Winter 1962

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WINTER · 1962

THE ROCKEFELLER INSTITUTE · A GRADUATE UNIVERSITY AND RESEARCH CENTE

Caspary Hall and Abby Aldrich Rockefeller Hall on a wintry day are seen in the cover drawing. Seminar and conference rooms, and the guest suites, lounge, and refectory of the Abby look out upon the snow-covered mall lined with plane trees.

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Electronic Techniques for Research in The Institute

FEW BIOLOGICAL INVESTIGATIONS are carried on today that do not depend in some important way on electronic techniques for instrumentation, observation, recording, or analysis of data. Indeed, electronics has come to play a central role, not only in contemporary research, but in all of modern life. It is therefore imperative that resources for study and use of electronic techniques be an integral part of an institution for graduate study and research such as The Rockefeller Institute. As will be seen below, the Electronics Laboratory has been of great help to many of the graduate students in their doctoral investigations; for most of them it has provided help and guidance in dealing with techniques that might be regarded by many as the exclusive province of the narrow specialist.

Research at the Institute in fields as varied as the physiology of the visual system, lipid metabolism, the control of infectious diseases, and the structure of proteins makes heavy use of electronics and has confronted the physicists and engineers in the Electronics Laboratory with some challenging problems, some of which are described below.

When Detlev Bronk became President of the Institute in 1953 and began the creation of its school of graduate study, one of his first moves was to strengthen an embryonic Electronics Laboratory that had been established many years before to serve the needs of the neurophysiologists. President Bronk was acutely aware of the growing importance of physics and electronics in biology for he was trained in electrical engineering and as a graduate student had obtained a Ph.D. degree in both physics and physiology. He had gone as a National Research Council Fellow to England, where his knowledge of engineering and physics were major assets in the neurophysiological investigations he and E. D. Adrian (now Lord Adrian and the Institute's newest Trustee) carried out at Cambridge. In the year 1928-1929 their classical experiments on the recording of electrical activity from single nerve fibers were completed, using the newly developed vacuum-tube amplifiers to drive oscillographs of various types. Bronk went on to become Professor of Biophysics in the University of Pennsylvania in 1929 and to organize and direct the Eldridge Reeves Johnson Foundation for Research in Medical Physics there.

It was only with difficulty that Bronk could obtain permission to include physics and physiology in his graduate study. Today, physics, electronics, and biology together form the common background of many. For example, after World War II several young physicists who had been at the Radiation Laboratory turned to biophysics. Among them were Dr. C. M. Connelly, now associated with Drs. Brink and Bronk at the Institute, and Dr. E. F. MacNichol, now in the Department of Biophysics at The Hopkins. Both men went to the Johnson Foundation in the University of Pennsylvania, then directed by President Bronk, where they were also associated with Frank Brink and H. K. Hartline, now members of the Institute faculty.

EXPANSION OF ELECTRONICS

A number of those who had been associated with President Detlev Bronk in biophysical investigations joined him when he came to The Rockefeller Institute. Among them were Dr. Brink, Dr. Hartline, and Dr. Connelly. Their needs for electronic assistance led Dr. Bronk to add strength to the Electronics Laboratory by placing it for the first time under a professional electronic engineer, John P. Hervey. Hervey, who had been Assistant Professor of Biophysics at the Cornell Medical College and most recently Associate Professor at The Hopkins, became Senior Electronic Engineer at the Institute's Jacques Loeb Laboratory in Woods Hole, Massachusetts. Under his supervision was an assistant, resident in the New York shop, Dr. C. Yang, from the Johnson Foundation in the University of Pennsylvania. Yang was aided by Warren Schaub, who had come to the Institute to assist the neurophysiology laboratories several years before. Schaub is still at the Institute, and he provides invaluable continuity with the past. Yang returned to China in 1956, and was soon replaced by Dr. Robert L. Schoenfeld, an engineer who was drawn into biological problems by an interest in psychology. Dr. Schoenfeld had worked on the development of electroencephalographic apparatus at the College of Physicians and Surgeons at Columbia University after which he went to Brooklyn Polytechnic Institute for graduate study.

Hervey, in Woods Hole, works on long-term projects; Schoenfeld's group in New York, under Hervey's direction, carries on development and research which require day-to-day consultation. Some of these undertakings are modest, such as a circuit to modulate an optical stimulator for use in the physiology course. Others are more elaborate, for example, the design of a reliable electronic programmed control for Professor Lyman Craig's countercurrent distribution apparatus.

A DIGITAL PROGRAMMER

Still other projects involve considerable research by the Electronics Laboratory. One such long-term project has been undertaken in collaboration with Dr. Hartline and Dr. Floyd Ratliff to automate a large portion of the collection and analysis of the data from neurophysiological investigations. Of necessity much of the data is obtained by electronic techniques, and over the years many means have been devised for recording and partly analyzing the observations. It now appears possible to integrate many of these techniques into a programmed system which will greatly increase the efficiency and variety of practical experiments. This was one of the first problems undertaken by Robert Schoenfeld when he joined the Institute's staff in 1957, and it is still under way.

Hartline's studies of the visual system have for many years centered around observations of the electrical response of and interactions among individual light receptors in the compound eye of the horseshoe crab, *Limulus*. In this work he and his coworkers have been faced with an increasing complexity of experimental manipulations, and electronic programming of the experiments has become a necessity. In certain experiments, as many as three light beams are used and the impulses

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from three nerve fibers, each associated with a separate visual receptor, are recorded. Each light beam is switched on and off for variable timed intervals during an experimental run. These intervals are interchanged between the light beams in successive runs according to a complex pattern. The timed intervals must be programmed in order to test the mutual interaction of the stimuli and to control the average illumination so that it will remain relatively constant for all three receptors. Carrying out and recording the results of these intricate experiments involves an elaborate sequence of switching and adjusting which can better be done electronically than by hand.

As a first step, Schoenfeld set himself the task of understanding the variety of electronic equipment used by Hartline and his co-workers and the different possible experimental uses to which it was put. This task was not simple, not only because Hartline's electronic gear included many sophisticated instruments designed by John Hervey, Edward F. MacNichol, and Hartline himself, but because of the many different functions and ways of interconnecting the equipment.

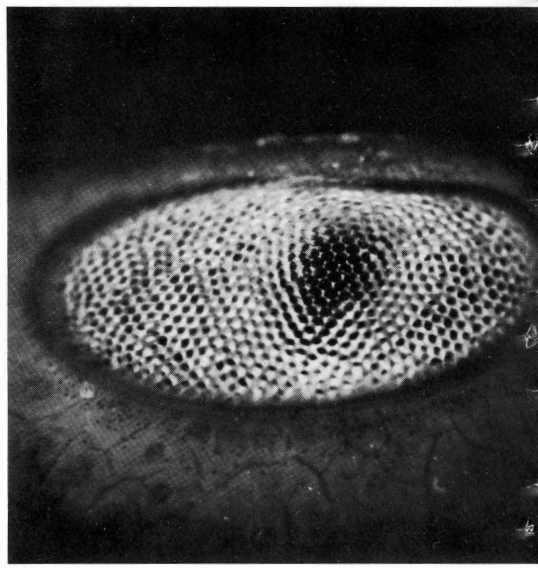
When Schoenfeld began work on this problem, Hervey indicated that the solution would require the application of digital technology. The conception of a digital programmer gradually took form during 1959-1960 as a result of many discussions between Hartline, Ratliff, and Schoenfeld. The main problem in the design was to make the equipment versatile enough to encompass future experiments which are not yet foreseen completely. A preliminary logical design for the programmer was made early in 1960. Hartline and Ratliff evaluated the performance capability of the proposed instrument by setting up hypothetical experiments for it to perform. On the basis of these studies, the complexity and sophistication of the design requirements increased considerably. The final logical design was completed in the spring of 1961. Solid state electronics in the form of printed circuit digital modules will be employed in the programmer, which is, in effect, a special purpose digital computer.

Before embarking on so ambitious an undertaking, Schoenfeld and his associates have wanted to obtain practical experience with the components of this elaborate system. One such "finger exercise," as Schoenfeld calls it, was developed cooperatively by Laurence Eisenberg of the Electronics Laboratory and Dr. Floyd Ratliff. They have devised equipment which automatically displays in numerical form the time of arrival of nerve impulses, or the time interval between successive impulses. Heretofore the almost microscopic photographic traces of high-frequency impulses had to be analyzed in terms of frequency and time of arrival by tedious measurement on an optical device Hartline devised from a ruling engine like that used by Rowland for producing diffraction gratings at The Johns Hopkins University. So lengthy was the analysis of the data that many experiments which could easily be performed were passed by for lack of time for processing the data. Now the time intervals are computed, displayed, and superimposed photographically on the oscilloscope record of the nerve impulses themselves. On the facing page is a photograph of such a record.

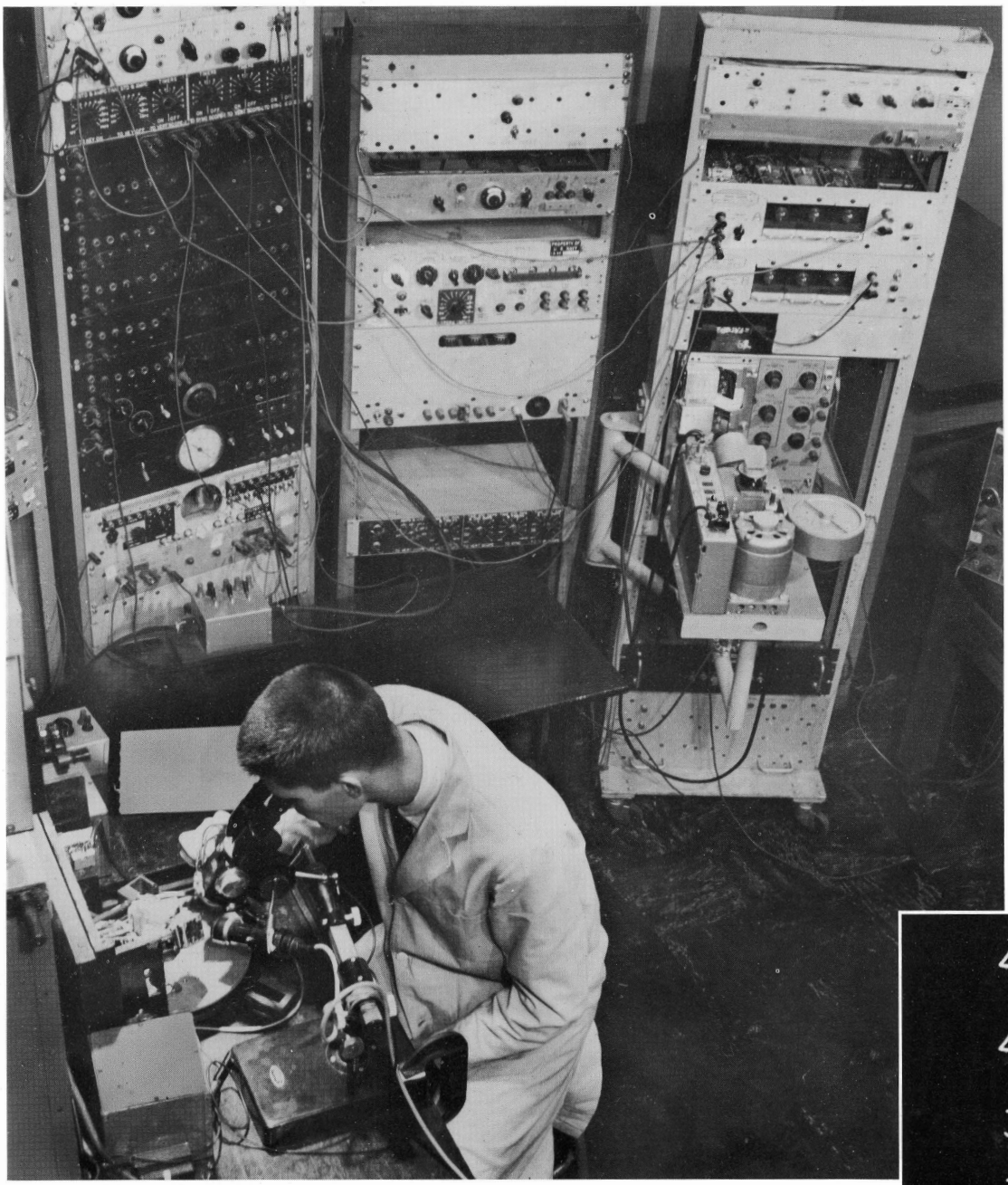
A modification of this system is a multifunction instantaneous display counter Schoenfeld and Eisenberg with the assistance of Willard Friedman developed for Dr. Vernon Brooks, neurophysiologist at the Institute. This unit will count mammalian nerve impulses (which occur at much higher counting rates than the impulses in the cold-blooded *Limulus)* of a preselected amplitude, and it will display instantaneously the total number in a given interval, the time they arrive following stimulus, etc.

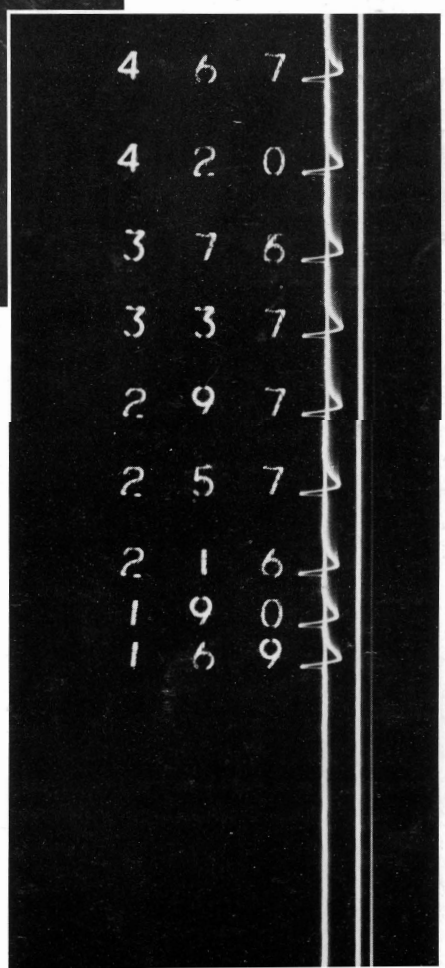
At his headquarters at the Marine Biological Laboratory in Woods Hole, John Hervey specializes in the development of systems and equipment which involve rigorous biological specifications necessitating long-term study and experiment. For example, though recently commercially available oscilloscopes, cameras, and stimulus-timing devices have met many needs, the initial amplifier stages, dealing with the lowest signal levels, have requirements which are not entirely met by any instruments on the market. One of the reasons for this is that the requirements of these amplifiers depend on the specific application and technique for which they are being used. Differential amplifiers, mentioned above, have in fact been developed for studies of single nerve fiber pulses such as in the research of Gasser and Erlanger and Adrian and Bronk, but no manufacturer has yet succeeded in building amplifiers as free from drift as those from the Electronics Laboratory, and with comparable discrimination. Recent advances in techniques of physiology such as the use of micropipettes for electrodes and micropointed metal electrodes have raised new problems. With these, the microelectrode (with a tip diameter of less than a micron) actually pierces the membrane of the cell or neuron, and signal amplitudes approximate the potential across the membrane, which may be from one hundred to one hundred and fifty millivolts.

The sharp localization of the observation thus achievable opened a new realm for investigation. But the microelectrode is not an unmixed blessing, for the small size of the electrode and the minute signals involved require that the associated circuitry be designed and constructed with



Above is the jewel-like compound eye of the horseshoe crab (Limulus), *about twenty times natural size, used by Professor Hartline in studies of the neurophysiology of vision. On the opposite page is the electronic apparatus used to analyze the response of any of the thousand or more receptors in the facets of the eye when they are stimulated by light. The technician is placing a facet under the light beam. At far right are data from a typical experiment. A counter displays on the oscillogram of the nerve impulses the time in milliseconds at which they appear following the onset of stimulation by light (marked by a step in the trace at bottom right).*





exquisite care. Even characteristics inherent in the construction of the vacuum tubes themselves, which are normally negligible, cause difficulties in conjunction with the microelectrode. Special amplifiers have been introduced to deal with these difficulties, and a variety of different designs have come from half a dozen laboratories. While these serve a very useful purpose and permit the physiologist to do many things not previously possible, they suffer from certain disadvantages which are not entirely understood. Analytical investigation of their properties has been carried out at the Institute, first by Dr. Yang, and now by Dr. Schoenfeld, with the aim of finding ways to maximize the speed of response. There remain large areas of investigation related to the intrinsic noise of these new systems and a good deal of engineering evaluation of the most suitable tubes and transistors to use in them.

One of Hervey's objectives at Woods Hole is to achieve a method of connecting the special circuitry developed to handle the microelectrode signals to the input end of the conventional differential direct-coupled preamplifier. This would extend the range of usefulness of the latter to microelectrodes, while reducing, if possible,

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ELECTRONIC TECHNIQUES

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the internal noise which tends to limit the former. During the past year an effort has been made to find out more about the grid current and sources of low-frequency noise in commercially available vacuum tubes. Concurrently, Hervey's development program has shown how to design power supplies with stabilities measured in the tens of microvolts.

Hervey has just completed the design of a preamplifier for use with the new Tektronix 502 cathode-ray oscilloscope. This apparatus will be used by students who are doing thesis research in the area of neurophysiology. Hervey's presence at Woods Hole is of great assistance to the students and faculty from the Institute who carry on their research there in the summer. Last summer, for example, four graduate students worked with him. One, Robert DeVoe, had just graduated, having written his thesis on an investigation of the electrical activity of visual receptors. From an initial interest in freely moving animals in their natural environment, DeVoe's interest changed to an enthusiasm for experimental cellular physiology and his initial disdain for electronic gear changed to a lively interest in it. DeVoe spent the summer with Hervey to perfect his knowledge of electronics as much as possible before beginning his academic career this fall in the Department of Physiology of The Johns Hopkins University School of Medicine. Clifford Slayman constructed the equipment he will use this year as he begins his thesis research, and Richard Purple and David Lange studied with Hervey how to design and build their own apparatus. Another of the students, Fred Dodge, who is completing a thesis investigation in neurophysiology in the laboratory of Professors Brink and Bronk this year, has acquired an unusual grasp of electronics while he has been at the Institute. He has designed and constructed much of the equipment he has used.

GAS-LIQUID CHROMATOGRAPHY

Gas-liquid chromatography (GLC) is a modern analytical technique in which many fields of specialization and investigators in many countries have played a role. Indeed, the rate of growth, activity, and development of this technique has been the most rapid of all modern analytical methods in chemistry, both in instrumental development and sophistication as well as in laboratory techniques. At The Rockefeller Institute the Electronics Laboratory has assisted Professor Edward H. Ahrens, Jr., and Professor Vincent P. Dole in developing gas chromatography apparatus to further their studies of the metabolism of high molecular weight fatty acids.

The first GLC apparatus at the Institute was obtained early in 1957 by Professor Ahrens to aid in his investigations on lipids. The instrument and technique were developed in England by Dr. A. J. P. Martin and Dr. A. T. James and featured the detection of the separated components in the effluent gas with the gas density balance. James brought such a detector and a column heating system from England, and he and Dr. William Insull, then in Professor Ahrens' laboratory, assembled the instrument with the aid of the Electronics Laboratory and the Instrument Shop. This instrument made possible the first successful analyses of long-chain fatty acids in this country by GLC; as little as 1 to 3 milligrams of fatty acids was required. This success sparked the acceptance of this new technique here and greatly accelerated certain phases of lipid chemistry.

James also brought with him news about a new type of detector, devised by Dr. J. E. Lovelock in England, that proved to be extremely important to the development of GLC throughout the world. Lovelock's ionization chamber detector was reported to be several orders of magnitude more sensitive than existing thermal detectors as well as the gas density balance. It was stable against temperature and pressure fluctuations, required no reference column, was fairly easy to construct, and, in short, more closely approached an ideal detector than any developed up to that time. The principle of operation upon which Lovelock's detector is based is well known to designers of nuclear particle counting instruments.

Professor Ahrens, alert to the need for higher detection sensitivity in order to carry out analyses on the microgram samples available in certain biological experiments, decided to construct an instrument utilizing this remarkable new detector. Working closely with Dr. Insull, who was responsible for the project, and with Nils Jernberg in the Instrument Shop, who constructed the boiling liquid column heating jacket, Dr. Schoenfeld supervised the construction of the electronic phase of the systems.

TROUBLE-SHOOTING

The completed instrument was tested in the spring of 1958 but the results were not entirely satisfactory, for the detector lacked the high sensitivity reported by Lovelock. It was at this time that Paul Rosen, a physicist, joined the Electronics Laboratory. Rosen was assigned the responsibility of carrying forward the project. Armed with a complete understanding of the essential requirements of good detector design, Mr. Rosen proceeded to modify the existing detector to include changes recommended by Dr. Lovelock. Not the least important of these recommendations was the use of a spark plug slightly modified to serve as the anode of the ionization chamber, a simple but critically important item. The results of the modified design proved to be extremely satisfactory, for it made possible complete analyses of complex mixtures of fatty acids using as little as 10 micrograms of material. An intensive investigation by Mr. Rosen was then initiated with Dr. Insull and later with Dr. John Farquhar in Professor Ahrens' laboratory to study the characteristics of the detector regarding sensitivity, linearity, accuracy, and proper operating conditions.

A year later a similar instrument was constructed for Dr. Dole to be used in his investigations of lipids. Mr. Rosen designed an electrical column heating system to replace the boiling liquid heating methods used with the earlier instruments. A second GLC machine will soon be delivered to Dr. Dole which will include improvements in design based upon the experience obtained with the earlier models.

The Electronics Laboratory enjoys the part-time assistance of Dr. Sid Deutsch, Associate Professor in Brooklyn Polytechnic Institute. Dr. Deutsch and Dr. Herbert Jaffe of the spectroscopy laboratory recently developed a miniature heating unit to fit inside the cuvette of an optical spectroscope. The platinum heating wire of this unit functions as part of an automatic temperature controller and permits fast response for optical studies of kinetics.

Dr. Deutsch is now working on a digi-

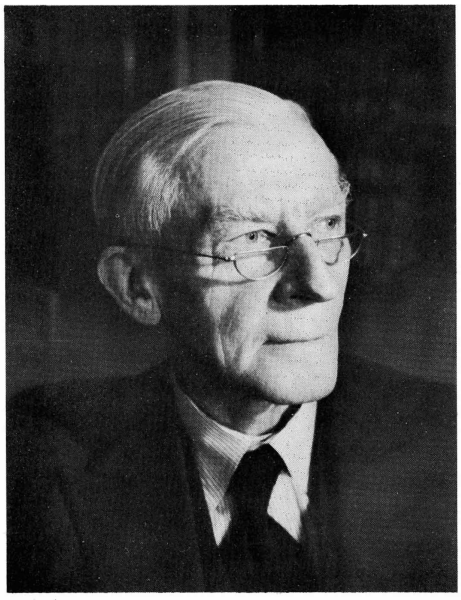
tal integrator for the Moore-Stein amino-acid analyzer. The heart of this design is a novel printed circuit, which carries twelve silvered tracks wrapped around a rotating drum on which contact brushes ride. The drum rotates to an angle proportional to the light transmitted through the sample from the amino-acid analyzer. The printed circuit around the drum converts the angle of rotation into numbers proportional to the logarithm of the angle, which is in turn proportional to the optical density of the sample. The printed circuit thus constitutes a logarithmic analog-to-digital converter and permits the data of an amino-acid analysis to be encoded as a set of numbers on punched paper tape. The tapes from a number of experiments or from different machines can be handled by one computing unit, which will add the numbers on the tape to compute the quantity of each component amino-acid present in the analysis.

Since the war the Institute of Radio Engineers has created a Professional Group on Medical Electronics. The work of The Rockefeller Institute's own Medical Electronics Center under the leadership of Vladimir K. Zworykin has previously been described in the *Quarterly* (Vol. 2, No. 1, 1958; Vol. 3, No. 1, 1959).

A pacemaker to stimulate a failing aged heart is an excursion into medical electronics by Dr. Alexander Mauro, a biophysicist now associated with Professor Frank Brink. Mauro has been deeply interested for a number of years in the possibility of developing electronic prosthesis for various excitable tissues. The implications for certain forms of paralysis are great, indeed, but the problems of synthesizing the intensity, wave form, frequency, etc., of motor nerve impulses are as yet insurmountable. Cardiac impulses are much simpler, and accordingly Mauro, in a development program that is peripheral to his chief biophysical interests, has proceeded with the cardiac pacemaker. It has given some challenging problems to the Electronics Laboratory. Stimulation of blocked hearts from internally implanted power sources or by wires passing from outside the body directly to the heart has numerous disadvantages. Mauro, who began to explore this problem while he was at Yale, was convinced that a battery-operated radio transmitter could transmit a precisely controlled impulse from an external source to a simple internal receiver. With the power source outside the body the pulse frequency and amplitude can be changed as the patient's condition warrants, and the simplicity of the implanted pick-up coil assures great reliability.

Laurence Eisenberg in the Electronics Laboratory and Dr. Mauro developed a transistorized unit with adequate power, producing the first successful unit in 1960. Shortly thereafter, a second and simpler miniaturized unit was developed and produced commercially, for production of units in quantities sufficient for clinical trials would have been beyond the capacity of the Electronics Laboratory. Dr. W. Glenn at the Yale University School of Medicine is carrying out clinical tests of this unit, and four patients are currently using this transistorized pacemaker with great success. Many problems remain in perfecting the apparatus and adapting it as a prosthetic device for stimulating nerve tissue. Mauro and Eisenberg have undertaken to continue this work.

Only a few examples have been given here of the multitude of ways in which electronic instrumentation and techniques are being used in biological and medical research. The growing importance of electronics and the increasing scope of the Institute's Electronics Laboratory assure that in future articles in this series on the Institute's scientific activities, opportunities will arise to tell more of the role of electronics in science.



EDGAR DOUGLAS ADRIAN, First Baron of Cambridge, Master of Trinity College, sometime Professor of Physiology and Vice-Chancellor of the University of Cambridge, has been elected Trustee of the Institute. It is noteworthy that in spite of the universality implicit in the idea of a university, election of a foreign scholar to the governing board of a university is unusual, if not without precedent. This action was taken in recognition of the growing international character of American institutions of higher learning. Visiting Professor since the creation of the Institute's School of Graduate Studies in 1954, Adrian was among the first recipients of its honorary degree of Doctor of Science in 1959 on the occasion of the first Academic Convocation for the Conferring of Degrees.

Lord Adrian received the Nobel Prize in Medicine and Physiology in 1932 with Sir Charles Sherrington for their investigations on neuromuscular coordination. With President Bronk, Lord Adrian pioneered the recording of electrical impulses from single nerve fibers, and he has made important contributions to the understanding of the nervous mechanisms underlying sensation and perception.

Adrian was President of the Royal Society from 1950 to 1955 after having served as Foreign Secretary since 1946. He was President of University College of Leicester from 1955 to 1957 and is now Chancellor of the University of Leicester. He was President of the British Association for the Advancement of Science in 1954 and is now President of the Royal Society of Medicine. Among the numerous scientific and scholarly societies throughout the world which have honored Lord Adrian by electing him to their fellowship are the National Academy of Sciences and the American Philosophical Society in the United States, the Accademia Nazionale dei Lincei in Italy, the Académie des Sciences in France, the Royal Danish Academy of Sciences and Letters, the Swedish Royal Academy of Sciences, and the Royal Academy of Sciences in The Netherlands. In addition to The Rockefeller Institute more than a score of other universities have conferred academic honors on him.

The Trustees

PHILIP BARD

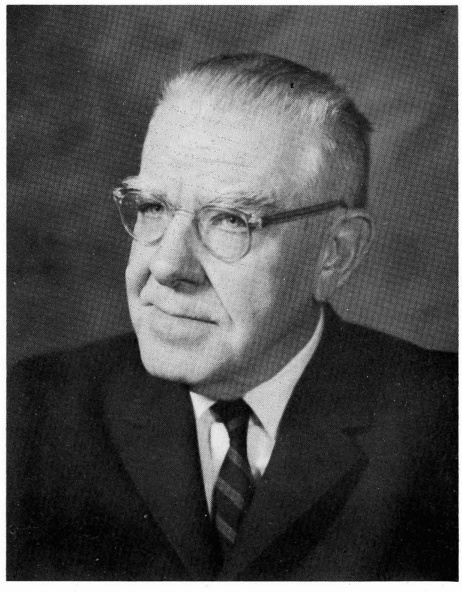
PROFESSOR OF PHYSIOLOGY in The Johns Hopkins University School of Medicine, Philip Bard was elected Trustee of the Institute in 1959. Teaching and research in physiology have been his chief interests since he was graduated from Princeton University in 1923. When he was fifteen he planned to become a physician, but after leaving Princeton he decided instead upon graduate study in physiology at Harvard University, where he earned the Ph.D. degree under Dr. Walter B. Cannon.

Cannon had been carrying on a series of experiments with cats which manifested rage upon recovering from anesthesia, though the cerebral cortex had been severed from the brain stem, isolating the supposed seat of emotions. The subcortical origin of this "sham rage" behavior was suggested by Dr. Cannon as a thesis problem, and it led Bard into a lifetime of investigations of physiological phenomena controlled by mechanisms in the brain and brain stem.

Dr. Bard entered into investigations of motion sickness through his membership on the wartime Committee on Aviation Medicine of the National Academy of Sciences—National Research Council. He says somewhat ruefully that they had great success in curing motion sickness in dogs, but since the procedure involved surgical removal of a portion of the cerebellum it was hardly useful for amphibious or airborne landings. Recently Dr. Bard has returned to an early interest in endocrine physiology, which many years ago had led him to enter the laboratory of Dr. Cannon. This is a logical development from his interest in the hypothalamus, for the hypothalamus is closely related to the pituitary, and the pituitary in turn is related to the regulation of the entire endocrine system.

After he received his Ph.D. degree, Dr. Bard remained with Cannon at Harvard briefly as a Teaching Fellow and Instructor in Physiology. In 1928 he returned to Princeton as Assistant Professor of Biology, and in 1931 he became Assistant Professor of Physiology and Tutor in Medical Sciences in the Harvard School of Medicine. In 1933 he became Professor of Physiology and Head of the Department in The Johns Hopkins University School of Medicine where he served as Dean of the Medical Faculty from 1953 to 1957.

The American Physiological Society elected Dr. Bard as its representative on the Division of Medical Sciences of the National Research Council in 1935, a responsibility he carried until after the war. In addition to membership on the Committee on Aviation Medicine he also served as Chairman of its Subcommittee



on Motion Sickness and as a member of the Committee on Shock and Transfusions, as well as a member of the postwar Committee on Neurobiology. The latter committee published in 1952 a survey containing a review by Dr. Bard of the status, trends, and needs of neurophysiology, which is still useful today.

Dr. Bard was President of the American Physiological Society from 1941 to 1946 and President of the Association for Research in Nervous and Mental Disease in 1950. He has been elected to numerous distinguished scientific organizations, chief among which are the National Academy of Sciences, the American Philosophical Society, and the Association of American Physicians. Honorary degrees have been conferred on Dr. Bard by Princeton University and Washington and Lee University, as well as the Catholic University of Chile in Santiago and the University of San Marcos in Lima, Peru. He is also an Honorary Member of the Faculty of Biological and Medical Sciences in the University of Chile and of the Medical Society of Santiago, and Honorary Member of the Argentine Biological Society. Dr. Bard's Latin American honors came to him through the respect and affection he has won from the numerous South American students who have studied with him in his laboratory at The Hopkins.

In addition to his devotion to teaching and research and his service to scientific societies, Dr. Bard has given much of his time to the literature of science. Not only has he served on the editorial boards of *Physiological Reviews* and the *American Journal of Physiology*, but he has lavished time and care on seeing four revisions of what was MacLeod's *Physiology in Modern Medicine* through the press. This labor of love he began in 1933 when he was asked by Dr. MacLeod to rewrite the chapters on the central nervous system in the seventh edition. MacLeod died soon thereafter, and Dr. Bard undertook to edit the eighth and following editions. A score of the seventy-two chapters in the eleventh (1961) edition were written by him or so extensively revised by him that they bear his name.

Dr. Bard's intense interest in his research and his numerous administrative responsibilities leave him little time for recreational activities. He occasionally finds time, however, to pursue an interest in certain aspects of American history, notably the Civil War and the events following in California, which have personal interest for him. His maternal grandfather founded the San Francisco *Bulletin* in the 1850's, and his father, on a postwar mission to California in 1870, founded what is now the town of Port Hueneme, where Dr. Bard was born, and organized the drilling of the first successful oil well in California.

Dr. Bard is married to Harriet Hunt, whom he had known as a child in Pasadena, California. They were married while he was an undergraduate at Princeton. This was most unusual in 1922 and could be done only with the approval of the Dean and the President. The necessary approvals were forthcoming, for the couple were hardly children. Dr. Bard had already seen two years of service abroad with the U. S. Army Ambulance Service in World War I, and his fiancée was a graduate of Stanford University. The Bards now have two grown daughters.

VISITING ANTHROPOLOGIST SHOWS DRAWINGS CLUE TO FORM OF CULTURE

"CAN THE STUDY of primitive cultures help to disclose the ultimately human qualities of man?" asked one of the Institute's graduate students recently during an orientation seminar in anthropology. Dr. Harold C. Conklin, Associate Professor of Anthropology in Columbia University and Visiting Lecturer in the Institute, to whom the question was put, acknowledged that this must be among the higher though perhaps distant aims of cultural anthropology. His seminars showed how this could be so, for he gave many insights into the variety of forms men's needs and aspirations may take. For example, the character and significance of the drawings made by the hill people in the Philippines show not only the universality of a sense of form and style but, also, on careful analysis, provide a key to the culturally significant items in the local environment.

On this page are shown three drawings of plants made by members of a remote mountain tribe on the island of Mindoro, the Hanunóo. Lovely for their delicacy and form, they are the more remarkable for having been drawn entirely from memory by men who had first used paper and pencil only a few weeks before.

Dr. Conklin explained in his lectures how this came about and what significance it has. He had chosen to be discharged from the army in the Philippines in order to begin ethnographic field work on Mindoro in 1947, and there he first met the Hanunóo. He returned in 1952 for eighteen months of study, in the course of which he discovered the natives' fascination with paper and pencil. He was surprised by the dexterity and detail with which they drew from memory objects (primarily plants) which they knew well. Dr. Conklin surmised that though he knew the language, the natives' drawings might provide useful leads into culturally significant items that his interrogations and observations had missed. All available paper and drawing material was put at the natives' disposal and the four or five hundred drawings which resulted amply supported his conjecture. Because the Hanunóo are acute observers, have well-developed visual memories, and in many cases are skillful artists, the result is most rewarding. The drawings are a continuing source for the study of the Hanunóo view of things. It can very quickly be seen from what was omitted or treated very schematically what are regarded as the significant characteristics.

The ability of the Hanunóo to draw is related to another feature of their culture: they are remarkably literate, and they write by incising in bamboo the forty-eight characters of their Indic script, derived from the ancient Sanskrit alphabet. Rarely do they cut representational drawings on their bamboo "tablets." The chief function of their writing is to record the love songs which form an important part of their rather formal courtship. It is obviously the young, therefore, who have the greatest interest in learning to write and who thus give life to the script. The identification of the bamboo plant in the picture at left below is written in the Hanunóo script as an imaginative and artful extension of a shoot from the plant.

Closer examination of the drawings shows that in contrast with the clarity and precision with which the stems and leaves are drawn, the root systems are always indifferently shown. This proves to be highly significant, and related to the basic concept of property ownership among the Hanunóo, the so-called "stem right." No one owns the land, or what is in it (including roots), but an individual may own the stem of a plant which he has cultivated, purchased or inherited. He does not necessarily own the "fruit rights," for any member of his family may harvest the crop, and he may sell the privilege to others. The major divisions of the local taxonomy, therefore, are all based on features of the stems of plants rather than their leaves or fruit, and regardless of how stylized or indistinct other features may be in a drawing, the distinguishing features of the stem are always detailed.

Among the Hanunóo Dr. Conklin also found skillful modellers in clay. They prepared for him a detailed and generally very accurate relief map of their neighboring vicinity in which he has discovered local distortions which are highly significant in terms of the form of the culture. He hopes to develop objective metrical analysis of the distortions so that models of landscapes can be used in cultures whose economy is organized around water rights as effectively as drawings have been used in the "stem rights" economy of the Hanunóo on the island of Mindoro.

Bamboo, arrow-grass, and rattan (left to right) drawn by Hanunóo in the Philippines. Vague treatment of root systems contrasts significantly with the carefully detailed stems.

MISCELLANY

Holiday Season Marked by Social Occasions

The Christmas season opened this year with a Christmas Ball on December 15th at which the Graduate Students were hosts. Held in the recreation room of their residence hall, which the students and their wives had elaborately ornamented for the occasion, the Ball featured music, dancing, and good fellowship for all. On December 19th the children of those at the Institute were entertained at their annual Christmas party in Welch Hall. President and Mrs. Bronk were hosts at a Carol Sing on December 20th in Welch Hall for faculty, students, staff, and friends of the Institute, followed by a tea. On New Year's Day the Bronks held open house for those of the faculty and students who were in New York on that day.

President Bronk Honored by The Franklin Institute and Holland Society

President Bronk received the Franklin Medal, highest honor of the Franklin Institute, on October 18th at the traditional Medal Day Dinner in Franklin Hall, Philadelphia. He was also the principal speaker at the occasion, choosing as his topic "The Humane Qualities of Science," a subject particularly appropriate on a day honoring Benjamin Franklin. The citation accompanying the medal noted that it was conferred in recognition of Dr. Bronk's "learned investigations of electrical and biochemical properties of nerves; for his contributions to our understanding of the central and peripheral nerves; for the perfection of his experimental techniques which set an inspiring example for coworkers; and for his scientific leadership in biophysics." Among former recipients of the medal are Thomas A. Edison, first recipient, Albert Einstein, and Orville Wright.

On November 3rd Dr. Bronk was honored in New York by the Holland Society, composed of descendants in the male line of residents in the Dutch Colonies in America before 1675. Dr. Bronk, a native of New York City himself, is a descendant of the Bronck family which settled in what is now the Bronx and later in the upper Hudson Valley during the first half of the 17th century. The gold medal of the Society was presented to Dr. Bronk at the Society's 77th annual dinner for his contributions to science and the promotion of international relations. It had been awarded in 1929 to Theobald Smith, a member of The Rockefeller Institute.

Reception for New Members of the Faculty and New Students

A reception for new members of the faculty and new students has become a traditional event in the fall at the Institute. This year, on October 23rd, nearly sixty who had joined the faculty since the previous fall were guests at a reception in Welch Hall. The twenty new graduate students for the academic year 1961-62 were also guests, and at an informal gathering before the reception they had an opportunity to meet the Trustees, who held their fall meeting on the same day.

Uhlenbeck Edits Studies in Statistical Mechanics

Professor George Uhlenbeck is co-editor with Professor J. de Boer of the University of Amsterdam of a new series of *Studies in Statistical Mechanics* to be published by the North-Holland Publishing Company in Amsterdam. The first volume, appearing in January, 1962, contains a contribution by Dr. Uhlenbeck and Dr. G.W. Ford of the University of Michigan on the theory of linear graphs with applications to the theory of the virial development of the properties of gases.

Lectures in the Humanities

A series of afternoon lectures in the humanities has been arranged for this academic year by Professor Edelstein. The first, given by Professor John E. Smith, Chairman of the Philosophy Department in Yale University, was a survey of problems in contemporary American philosophy. Professor Smith's lecture on November 8, 1961, was oriented toward questions of general interest and on the morning following he met informally with some of those in the audience who wished to pursue further some of the ideas he had discussed. On December 4th, Dr. Erwin Panofsky, historian of art in the Institute for Advanced Study at Princeton, presented the results of his investigations of the puzzling murals in the *Camera di San Paolo* at Parma, painted early in the sixteenth century by Correggio. Panofsky's careful analysis of the baffling classical pagan motifs in the drawing room of the famous abbey has disclosed a consistent and bold scheme, carried out by Correggio, by which the abbess expressed her defiance of papal discipline.

Craig, Moore, and Stein Give Third Christmas Lecture Series

The Rockefeller Institute's Christmas Lectures for High School Students were given this year for the third successive season to an audience of selected young people from the public, private, and parochial schools in the New York metropolitan area. Three lecturers from the Institute, Professors Lyman Craig, Stanford Moore, and William Stein, collaborated to present a series of five lectures on the topic "Separating Things." They showed how the evolution of more and more discriminating means for physical and chemical separation of materials has been of vital importance to the growth of science and industry. In particular, the role of refined techniques for separating biological substances was emphasized, and the students were given numerous examples and demonstrations of processes that are now widely used in research. The lectures were illustrated with several color motion pictures produced at the Institute, and through the kindness of the Merck Sharp and Dohme Company a collection of beautiful color micrographs of numerous crystalline biological materials was exhibited.

The response of the students to the lectures was enthusiastic, and from a subsequent survey many specific and illuminating comments were obtained. Nearly 60% of the students invited to the lectures responded to the questionnaire sent to them afterward. Almost without exception they

found the lectures to be inspiring and satisfying. Several wrote that their decision to enter science had been precipitated or confirmed by the lectures, and many said that they had been shown science in a new perspective. "I used to feel that each subject was an entity unto itself, but after attending these lectures I realize that all the sciences are greatly related," wrote one student, and another added: "The lectures have made me more aware of the complexities of science; therefore my faith in science has been reaffirmed by the lectures and I am more determined than ever before to have a career in science." Yet another wrote: "I used to think of science as a systematic and more or less static body of knowledge. Now I recognize it as a continuous and very personal attempt at understanding what exists."

This year the Christmas Lectures, inaugurated at The Rockefeller Institute in 1959 by Professor René Dubos, are becoming national in scope through a grant from the National Science Foundation to the American Association for the Advancement of Science. Professor Paul Weiss, last year's lecturer at the Institute, repeated his lectures on "Living Form" before a student audience in San Francisco at Christmas time. Professor Dubos has been asked by the AAAS to present his lectures during the Easter vacation in Cincinnati this spring.

Hartline Resigns from Space Science Board

During the months preceding the creation of the National Aeronautics and Space Administration, the National Academy of Sciences organized a Space Science Board in order to foster and guide research in outer space. This Board, comprising more than a dozen of the leading scientists of the country, gave invaluable advice to the Government during the early days of NASA. Among the initial members of this Board, two represented the life sciences: Professor H. Keffer Hartline of the Institute and Professor S.S. Stevens of Harvard. During the succeeding years in which the Space Science Board has played an increasingly important role in defining the scientific objectives of NASA, Professor Hartline, with Professor Lederberg of Stanford, Professor Pittendrigh of Princeton, and Professor Lambertson of the University of Pennsylvania, have had an outstanding influence in the formulation of this major national undertaking.

Now that the initial phases of the Space Science Board program have been realized and plans for the future formulated, the Academy has announced a reorganization of the Board, including resignation of Professor Hartline so that he may devote full time to teaching and research.

New Lecture Hall Available in South Laboratory

With the increased scope in graduate education at the Institute, there has been a growing need for conference rooms and lecture halls. During December, the newest and second largest of the lecture halls has been completed at the west end of the second floor of the new laboratory. This hall, which seats approximately one hundred, is notable for its lecture and demonstration facilities.

Institute Scientists in Tokyo

During the third week in December, President Bronk was made an honorary citizen of Tokyo and presented with The Key to the City by the Governor of the Metropolis of Tokyo. An interesting feature of the event was the fact that Governor Azuma and Dr. Bronk were colleagues at one time when both were carrying on research in muscle physiology in the laboratories of Professor A.V. Hill at University College, London.

The occasion for President Bronk's being in Tokyo was the initial meeting of the joint United States – Japan Science Committee inaugurated last year by President Kennedy and Prime Minister Ikeda in order to develop cooperative research undertakings between the two countries. Trustee Robert F. Loeb was also a member of the six-man American delegation.

Shope Appointed Member of Academy Committee on Government Relations

Dr. Richard E. Shope has been appointed a member of the Committee on Government Relations of the National Academy of Sciences. This Committee, which has been created by President Bronk to provide scientific advice on the request of the President of the United States and the Congress, is a response by the Academy to the growing need for scientific guidance at the highest levels of Government.

du Noüy Award Presented at The Rockefeller Institute

The Pierre Lecomte du Noüy American Foundation, established in 1954 in honor of the French scientist, philosopher, and author, presented its 1961 award to Dr. Loren C. Eiseley at ceremonies in Welch Hall of The Rockefeller Institute on December 13th. The late Lecomte du Noüy was a member of the scientific staff of the Institute with Alexis Carrel from 1920 to 1928. Dr. Eiseley, University Professor of Anthropology and the History of Science in the University of Pennsylvania, was Sigma Xi lecturer at the Institute last year.

Resident Architect Appointed

John P. Turner, from the staff of Harrison and Abramovitz, has been appointed Resident Architect at the Institute in order to facilitate the rapid preparation of preliminary plans for new construction. Among the initial undertakings in which Mr. Turner is engaged are plans for the Avery Memorial Gateway, a residential building for the faculty, and a new unit of the graduate students' dormitory. Mr. Turner is working closely with the Institute's architect, Wallace K. Harrison, and landscape architect, Dan Kiley, who are evolving plans for the future development of the south half of the Institute campus.

Quotation

WILLIAM JAMES ON
"PHILOSOPHY AND ITS CRITICS"

"To know the chief rival attitudes towards life, as the history of human thinking has developed them, and to have heard some of the reasons they can give for themselves, ought to be considered an essential part of liberal education. Philosophy, indeed, in one sense of the term is only a compendious name for the spirit in education which the word 'college' stands for in America."

From *Some Problems of Philosophy*, 1911

FACULTY ACTIVITIES

Academic Honors

RENÉ DUBOS
Doctor of Humane Letters, Yeshiva University.

Awards

DETLEV W. BRONK
The Franklin Medal of the Franklin Institute.
The Holland Society of New York Gold Medal.

Academic Appointments

RENÉ DUBOS
Visiting Professor, University of Florida.

Addresses and Lectures

ARMIN C. BRAUN
University of Connecticut Evening Biology Lecture Series.
University of Pittsburgh.

DETLEV W. BRONK
50th Anniversary, the Ohio State University Graduate School.
Dedication Address, Monsanto Chemical Company Research Center.
ENIAC Celebration Dinner, University of Pennsylvania.
Centennial Convocation of Land-Grant Colleges and State Universities.

VERNON B. BROOKS
Tulane University Medical School.
Geigy Research Institute.

RENÉ DUBOS
Baker Lecture, National Association for Mental Health Annual Meeting, Miami.
University of Maryland International Health Lecture Series.

SAM GRANICK
Brandeis University.
Dartmouth College.

JULES HIRSCH
Brooklyn Society of Internal Medicine.

DANIEL E. KOSHLAND, JR.
University of California Medical School, San Francisco.

FRITZ LIPMANN
Vatican Academy of Sciences, Rome.

DAVID C. MAUZERALL
Dartmouth College.

MACLYN MCCARTY
J. Howard Mueller Memorial Lecture, Harvard University Medical School.

GEORGE E. PALADE
Saturday Scientific Program, Columbia University, Institute of Cancer Research, Delafield Hospital.

FLOYD RATLIFF
Zoological Journal Club, Yale University.

HOWARD A. SCHNEIDER
Enzyme Clubs of the University of North Carolina, North Carolina State College and Duke University at Raleigh.

ROBERT L. SCHOENFELD
IRE-AIEE Lecture Series, New York.

PHILIP SIEKEVITZ
Institute of Cell Biology, University of Connecticut.

LOUIS E. SILTZBACH
House Officers Association, Boston City Hospital.
Attending and House Staff, St. Luke's Hospital, New York.

EDWARD L. TATUM
Research and Development Section, Pharmaceutical Manufacturers Association, Colorado Springs.
Research Society, Downstate Medical Center, Brooklyn.

DONALD D. VAN SLYKE
Dedication Address, Dedication of Nuclear Reactor of the Republic of China at Taipeh, Taiwan.
International Medical Society, Taipeh, Taiwan.

PAUL WEISS
Graduate Convocation Address, the University of Texas, Austin.
AAAS 1961 Holiday Science Lectures, California Academy of Sciences.

MAX WOODBURY
Brown University Computer Laboratories, Providence.

VLADIMIR K. ZWORYKIN
University of Bologna, Italy.
Northeast Electronic Research and Engineering Meeting, Boston.

Participation in Conferences and Symposia

EDWARD H. AHRENS, JR.
Symposium on Lipid Metabolism and Diabetes, Brook Lodge, Michigan.
International Conference on Diet, Serum Lipids and Atherosclerosis, Nutrition Foundation, Rye, New York.
Washington State Heart Association, 13th Annual Symposium on Heart Disease, Seattle.

EDWIN L. BIERMAN
Symposium on Lipid Metabolism and Diabetes, Brook Lodge, Michigan.

VERNON B. BROOKS
International Neurophysiological Symposium on the Physiological Basis of Mental Activity, Mexico City.

ARPAD I. CSAPO
Symposium on Vascular Smooth Muscle, National Academy of Sciences-National Research Council.

RENÉ DUBOS
National Association for Mental Health Annual Meeting, Miami.
Conference on Medicine and Anthropology, Arden House, Harriman, New York.

HANS J. EGGERS
Symposium on Chemical Control, 53rd Annual Meeting, American Phytopathological Society, Biloxi, Mississippi.

RICHARD M. FRANKLIN
Meeting on Tissue Culture and Cell Biology Training Problems, National Institutes of Health, Bethesda.

JULES HIRSCH
Delegate, Council on Arteriosclerosis, 15th Annual Meeting, American Heart Association, Miami.
Food Forum, Grocery Manufacturers of America.

ROLLIN D. HOTCHKISS
Josiah Macy Foundation Conference on Genetics, Princeton.
Symposium, American Society for Cell Biology, Chicago.

DANIEL E. KOSHLAND, JR.
Symposium on Enzymes, Annual Meeting of British Biophysical Society, Royal Institution, London.

FRITZ LIPMANN
Chairman, Symposium on Biochemical Mechanisms in Lipid Synthesis, Robert A. Welch Foundation Conference, Houston.

HANS J. MÜLLER-EBERHARD
Second International Symposium on Immunopathology, Brook Lodge, Michigan.

GEORGE E. PALADE
Symposium of the American Society for Cell Biology, Chicago.

HOWARD A. SCHNEIDER
1961 Cornell Nutrition Conference, Buffalo.
Discussion Leader, Biomedical Engineering Conference, University of Nebraska.

NORMAN R. STOLL
Symposium on Intestinal Parasitism, Congreso Latinoamericano de Microbiología, San José, Costa Rica.

DONALD D. VAN SLYKE
International Congress of Microchemistry, Pennsylvania State University.
National Science Week, Manila, Republic of the Philippines.

PAUL WEISS
Introductory Lecture, Welch Foundation Conference, Houston.
Conference on Development, Harvard Medical School, Endicott House, Ipswich, Massachusetts.

MAX WOODBURY
89th Annual Meeting of the American Public Health Association, Detroit.

Society Elections

M. A. ATAMER
Member, American Society of Hematology.

ROLLIN D. HOTCHKISS
Member of Council, American Society for Cell Biology.

ALEXANDER G. BEARN
Fellow, American Association for the Advancement of Science.

DANIEL E. KOSHLAND, JR.
Member, Executive Committee, Biological Chemistry Division, American Chemical Society.

GEORGE E. PALADE
Member of Council, Electron Microscope Society of America.
Member of Council, American Society for Cell Biology.

PHILIP SIEKEVITZ
Member of Council, American Society for Cell Biology.

NORMAN R. STOLL
Fellow, The New York Academy of Sciences.

DONALD D. VAN SLYKE
Honorary Member, Accademia Nazionale dei Lincei, Italy.
Honorary Member, Österreichische Gesellschaft für Mikrochemie.

PAUL WEISS
Member of Council, American Society for Cell Biology.

Other Elections and Appointments

ALEXANDER G. BEARN
Co-editor, *Progress in Medical Genetics.*
Consultant, Genetics Training Committee, Division of General Medical Sciences, U.S. Public Health Service.

DETLEV W. BRONK
Honorary Vice President, the International Benjamin Franklin Society.
Member, Operations Research Society of America.
Member, Joint U.S.-Japan Committee on Scientific Cooperation.
Member, U.S. Public Advisory Panel to the United Nations Conference on the Application of Science and Technology to the Less Developed Countries.
Member, Advisory Committee of the International Section of the Program of Continuation Education, Columbia University.
Member, Honorary Degree Committee of the University of Pennsylvania.

FRITZ LIPMANN
Member, Scientific Advisory Council, Massachusetts General Hospital.

MARIA A. RUDZINSKA
Member, Advisory Board, Biological Research Committee, Gerontological Society.

PAUL WEISS
Member, International Advisory Board, *L'Année Biologique.*

New Appointments to the Faculty

ALLEN T. ANSEVIN, Research Associate with Professor Craig. Formerly Research Assistant in the University of Pittsburgh.

HIROSHI ASANUMA, Guest Investigator with Associate Professor Brooks. Rockefeller Foundation Fellow on leave from Osaka City University Medical School in Japan, where he is a Lecturer.

LARS INGEMAR BERGGARD, Guest Investigator and Assistant Physician with Associate Professor Bearn. Formerly Research Associate at the Institute of Medical Chemistry, University of Uppsala, Sweden.

ULRICH GERLACH, Guest Investigator with Professor Lipmann. On leave from the University of Münster, Germany.

FACULTY ACTIVITIES *continued from page eleven*

WILLIAM T. HALL, Guest Investigator with Associate Professor Moore. United States Public Health Service Fellow; from Fordham University.

FRANZ JAISLE, Research Associate with Associate Professor Csapo. On leave from the University of Würzburg, Germany, where he is a Research Associate.

ZELJKO KUCAN, Guest Investigator with Professor Lipmann. International Atomic Energy Agency Fellow; Assistant, Department of Radiobiology, Rudjer Bošković Institute, Zagreb, Yugoslavia.

VIRGINIA LITTAU, Research Associate with Professor Mirsky. Formerly Guest Investigator.

JAMES OFENGAND, Research Associate with Professor Lipmann. Formerly Visiting Research Fellow of the National Science Foundation in the Medical Research Council Unit of Molecular Biology at Cavendish Laboratory, Cambridge.

HENRYK PANUSZ, Guest Investigator with Professor Mirsky. Rockefeller Foundation Fellow; on leave from the Academy of Medicine, Lodz, Poland, where he is Senior Assistant in the Department of Physiological Chemistry.

JOSEPH V. PRIMOSIGH, Research Associate with Professor McMaster. Formerly Research Associate, Max-Planck-Institut für Biologie, Tübingen, Germany.

MORRIS SCHREIBER, Lecturer. Assistant Professor of Mathematics on leave from Cornell University as Research Associate in the Institute of Mathematical Sciences, New York University.

HOWARD RASMUSSEN, Affiliate. Formerly Assistant Professor in Endocrine Physiology. He is Associate Professor in the University of Wisconsin.

MARIA TOMASZ, Research Associate with Associate Professor Pelletier. From Columbia University.

TSUNEO TOMITA, Visiting Professor. Professor of Physiology, Keio University School of Medicine, Tokyo.

Departures from the Faculty

MURIEL M. ANDREWS, Research Associate, left in October to return to her position with the Medical Research Council Chemotherapy Department at Western Infirmary, Glasgow.

ROBERT M. FAUVE, Research Associate, resigned in October to return to the Pasteur Institute in France.

J. ALLEN HOLT, Research Associate, left at the end of December to accept a position in the Chemistry Department of Oklahoma Baptist University, Shawnee.

BYRON LANE, Research Associate, resigned in November to accept a position as Assistant Professor of Biochemistry in the University of Alberta, Canada.

THOMAS A. LANGAN, Guest Investigator, left at the end of October to go to the Wenner-Gren Institute at the University of Stockholm.

TAPANI LUUKKAINEN, Research Associate and formerly Guest Investigator, left early in October to return to Finland where he is associated with the University of Helsinki.

ROBIN E. MONRO, Research Associate, left at the end of November to return to England where he will be at the Laboratory for Molecular Biology at the Post-Graduate Medical School in Cambridge.

ROSS B. PRINGLE, Assistant Professor, resigned at the end of November to accept a position as Head of the Chemistry Department at the National Plant Research Institute in Ottawa.

BRUCE I. H. SCOTT, Guest Investigator, left at the end of December to return to the University of Tasmania where he is Senior Lecturer.

GUMPEI URATA, Research Associate, left in December to return to the Institute of Public Health in Tokyo.

BEVERLY WOLF, Research Associate, resigned at the beginning of December to go to the Biological Laboratories at Harvard University.

E. CARLYLE WOOD, Research Associate, left in October to return to the Queen Charlotte Maternity Hospital in London.

Guest Speakers

MARCEL A. BALUDA, City of Hope Medical Center, Duarte, California.

MARCEL BESSIS, National Blood Transfusion Center, Paris.

CHRISTIAN DE DUVE, Catholic University of Louvain.

S. R. DE GROOT, University of Leiden.

A. DICKINSON, Animal Breeding Research Organization, Edinburgh, Scotland.

TH. DOBZHANSKY, Columbia University.

ANDREW M. GLEASON, Harvard University.

STERLING B. HENDRICKS, U. S. Department of Agriculture.

MOLLIE HOLMAN, Melbourne University, Australia.

WILLIAM P. JENCKS, Brandeis University.

AHARON KATCHALSKY-KATZIR, The Weizmann Institute of Science.

MARIAN KOSHLAND, Brookhaven National Laboratory.

GUIDO MAJNO, Harvard Medical School.

JERROLD MEINWALD, Cornell University.

HAROLD MOROWITZ, Yale University.

LEONARD ORNSTEIN, Mount Sinai Hospital , New York.

ERWIN PANOFSKY, Institute for Advanced Study, Princeton.

HERMAN PASSOW, Hamburg University Institute of Physiology.

PETER PERLMANN, the Wenner-Gren Institute for Experimental Biology, Stockholm.

COLIN S. PITTENDRIGH, Princeton University.

PAUL VON R. SCHLEYER, Princeton University.

GUNTHER SIEBERT, Johannes Gutenberg University, Mainz.

JOHN E. SMITH, Yale University.

E. J. WATSON-WILLIAMS, University College, Ibadan, Nigeria.

R. K. ZAHN, University of Frankfurt.

CHRISTOPHER ZEEMAN, University of Cambridge and The Institute for Advanced Study, Princeton.