affinities for sulfanilamide and para-aminobenzoic acid.

An essential element in the experimental techniques involved in this work is the preparation of very precisely constituted media on which or in which, as the case may be, to grow colonies of the cells being studied. Media preparation is a story in itself, and we pause here only to remark that close association with the transformation experiments so aroused the interest of Miss Audrey Evans, Supervisor of Media Preparation, that she began experiments of her own. In fact the study of the sulfanilamide-resistant variants just described was carried out by Miss Evans, working in close collaboration with Dr. Hotchkiss' laboratory.

Hotchkiss and Fox are now studying variations in the uptake of DNA and the efficiency of the transformation process under different conditions either in the cell's environment or in its own state, as for example whether it is resting, actively growing, or in process of dividing.

It seems clear from this and other work that DNA has much to do with the regulation of the cell's metabolic processes. It has long been known that protein synthesis occurs in the cell, but only recently Dr. Alfred Mirsky and his colleague, Dr. Vincent Allfrey, showed that this occurs in the nucleus of the cell as well as outside it. It had also been established by Dr. Fritz Lipmann, who recently came to the Institute, that the energy for protein synthesis in the cell comes from chemicals called nucleotide polyphosphates, one of the most important of which is adenosine triphosphate or ATP. Recently Mirsky and Allfrey have found that DNA is also essential to the synthesis of ATP by the nucleus. They were surprised to find, however, that in contrast to the highly specific function of DNA from each type of organism in determining its unique character, DNA from many different sources seems capable of promoting ATP synthesis in the same nucleus. For example, when DNA was destroyed in the nuclei of cells from the thymus gland of a calf (using Kunitz' DNA-ase) ATP synthesis stopped, to be resumed again when DNA from the sperm cells of the sea urchin was added as a replacement!

DNA AND VIRUSES

We turn now, for further evidence about DNA's importance, to a level still lower in the scale of life than bacteria—the bacteriophage or bacterial virus. These tiny sperm-like particles, which seem to lie on the borderline between living organisms and mere chemical complexes, are now believed to contain a chromosome of DNA in the head enclosed in a jacket of protein. Viruses seem to be alive in the sense that they are able to duplicate themselves, multiply, and transmit their individual traits from one generation to the next. They seem to be non-living because they have no intrinsic metabolism and in some instances at least can be crystallized like mere proteins. Living or dead, however we may regard them, viruses can multiply only inside a living cell, which usually is damaged and may die after its attacking virus has multiplied sufficiently. It now is clear that DNA determines the hereditary traits and controls functions at the level of bacterial viruses somewhat as at the level of cells.

In 1952, A. D. Hershey and M. Chase, at the Carnegie Institution's Cold Spring Harbor Laboratory, showed that when a virus particle, called a bacteriophage, attaches by its tail to the cell in which it will multiply it leaves its protein jacket outside. Only the DNA enters the cell, there to reorganize or parasitize the cell's metabolism, and after 20 or 30 minutes enough virus DNA and protein jackets for several hundred new phages have been fabricated. These materials are produced separately and are assembled into complete virus particles shortly before they leave the host cell, which usually is damaged as they go. The new generation of virus particles or phages seeks out new cells in which to repeat the astonishing process. Thus, virus infection spreads, usually destroying its host cells as it goes.

Incidentally, there has been much interest in how the DNA is injected by the phage into the cell. Dr. Walther Goebel and Dr. Margeris Jesaitis, found that the surface of certain cells contains a complex sugar antigen that causes the phages virtually to explode on contact. Instead of destroying the phage particle, however, this antigen triggers the injection of the DNA into the cell. This reaction is highly specific; only certain phages react with certain surface antigens, and for this reason not all types of phages infect all types of cells.

With this brief account of bacterial virus infection we can now explain the remarkable and significant discovery by Dr. Norton Zinder, a young geneticist, who is now at the Institute. Zinder, working with Dr. Joshua Lederberg, a geneticist at the University of Wisconsin, found that inheritable changes occurred in a strain of *Salmonella typhimurium* in somewhat the same way as transformation occurred in the pneumococci that had been so thoroughly studied at the Rockefeller Institute. Yet there were important differences, one of the most disturbing of which was that the "transformation" took place even when the transforming extracts were treated with the enzyme DNA-ase to remove every possible trace of DNA.

To make a long and intricate story as short as possible, Zinder found that the

change in genes of his *Salmonella* was caused by the DNA from a virus infection that passed from one strain of bacteria to another, carrying some of the first strain's heritable traits with it! DNA-ase had no effect on the phage's DNA, because when it was outside the cell the DNA was protected by its protein jacket, and when it was inside the cell it was protected by the cell wall. This process of the transfer of traits from one strain of bacteria to another by a virus, Zinder and Lederberg called "transduction". It appears that a fragment of the host cell's own DNA may be packaged in one of the phage particles when it is assembled and by this means finds its way from one cell to another, carrying a transforming property with it.

Evidently, however, when the DNA from a phage enters a cell it may not multiply at once and destroy the cell. Instead it may insinuate itself among the DNA of the cell's chromosomes and, disguised as a gene, so to speak, it may be propagated for several generations by the descendants of the cell it originally entered. In this latent form the virus is referred to as pro-phage. Now under certain stimuli the latent pro-phage DNA among the genes of its host may end its passive phase and begin the process of manufacturing more phage DNA and protein jackets. This in turn will burst the cell and release the new generation of phage particles, perhaps many generations after their predecessor had infected the original host cell. These new phages may induce a latent infection in another strain of cells in their environment, injecting the new cells with phage DNA which insinuates itself among *their* genes.

The evidence from Zinder's transduction experiments is that the phage DNA in this new generation of virus may now contain some DNA picked up from the bacteria in which the phage had passed the latent portion of its career. And with the bacterial DNA, carried by the phages into the new cells, go some of the genetic traits of their former hosts; hence, transduction of genetic traits through infection of one strain of bacteria by virus from another.

Zinder is understandably fascinated with all sides of this new phenomenon and it has many. There is the question of what effects the phage DNA may have in the bacterium where it resides in latent form, as pro-phage. One effect appears to be that the bacterium is rendered immune to invasion by related phages. It may, however, be put upon by a different strain of phage which may also produce only a latent infection, and in turn both forms of pro-phage may be aroused and a new generation of phages assembled in the cell. Wonder of wonders, however, the new generation may contain viruses which combine traits of the two latent viruses—e.g., it has been possible to cross-breed viruses!

We have only just begun to accommodate ourselves to the idea of bacterial genetics when we find we must begin to think in terms of the genetics of bacterial viruses. Work in both these fields is actively in process at the Institute. We learned with interest that it was Dr. Edward Tatum, who, with Lederberg a decade ago, discovered the process of sexual reproduction in bacteria. This work (at Yale University) led Lederberg and Zinder at the University of Wisconsin to their experiments with *Salmonella* and the discovery of transduction. Now Tatum and Zinder, colleagues on the faculty of the Rockefeller Institute, are following the implications of bacterial and viral genetics where they may lead.

But space prevents us from following these implications in this article for they would lead us far from DNA into virology, cytology, protein synthesis, and the genetics and biochemistry of inheritable disease, to name a few of the rather closely connected lines of research at the Institute that we have had to forego describing here. The connectedness of the whole of science is often spoken about, but seldom seen so directly as in the story of DNA and genetics. Levene, the chemist, laid the foundation, and Avery, a physician turned bacteriologist, discovered the significance of DNA. Hundreds of others—scientists in many fields—have contributed to research on DNA and its role in genetic processes. Meanwhile the techniques of the geneticists are providing powerful tools for biochemical research. Intricate cross-breeding experiments, such as those carried on at the Institute by Tatum, Hotchkiss, and Zinder, are elucidating the biochemical processes that go on at the level of the cell and even at the level of the bacterial virus.

Perhaps in another issue we may be able to tell more of the unfolding understanding of the inter-related processes of life and the work of the Rockefeller Institute in quest of that understanding.

MEDICAL ELECTRONICS CENTER AT THE ROCKEFELLER INSTITUTE

TO ENCOURAGE and simulate interactions between those facing new challenges in biology and medicine and those whose achievements in the physical sciences and engineering have given us radar, television and nuclear energy, the Medical Electronics Center was established at the Rockefeller Institute in the Spring of 1955. Such inter-relations are not new to medical science nor foreign to the Institute. A recent editorial observed that neither the Panama Canal nor the electrocardiograph could have been built but for the cooperation of medical men and engineers. Our readers were reminded in an earlier issue that a significant part of the development of electrocardiography was carried out at the Institute by Dr. Alfred Cohn. Indeed a long list of examples could be cited from the Institute's past, including Lindbergh and Carrel's development of mechanical pumps suitable for organ perfusion and, more recently, Dr. Rothen's development of a photo electric ellipsometer for studying enzyme reactions in thin films. In the laboratories of Drs. Bronk, Brink and Hartline, electronic methods have been applied to the elucidation of biological problems. This should surprise no one who recalls that President Bronk is virtually the founder of the field of biophysics. Drs. Bronk and Brink have been studying processes in nerve cells electronically as a means of learning more about cell physiology. Dr. Hartline and his colleagues are investigating the integration of impulses from the compound eye, finding an elec-

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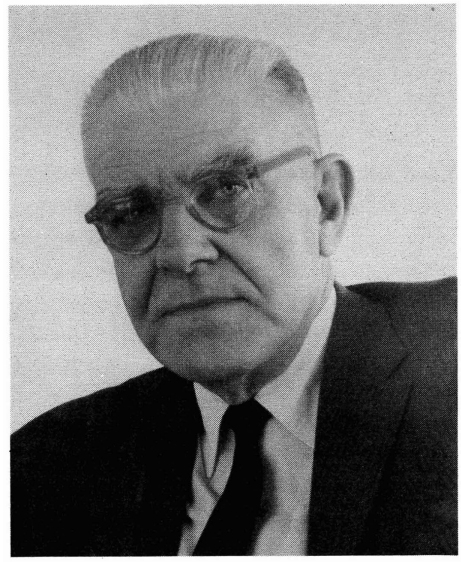
tronic analogue computer of assistance.

But by and large these and other applications of techniques from physics and electronics have occurred sporadically and have depended upon chance associations of interests among a relatively few individuals. It was the conviction of President Bronk and Dr. Vladimir K. Zworykin, Head of the Medical Electronics Center, that in an era of engineering, electronics, and the physical sciences, active steps should be taken to bring techniques developed in those fields to bear on problems of bio-medical research.

When Dr. Zworykin, Honorary Vice President for Research of the Radio Corporation of America, established his laboratory at the Rockefeller Institute in 1954 he set about at once to consider how he could carry out this objective. Establishing the Medical Electronics Center was one of his first steps. Through the Center he has organized a series of small, informal conferences in which medical and biological research scientists, physicists and electronic engineers, instrument manufacturers, and in some cases clinicians exchange views about certain problem areas. Six conferences to date have discussed such varying topics as electroencephalography, applications of television techniques in medicine, the measurement of very small protein concentrations, problems of artificial internal organs, and the use of electronic instrumentation in surgery. This is not the place to report the conferences' conclusions in detail, but a few words about them will show something of the kind of matters that come within the scope of medical electronics.



DR. PHILIP BARD, newly elected member of the Board of Trustees of the Rockefeller Institute, is Professor of Physiology at The Johns Hopkins University School of Medicine.

Many distinguished societies have elected Dr. Bard to their membership including the National Academy of Sciences, the Association of American Physicians, the American Academy of Arts and Sciences, and the Harvey Society. He is also an honorary member of the Sociedad Argentina de Biologica.

Dr. Bard began his professional career with undergraduate work at Princeton University, and he received his Ph.D. degree in physiology at Harvard University in 1927. He has been a member of the faculty at both Harvard and Princeton, and in addition to being professor and head of the department at The Johns Hopkins University School of Medicine since 1933, he served from 1953 to 1957 as Dean of the Medical Faculty.

MICRO-ANALYSIS

Interest in measuring very small protein concentrations, for example, is potentially very great. If the amount of protein in a single living cell (or, ultimately, in a single molecule) could be measured we would be near to having a means for determining the modes of transmission of various virus diseases. But the mass of a virus particle may be only of the order of 10^{-15} grams. Magnitudes such as these lie closer to the realm of the atomic physicist than to the biological scientist, and it is likely that only with their cooperation can the problems be adequately studied. The conference on measurement of small protein concentrations covered such methods as magnetophoresis, fluorescence, photometry and ultraviolet absorption.

The discussion of instrumentation in surgery included such subjects as the desirability of being able continuously to monitor the carbon dioxide content of an anesthetized patient's blood and from this signal to control a mechanical respirator. The chief difficulty seems to lie neither in physiology nor electronics, but in the physical chemistry of the situation—there is no reference electrode that performs reliably in a moving stream of blood. Another interesting conclusion of the discussions was that there is a serious need for informing hospital architects of the present and future needs for space and facilities in operating rooms to support adequate instrumentation. In a similar vein the electroencephalography conference concluded with a plan to define specifications for improved vacuum tubes and cathode ray tubes for use in electroencephalography. These were communicated to the tube manufacturers in the interest of better amplifiers and visual display for electroencephalographic data.

Running through all the discussions has been a problem analogous to the uncertainty principle in physics; namely the difficulty of designing a transducer (sensing element) that detects what we wish to observe, measure, or control without modifying it so much in the sensing process that the result is meaningless. The outlook here is not so gloomy as Heisenberg's, for skillful and ingenious design, particularly in the direction of being able to work with ever smaller signals, may overcome the problem in most applications.

ARTIFICIAL ORGANS

The most recent of the conferences was on Methodology and Problems in Artificial Internal Organs. Held at the Institute on January 15, 1958, it was sponsored by the Institute's Center jointly with the Society for Artificial Organs and the Institute of Radio Engineers' Professional Group of Medical Electronics of which Dr. Zworykin is past chairman. First, various artificial systems were discussed such as kidneys, respirators and oxygenators, ocular devices, and guidance systems for the blind. General questions were then considered, such as choice of materials in terms of corrosion characteristics, toxicity, carcinogenicity, etc.; power requirements and power supplies for various organs; problems of long-term reliability and fail-safe design; and controls and control signals. The proceedings of this conference are being edited for publication. After this exploratory conference of a general nature on this problem (which was under active study at the Institute 40 years ago) more

specialized discussions will be arranged for the future on topics that appear to be significant and encouraging.

Conferences can be very helpful, of course, but not everyone can attend them, nor are they continuous. Dr. Zworykin therefore intends to supplement them with a bibliography which the Center is compiling. Work of interest to the Center may appear in journals scattered among the physical and life sciences, medicine, and engineering. Bibliographic assistance for reaching the literature relevant to medical electronics is perhaps more needed, therefore, than in most fields, where the literature is confined to a few key journals. The first edition of the bibliography to be published as a supplement to the transactions of the Institute of Radio Engineers will contain references to approximately three thousand articles. These are being indexed in detail by subject as well as by author. When a new increment to the bibliography is published the indexes will be published cumulatively.

To help him with the organization of these undertakings Dr. Zworykin has secured the assistance of Mr. Carl Berkley as Research Associate and Conference Secretary of the Medical Electronics Center. Mrs. W. Jacquet is assisting Mr. Berkley as bibliographer.

An unusual background combining biological research at the American Museum of Natural History, film development with the Agfa Ansco Corporation and, most recently, special products engineering with the Allen B. DuMont Laboratories has prepared Mr. Berkley almost uniquely for his work at the Rockefeller Institute.

DR. ZWORYKIN'S LABORATORY

Stimulating as these activities may be, a man with Dr. Zworykin's restless and productive temperament could not be content with talking about other people's research. Dr. Zworykin is pursuing research interests of his own with Mr. Berkley and Mr. Fred L. Hatke. Mr. Hatke, an electrical engineer, came to the Institute three years ago from the Development Engineering Department of the National Broadcasting Company where Dr. Zworykin had worked with him on a color TV camera using experimental Vidicon image tubes.

Perhaps the best known of the achievements to date in Dr. Zworykin's laboratory is the development of a pressure-sensitive ingestible FM radio transmitter in cooperation with the RCA Laboratories in Princeton and Dr. John T. Farrar of the Veterans' Administration Hospital in New York. This device is an impressive example of one solution to the need for developing internal sensing devices that are not in themselves traumatic. Never before has it been possible to study gastric, small intestinal, and proximal colonic motility, for example, without violent disturbance of the normal physiological processes by the wires that had to be attached to any pressure-sensing element in the gastrointestinal tract. Incidentally, Dr. Zworykin points out that he has learned recently that work parallel to this has been proceeding in two other laboratories abroad, without their having been aware of each other's interests, which emphasizes the need for better communication among medical electronic research laboratories.

COLOR TV MICROSCOPY

Dr. Zworykin's laboratory at the Institute is also at work on the applications of an ultraviolet color translating television microscope developed at the Medical Electronics Center. The primary objective of this device is to be able to observe living systems microscopically, "staining" them electronically by a suitable choice of ultraviolet frequencies. Three different wavelengths of ultraviolet light, passed through the sample and differentially absorbed by the components of the tissues observed, are converted arbitrarily to three different visible colors—red, blue and yellow—and displayed on a color television tube. By choosing frequencies that are sufficiently absorbed by certain of the components of living cells the movement and distribution of these components into, within, and out of the cell can be observed. The process has already been shown to be workable though details remain to be worked out. If current attempts are successful to control precisely the relative intensities of the various frequencies, as they are projected on the TV screen, it may become possible to make quantitative analysis of the chemical composition of individual cells.

Many other ideas are being considered by Dr. Zworykin's laboratory and the Medical Electronics Center or with their cooperation in other laboratories. For example, in cooperation with Drs. Lowenfeld and Lowenstein of the Department of Ophthalmology of the College of Physicians and Surgeons of Columbia University, they have under investigation various means for measuring the pressure of the fluids within the eye without disturbing it. And by making use of the reverse thermoelectric effect the Center hopes to be able to produce a tiny freezing cell for a microscope stage that will freeze specimens very quickly when an electric current is applied while the specimen is under observation. In a still different area they have been exploring with colleagues at the Cornell Medical Center and at the Computer Laboratories of RCA in Princeton and Camden whether the logical processes in correlating the objective symptoms of certain classes of diseases may be improved by analysis of the relative frequency with which various symptom patterns occur in established diagnoses. The use of large-scale digital computers has made possible the correlation of large amounts of case history material in the field of hematology.

One of the most ambitious new undertakings of the Medical Electronics Center is the organization of an International Conference on Medical Electronics to be held in 1959 somewhere in Europe. The Council of International Organizations of the Medical Sciences (CIOMS), under the aegis of UNESCO and the World Health Organization, will sponsor the conference, and a preliminary planning meeting will be held in Paris on June 26, 27, and 28, 1958. Among the topics to be considered by the conference will be means for increased international cooperation in the bibliography of medical electronics, and creation of an international clearing house for problems and new applications in medical electronics. Contributions on research in allied fields will be welcomed.

In its function as a clearing house for medical electronics investigations the staff of the Medical Electronics Center will make its bibliographic facilities available to those desiring references to source material and will welcome correspondence in its areas of competence. Through services such as these and through its conferences and its own research the Medical Electronics Center hopes to increase the effectiveness of work in its field and to arouse new interest in cooperation among the life sciences, the physical sciences, and engineering.

SEMINARS ON TRENDS IN DEVELOPMENTAL BIOLOGY

EIGHT SEMINAR SESSIONS on present and prospective trends in developmental biology were held at the Institute during a period of three weeks between February 19 and March 13. The seminars, which were organized by Dr. Paul Weiss, Member and Professor of the Institute, were sponsored by the Rockefeller Institute with financial assistance from the National Science Foundation. Dr. Weiss served as moderator, assisted by Professor Jean Brachet, Professor of General Biology, Faculty of Sciences, University of Brussels, who is also a Visiting Professor at the Rockefeller Institute.

Developmental biology was considered in its broadest sense, as may be seen from the subjects of the eight sessions: morphology and morphogenesis, cytology and histogenesis, genetics, biochemistry, biophysics, microbiology, immunology, and pathology. Rockefeller Institute faculty and graduate fellows were among the participants.

The following group of invited participants from the Eastern Seaboard also attended the seminars: Dr. Dietrich Bodenstein, Gerontology Branch, U. S. Public Health Service, Baltimore City Hospitals; Dr. James D. Ebert, Director, Department of Embryology, Carnegie Institution of Washington; Dr. Mac V. Edds, Associate Professor of Biology, Brown University; Dr. Samuel P. Hicks, Laboratory of Pathology, New England Deaconess Hospital; Dr. Sylvia F. Jackson, Research Fellow in Medicine, Massachusetts General Hospital; Dr. William P. Jacobs, Associate Professor of Biology, Princeton University; Dr. Thomas J. King, Research Associate, Institute for Cancer Research and Lankenau Hospital Research Institute; Dr. Clement L. Markert, Professor of Zoology, The Johns Hopkins University; Dr. William Robbins, Director Emeritus, New York Botanical Garden; Dr. Nelson T. Spratt, Jr., Program Director for Developmental Biology, National Science Foundation; Dr. Salome G. Waelsch, Associate Professor of Anatomy, Albert Einstein College of Medicine; Dr. Paul B. Weisz, Associate Professor of Biology, Brown University; Dr. B. H. Willier, Mergenthaler Laboratory of Biology, The Johns Hopkins University; and Dr. Edgar Zwilling, Associate Professor of Biology, University of Connecticut College of Agriculture.

FACULTY COMMITTEES ON THE LIBRARY

AS THE SIZE, scope, and character of the Institute have been changing so markedly during the past four or five years one of the important peripheral problems has been to assure that our library services keep pace.

President Bronk has recently appointed a Faculty Committee on the library to advise him on the needs of the library in relation to the over-all Institute program. The new Committee will also assist Miss Esther Judkins, Librarian of the Rockefeller Institute, in devising means to assure that our library services tomorrow are as modern and effective as they are today.

Chairman of the Library Committee is Dr. James S. Murphy. Members include Dr. Vincent P. Dole, Dr. Sam Granick, Dr. Theodore Shedlovsky, Dr. Norman R. Stoll, and Dr. Tom T. Stonier. Mr. Charles I. Campbell, Associate for Information Services, is a member *ex officio* and secretary of the Committee.

To give new perspective in our future planning, Mr. Herman Henkle, Director of the Crerar Library of Science and Technology in Chicago, Illinois, has been appointed consultant on library problems at the Institute. One of the first activities of the new Committee was to meet with Mr. Henkle, Miss Judkins, and Dr. Bronk to discuss future plans for the library.

How to increase the accessibility of books and journals in the library is one of the major concerns of the library today. This may soon become a critical question, for our 40,000-volume collection of books and journals almost fills the library and new volumes are being added at a greater rate than ever before. Another question is how not only to keep pace with but to anticipate the literature needs of new laboratories at the Institute and the graduate education program. Systematic means for selecting new advanced college texts are needed, for example, and for selecting books in fields of research not intensively pursued at the Institute, such as mathematics and physics.

This gives us an occasion to mention another Committee that has been concerned with questions of a somewhat different nature. For some time President Bronk has encouraged the addition to the library of classical and current works of general interest in art, literature, history, politics, etc. To assist Miss Judkins in selecting such books, a Committee under chairmanship of Dr. Alfred Mirsky has for more than a year compiled lists of its own and received and considered suggestions from members of the faculty, students, and Institute staff. Members of Dr. Mirsky's Committee are Dr. Alexander G. Bearn, Mr. Charles I. Campbell, Dr. René Dubos, Dr. Duncan MacInnes, Dr. Peyton Rous and Dr. Howard Schneider.

These committees can be of great value in bringing to Miss Judkins and the Administration the views and needs of the faculty and students. But their aim is to supplement and not to replace that invaluable resource of good library administration: the close and lively interest of those who use its services.

THE GREAT CHALLENGE

OVER TEN MILLION PEOPLE have now watched the first practical tests of the suitability of Caspary Auditorium for television broadcasting. A series of seven television symposia, sponsored by the CBS Television Network, is being broadcast from Caspary Auditorium, four of which have already been held. The series, titled *The Great Challenge,* is devoted to analyses of the major problems that face our society today in education, science, economics, government, foreign policy, human relations, and in the area of our basic political, moral and philosophical beliefs.

The panel members on the first program, "Education for What?", presented on Sunday afternoon, February 23, at 5:00 p.m., included Harrison Brown, Professor of Geochemistry, California Institute of Technology, Clarence H. Faust, President of the Fund for the Advancement of Education, Harold Gores, Superintendent of Schools in Newton, Massachusetts, The Very Rev. Theodore M. Hesburgh, President of Notre Dame University, Max Lerner, Newspaper Columnist

and Professor at Brandeis University, Harold Taylor, President of Sarah Lawrence College, and J. Wallace Sterling, Professor of Stanford University. James L. Morrill, President of the University of Minnesota, and President Bronk were unable to participate because of illness. Howard K. Smith was moderator.

The second discussion, held on March 16, concerned "The Role of the Scientist in America's Future" and the panel included Howard L. Bevis, Chairman of the President's Committee on Scientists and Engineers, Clifford Furnas, Chancellor of the University of Buffalo, Joseph Kaplan, Chairman of the U.S. National Committee for the IGY, William L. Lawrence, Science Editor of The New York Times, Roger Revelle, Director of the Scripps Institute of Oceanography, Paul B. Sears, Professor of Conservation at Yale University, and Edward Teller, Professor of Physics at the University of California. President and Mrs. Bronk were hosts to the panel and officials of the CBS Television Network at an informal reception at the President's House following the program.

The third program, on March 23, considered the question "How Strong is our Economy?". The remaining programs in the series are titled "Individual Relationships in a Mass Society," April 20; "Government and the Democratic Process," April 27; "Foreign Relations," May 18, and "What Beliefs Sustain the Western World?," May 25.

FIFTY YEARS AGO AT THE ROCKEFELLER INSTITUTE

Emergency Serum for Meningitis

Last Fall we noted here a newspaper account of Dr. Flexner's work with a serum for epidemic cerebrospinal meningitis. Fifty years ago this Spring a sudden and acute need arose for some of his experimental serum, according to the following undated newspaper clipping from February, 1908:

"Dr. William Goodell Frost, President of Berea College, asleep in his hotel room, was aroused at 2 o'clock yesterday morning by a telegram from Dr. Robert Crowley, physician of the Kentucky Mountain Institution. It told of an epidemic of meningitis at the college. Two students had died and a third was stricken. The telegram advised an instant trip to the Rockefeller Institute for some of Dr. Flexner's serum.

"Dr. Frost arrived before the closed door of the Institute at 3 in the morning. Unable to arouse anyone at that hour, he sat on the doorstep to wait. Dr. Flexner, the Institute's director, was an early arrival. While perfectly willing to provide the serum, he explained that it was still in an experimental stage. Dr. Frost showed the telegrams and stated that Dr. Crowley was a competent practitioner. Six bottles of the serum were thereupon given to him. They were rushed to Berea yesterday."

NEUROPHYSIOLOGY—A FOCUS FOR U.S. AND FOREIGN SPEAKERS

A SERIES OF ADVANCED seminars in neurophysiology has been organized by Dr. H. Keffer Hartline and Dr. David P. C. Lloyd in connection with the Institute's graduate education program. Distinguished neurophysiologists from this country and abroad have joined with members of the faculty of the Institute to present 13 seminars. Aimed at a high professional level, the seminars have been attended by audiences of 30 to 50, including not only graduate fellows at the Institute, but members of our faculty and guests from other institutions as well.

Following the formal seminars, held in Caspary Auditorium, which are open to the scientific public, an informal dinner is given in Abby Aldrich Rockefeller Hall to give the graduate fellows an opportunity for more intimate and informal discussion with the speaker. Dinner is usually followed by coffee and more discussion in one of the seminar rooms.

The seminar series was begun in January by Professor Bernard Katz, University College, London, speaking on "A Physiological Quantum of Action at the Neuromuscular Junction." Subsequent seminars have been on "Synaptic Excitation and Inhibition" by Professor Stephen W. Kuffler, who is at The Johns Hopkins University School of Medicine; "Studies on the Mechanism of Curarization" by Professor Carlos Chagas, Institute of Biophysics of the University of Brazil; "Ionic Movements in Muscle" by Professor Alan Hodgkin, Laboratory of Physiology, Cambridge University; "Metabolism and Ionic Movements in Nerve" by Dr. Clarence M. Connelly, Assistant Professor at the Institute; "Restoration of Sodium Deficient Nerve Fibers by Onium Ions" by Dr. Raphael Lorente de Nó, Member and Professor at the Institute, and "The Utilization of Phosphate Bond Energy for Active Transport in the Squid Giant Axon" by Dr. Richard Keynes, Physiological Laboratory, Cambridge University.

FUTURE SEMINARS

Six seminars remain to be given in the series during April and May. Professor A. M. Monnier of the University of Paris at the Sorbonne, who is also Visiting Professor at the Rockefeller Institute, will speak on some investigations on the constituents of model cellular membranes. Dr. D. J. Robertson of University College, London, will discuss the ultrastructure of the nerve cell membrane. Dr. Herbert H. Jasper of the Montreal Neurological Institute and the Department of Neurology and Neurosurgery at McGill University will talk on his studies of the electrical activity of the brain during habituation, attention and conditioning. Dr. Alexander von Muralt, who is Professor of Physiology at the University of Bern and Visiting Professor at the Rockefeller Institute, will discuss the role of thiamine in nervous excitation.

The last two seminars will be given in May by Professor Ragnar Granit, Professor of Neurophysiology at the Karolinska Institute in Sweden and Director of the Nobel Institute for Neurophysiology, and Dr. Philip Bard, Professor of Physiology at The Johns Hopkins University School of Medicine. Dr. Granit is also Visiting Professor at the Rockefeller Institute and Dr. Bard was recently elected Trustee of the Rockefeller Institute. Nearly twenty of the graduate fellows at the Institute are attending the series. Plans are already being considered for arranging a seminar series in neurophysiology next year in which the graduate students themselves will play an active part.

FACULTY ACTIVITIES

Academic Appointments

DETLEV W. BRONK
Foreign Member, Royal Academy of Science of Sweden.

ARPAD I. CSAPO
Guest Investigator, Department of Physiology, University of Bahia, Brazil.

ROLLIN D. HOTCHKISS
Visiting Professor of Biology, Massachusetts Institute of Technology.

ALFRED E. MIRSKY
Visiting Professor, University of Texas.

Lectures, Conferences and Symposia

A. G. BEARN
Conference on Serum Enzymes, New York Academy of Sciences.

CARL BERKLEY
American Institute of Electrical Engineers' Convention.
New York University Postgraduate Medical School.

ARMIN C. BRAUN
Harvard University.

DETLEV W. BRONK
Address, Delaware Valley Section, American Chemical Society.
Address, American Institute of Mining, Metallurgical and Petroleum Engineers.
Address, University Club of New York.

MERRILL W. CHASE
The Johns Hopkins University School of Medicine.
International Symposium on The Mechanisms of Hypersensitivity, Henry Ford Hospital, Detroit.

GEORGE W. CORNER
Symposium, Section on Historical and Cultural Medicine, New York Academy of Medicine.
Macy Foundation Lecture, Harvard Medical School.

LYMAN C. CRAIG
Ciba Conference on Amino Acids and Peptides with Antimetabolic and Cytotoxic Properties, London.

ARPAD I. CSAPO
Conference on the Uterus, New York Academy of Sciences.

HOWARD G. DAVIES
New York State University College of Medicine, Brooklyn.

THOMAS D. C. GRACE
Wistar Institute, Philadelphia.
Connecticut Agricultural Experiment Station, New Haven.

FRANCIS O. HOLMES
University of New Hampshire.

FRANK L. HORSFALL, JR.
Symposium on Perspectives in Virology, Rutgers University.

SEYMOUR J. KLEBANOFF
Physiological Society, Toronto.

HENRY G. KUNKEL
Brookhaven National Laboratory.
Fordham University.

VIRGINIA C. LITTAU
Northeastern Division, American Phytopathological Society, West Springfield, Massachusetts.

LEWIS G. LONGSWORTH
Chemistry Department Colloquium, Columbia University.
Southwestern Connecticut Section, Optical Society of America.
Chemistry Department Seminar, Yale University.

RAFAEL LORENTE de NÓ
Brookhaven National Laboratory.
The Physiological Society of Philadelphia.

KARL MARAMOROSCH
University of Chicago.
Biology Session, New York Academy of Sciences.
Department of Plant Pathology, Rutgers University.

A. GEDEON MATOLTSY
Symposium on the Biology of the Skin, Brown University.
Department of Dermatology, Cornell University Medical College.

MONTROSE J. MOSES
New York University College of Medicine.
Department of Pathology, New York State University College of Medicine, Brooklyn.
Career Conference for Undergraduates, Bates College, Lewiston, Maine.
Department of Biology, New York University.

JOHN B. NELSON
Institute of Microbiology, Rutgers University.

GEORGE E. PALADE
Department of Biology, Harvard University.
Symposium on Microsomal Particles and Protein Synthesis, Biophysical Society, Massachusetts Institute of Technology.
New York University College of Medicine.
Conference on Metabolic Factors in Cardiac Contractility, New York Academy of Sciences.
University of North Carolina College of Medicine, Chapel Hill.

CYNTHIA H. PIERCE
New York Academy of Medicine.

KEITH R. PORTER
New York University College of Medicine.
University of Western Ontario, London, Canada.
The Institute of Humanistic Studies, University of Pennsylvania.
Southwestern Medical School, University of Texas.

HOWARD A. SCHNEIDER
Walter Reed Army Medical Center.
Columbia University School of Public Health.

RICHARD E. SHOPE
National Crusade Meeting, American Cancer Society, Chicago.
Cornell University Medical College.
Symposium on Perspectives in Virology, New York.
University of Chicago School of Medicine.

PHILIP SIEKEVITZ
Conference on Metabolic Factors in Cardiac Contractility, New York Academy of Sciences.
National Cancer Institute, Notre Dame Hospital, Montreal.
Biology Division, Oak Ridge National Laboratory.
Department of Biochemistry, Albert Einstein College of Medicine, Yeshiva University, New York.

IGOR TAMM
Eastern Surgical Society.
Postgraduate Course, The American College of Physicians, Cornell University Medical College and the New York Hospital.
Institute of Microbiology, Rutgers University.

PAUL A. WEISS
Medical College Lecture, University of Iowa.
Zoology Club, University of Chicago.
Sigma Xi, Brown University.
McCollum-Pratt Institute Symposium, The Johns Hopkins University.

STEVEN L. WISSIG
New York University College of Medicine.
Department of Anatomy, Yale University.

Society Elections

ROLLIN D. HOTCHKISS
President-Elect, Harvey Society, New York.

HENRY G. KUNKEL
Editorial Board, Journal of *Arthritis and Rheumatism,* American Rheumatism Association.

KARL MARAMOROSCH
Secretary, Relations of Insects to Plant Diseases Section, Entomological Society of America.

Other Appointments and Distinctions

DETLEV W. BRONK
Gold Medal Award, International Benjamin Franklin Society.

FRANK L. HORSFALL, JR.
Co-editor, 3rd Edition, "Viral and Rickettsial Infections of Man", the National Foundation for Infantile Paralysis, Inc.

MACLYN MCCARTY
Member, Advisory Board, Lobund Institute, University of Notre Dame.

PETER K. OLITSKY
Member, Subcommittee on Arthropod-borne Encephalitis Viruses, International Commission of Bacteriological Nomenclature and Taxonomy.

RICHARD E. SHOPE
Member, Advisory Board, Lobund Institute, University of Notre Dame.

PAUL A. WEISS
Annual Honorary Lecture Award for 1958, Albany Medical College, Union University.
Chairman, Editorial Board, *Developmental Biology.*
Member, President's Scientific Advisory Committee.

DOUGLAS M. WHITAKER
Consultant for biology, Study of Graduate Education in the United States, University of Chicago.

INSTITUTE MENTION

New Appointments to the Faculty

DR. JEAN BRACHET, who has been a Professor, Department of Anatomy, Université Libre, École de Médecine, Brussels, has been appointed Visiting Professor to participate in a series of seminars on problems in developmental biology planned by Dr. Weiss.

DR. EDWARD O. HAELTERMAN, who has been an Instructor, Department of Veterinary Sciences at the Agricultural Experiment Station, Purdue University, has been appointed Guest Investigator in Dr. Shope's Laboratory, beginning March 1, 1958.

DR. NORMAN E. KEMP, who has been Associate Professor of Zoology, University of Michigan, has been appointed Guest Investigator in Dr. Weiss' Laboratory, beginning February 1, 1958.

DR. LUDWIK T. RZUCIDLO, who has been a member of the Research and Laboratories Department, National Jewish Hospital, Denver, has been appointed Guest Investigator to work in Dr. Dubos' Laboratory, beginning January 27, 1958.

DR. TOSHIO SAKAI, who has been in the Department of Physiology, School of Medicine, Tokyo, has been appointed Guest Investigator to work in association with Dr. Csapo, beginning March 31, 1958.

DR. FRIEDRICH SEILERN-ASPANG, who has been with the Zoologisches Institut, Innsbruck, has been appointed Research Associate in Dr. Paul Weiss' Laboratory.

DR. FABIO SPARATORE, who has been in the Division of Pure Chemistry, the National Research Council of Canada, has been appointed Research Associate in Dr. Granick's Laboratory.

DR. HENRY G. WAGNER, Captain in the United States Navy, Naval Medical Research Institute, Bethesda, has been appointed Guest Investigator in Dr. Hartline's Laboratory, beginning March 15, 1958.

INSTITUTE MENTION

(continued from page eleven)

Faculty Terminations

DR. GUY T. BARRY, who has been an Assistant Professor in Dr. Goebel's Laboratory, resigned February 1, 1958. He has accepted an appointment as Professor of Biochemistry and Microbiology at the University of Tennessee Memorial Research Center and Hospital.

DR. RODERICK P. KERNAN, who has been a Research Associate in Dr. Corner's Laboratory, left March 20, 1958, returning to the Department of Biochemistry, University College, University of Dublin.

DR. W. HENRY SEBRELL, JR., who has been a Consultant, resigned February 1, 1958, to accept an appointment as Professor of Public Health Nutrition and Director of the Institute of Nutrition Sciences, Columbia University.

Guest Speakers

Albert Szent-Gyorgyi, Director, Institute for Muscle Research, Marine Biological Laboratory, Woods Hole, Massachusetts, January 14, 1958.

Ephraim Katchalski, Head, Department of Biophysics, Weizmann Institute of Science, Rehovot, Israel, January 21, 1958.

Theodosius Dobzhansky, Professor of Zoology, Columbia University, January 23, 1958.

John C. Kendrew, Medical Research Council Unit for Molecular Biology, Cavendish Laboratory, Cambridge University, January 28, 1958.

Felix Bronner, Hospital for Special Surgery, Cornell Medical Center, February 7, 1958.

Samuel A. Goudsmit, Chairman, Department of Physics, Brookhaven National Laboratory, February 18, 1958.

George Cotzias, Head, Division of Physiology, Medical Department, Brookhaven National Laboratory, February 21, 1958.

I. Reichert, Agricultural Research Station, Hebrew University, Israel, February 24, 1958.

Jean Brachet, Department of Anatomy, Université Libre, École de Médecine, Brussels, February 25, 1958.

Martin T. Hutchinson, Rutgers University, March 3, 1958.

Lewis Thomas, Professor and Chairman, Department of Pathology, New York University College of Medicine, March 7, 1958.

Donald B. McMullen, Chief, Department of Medical Zoology, Walter Reed Army Institute of Research, March 14, 1958.

Erwin Chargaff, Columbia University, March 19, 1958.

Heinz Holter, Professor, Carlsberg Laboratory, Physiological Department, Copenhagen, March 21, 1958.

Leland J. Haworth, Director, Brookhaven National Laboratory, March 25, 1958.

Guest Seminars in Medicine

Carl Smith, Professor of Clinical Pediatrics, Cornell University Medical College, January 22, 1958.

Irving S. Cooper, Professor of Research Surgery, New York University Postgraduate Medical School, January 29, 1958.

Ralph L. Engle, Jr., Associate Professor of Medicine, Cornell University Medical College, February 5, 1958.

Harriet Hardy, Department of Preventive Medicine, Harvard Medical School, February 12, 1958.

David A. J. Tyrrell, Common Cold Research Unit, National Institute for Medical Research, Harvard Hospital, Salisbury, England, March 12, 1958.

Visiting Professors in Residence

DR. JOHN C. BUGHER, Director for Medical Education and Public Health, The Rockefeller Foundation, March 10-12, 1958.

DR. THEODOSIUS DOBZHANSKY, Professor of Zoology, Columbia University, January 20-24, 1958.

DR. SAMUEL A. GOUDSMIT, Chairman, Department of Physics, Brookhaven National Laboratory, February 17-21, 1958.

DR. ISIDOR I. RABI, Higgins Professor of Physics, Columbia University, February 24-28 and March 3-7, 1958.

New Grants and Contracts

From the United States Public Health Service for Dr. Lipmann's work on biosynthetic mechanisms $43,010

From the National Science Foundation for Dr. Weiss' seminar series on developmental biology $2,000

From the National Science Foundation for Dr. MacInnes' work on the redetermination of the value of the Faraday $15,300

From the United States Public Health Service for Dr. Bearn's research on the characterization of certain proteins in human serum $16,221

Grants may be made for more than one year but funds for the current year only are shown.

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