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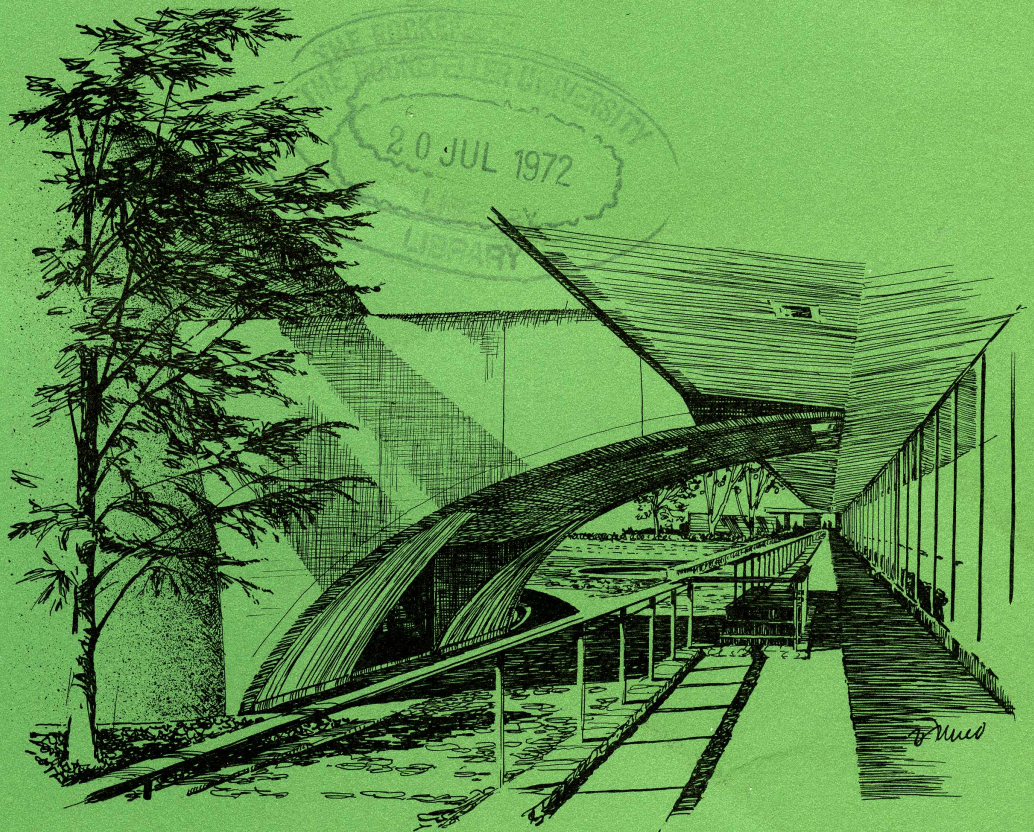
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THE ROCKEFELLER INSTITUTE

Quarterly

SPRING • 1960



THE ROCKEFELLER INSTITUTE • A GRADUATE UNIVERSITY AND RESEARCH CENTER

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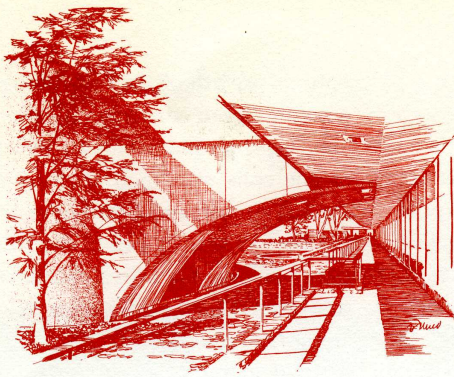
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The limousine entrance to Caspary Auditorium is shown in unusual perspective in the sketch by Vincent Furno on the cover. The half-arch spans a stone-paved driveway, extending from the parking pavilion, seen in the distance, to the Sixty-sixth Street drive. The auditorium is on the left. On the right are the windows of the music room, seminar room, and recreation room of Alfred H. Caspary and Abby Aldrich Rockefeller Halls. In the distance on the left are shaded gardens ornamented with fountain pools, one of the most lovely areas of natural beauty in Manhattan.

CROWN GALL AND THE WIDER SIGNIFICANCE OF PLANT PATHOLOGY

TWIN QUESTIONS of utmost fundamental as well as practical importance are: how are the processes of growth and cellular differentiation in higher organisms regulated to produce coherent living structures, and why does a relaxation of this orderly control sometimes occur, leading to the formation of various types of tumors and cancers? Dr. Armin C. Braun and his co-workers at the Rockefeller Institute, through their studies on normal and abnormal growth in plants, are shedding light on many aspects of these questions as they relate not only to plant growth but to man and animals as well.

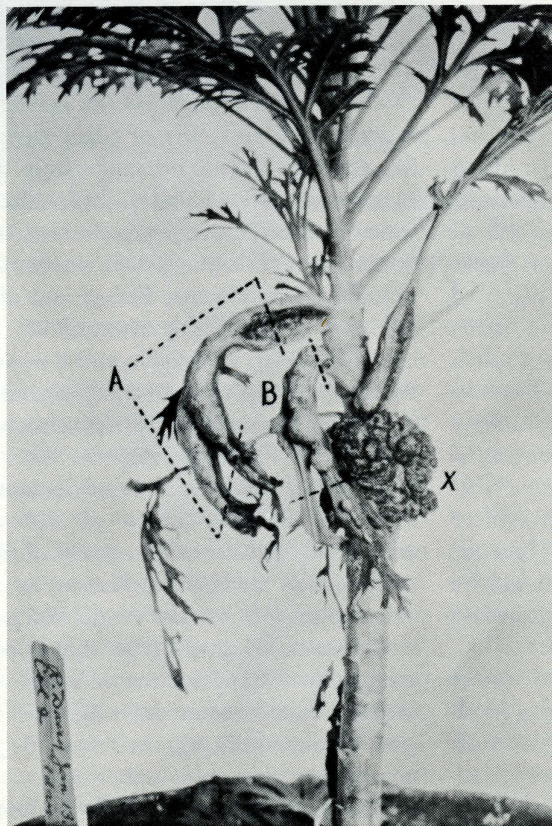
Dr. Braun's work is one of the more recent fruits of the wise decision taken by the Institute's Board of Scientific Directors in 1926 to establish a department of plant pathology. It was their conviction then that study of plant diseases would illuminate our understanding of the physiology and pathology of man and animals. One of the first brilliant achievements of the Division of Plant Pathology, established at Princeton, New Jersey, in 1931, was the purification and crystallization of the tobacco mosaic virus. This work, carried on by Dr. Wendell M. Stanley (for which he shared the Nobel Prize with Dr. John Northrop, also at Princeton), suddenly placed the question "what is life?" in a new and strange perspective. But the long history of the Institute's work with plant viruses, begun under Dr. L. O. Kunkel at Princeton and actively pursued at the Institute today, will be reserved for later telling.

Armin Braun joined the Institute's

Princeton Laboratory in 1938, having studied bacteriology and plant pathology at the University of Wisconsin as well as in several European laboratories. Following his appointment at the Institute, Dr. Braun began a study of a tumorous disease of plants known as crown gall. The crown gall disease had been found by Smith and Townsend in 1907 to be the result of a bacterial infection. This finding attracted considerable interest among pathologists generally because at the time of that dis-

covery no animal tumor had yet been produced experimentally. It was not until several years later that Dr. Peyton Rous demonstrated the viral cause of the chicken sarcoma. Comparative studies of crown gall and malignant animal tumors carried out over a period of twenty years showed that these two types of growth had much in common. There appeared, however, to be one fundamental difference. It was believed that the crown gall tumors, unlike animal cancers, required continuing stimulus of the causative bacteria for their continued growth. Braun showed in 1941 that this was not true, for he found that many secondary tumors that arise at points

(continued on page two)



Crown gall tumors produced in the daisy by inoculation with the tumor-inducing bacteria. Tumor marked X is at site of inoculation. Secondary tumors, A and B, may be bacteria-free. Erwin F. Smith and C. O. Townsend of the U.S. Department of Agriculture first isolated the causative bacterium, now called *Agrobacterium tumefaciens*, from crown gall tumors in 1907. This photograph was taken by Erwin Smith about five years later.

distant from the primary growth were sterile—that is, they were completely free of bacteria.

With this observation, Braun launched on a study that has led him ever deeper into the phenomena of growth, development, and tumor formation. Dr. Braun and a colleague at Princeton, Dr. Philip R. White, engaged in a joint attack on the crown gall problem, using White's great skill and experience in plant tissue culture. White, who is now at the Roscoe B. Jackson Memorial Laboratory, Bar Harbor, Maine, had become interested in plant tissue culture several years before. Since coming to the Princeton Laboratory in 1932, he had concentrated on the problem of developing wholly defined nutritional media for growth of certain plant organs. Such a medium could be of great importance, not only for studying plant metabolism, but for understanding how growth and differentiation are regulated biochemically. By 1939 White had developed a completely known nutrient fluid, sufficient for unlimited growth of tomato root tips, containing water, sugar, ten inorganic compounds supplying minerals, as well as three vitamins, thiamine, pyridoxine, niacin, and the amino acid glycine.

BACTERIA-FREE TUMORS

Braun and White began their joint effort by growing bacteria-free tumor tissue in cultures. It was found that the bacteria-free secondary tumors occurring on plants continued to grow in a tissue culture medium that would not support growth of normal cells. This indicated that a profound and heritable change had occurred in those tumor cells. By grafting sterile fragments of the tumor tissues back into a healthy host and obtaining massive tumorous growths from the implants, Braun and White demonstrated the true autonomy of the crown gall tumor cell and, hence, its similarity to the independent growth of animal cancer cells. In several other experiments Braun and White were able to demonstrate similar autonomous growth in other plant tumor tissues.

Having shown that crown gall tumor cells were permanently altered as a result of the bacterial infection, after which such cells continued their abnormal growth indefinitely, Braun undertook to define the

conditions under which cellular change was accomplished. Using a heat-treatment technique developed by Dr. L. O. Kunkel for destroying certain viruses in plants, Braun selectively killed the bacteria in the plants at various times after inoculating them with the inciting organisms. He found that the bacteria require about 4 days to induce rapidly growing fully autonomous tumors. When the bacteria were destroyed 50 hours after they were inoculated into plants, moderately fast-growing tumors resulted, while very slow-growing benign growths were initiated in a 34-hour period. Whether fast-growing or slow, the rate of tumor growth was fixed at the time that the bacteria were killed and thereafter that rate persisted indefinitely. It was thus possible to obtain at will different degrees of cellular change ranging from slowly growing benign to very rapidly growing potentially malignant tumor cell types.

TUMOR INDUCTION

Tumor induction depends not only upon presence of the tumor-inducing bacteria, but upon other conditions as well. In particular, irritation accompanying a wound or bruise is essential if normal cells are to be transformed to tumor cells in the crown gall disease. This had been known for some time, but the reason had remained obscure. Braun found that the period of maximum vulnerability of plant cells to the tumor-inducing principle from the bacteria, occurring about 60 hours after a wound is made, corresponds closely to the beginning of cell division in the normal wound-healing process. Before and after this time of maximum susceptibility the host cells are less vulnerable, and as wound-healing progresses toward completion they become once more completely insensitive to the tumor-inducing principle.

With this understanding of the conditions for inducing tumors of different degrees of cellular change, Dr. Braun undertook to study the difference in the metabolism of tumors with different growth-rates. By growing the tumors on a completely defined culture medium, the nutrient factors required for different degrees of autonomous growth could be determined.

The basic culture medium supported

optimal growth of the fully altered rapidly growing tumor cell with no dietary supplements added. The moderately fast-growing tumor cells sustained their growth adequately on this medium but to make their growth rate match that of the fully altered tumor cell they required certain additional substances that their faster-growing fellows are able to manufacture for themselves in optimal amounts from the mineral salts and sugar in the basic medium.

Specifically, when glutamine, inositol and the plant growth hormone auxin, which is concerned with cell enlargement, are added to the medium, the moderately fast-growing cells can grow and multiply like the fully altered crown gall tumor cells.

He also found that the third or slowest-growing benign tumor cells that were altered by the bacteria in a 34-hour period require still more dietary supplements. In addition to the three compounds listed above, cytidylic and guanylic acids as well as aspartic acid or asparagine are required as supplements for such cells to achieve a growth rate comparable to that of the fully altered tumor cells.

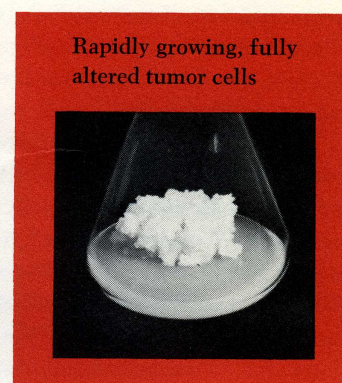
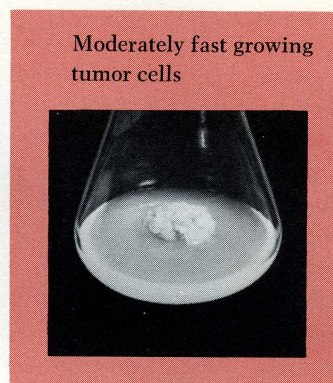
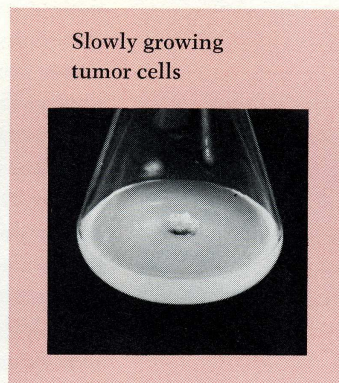
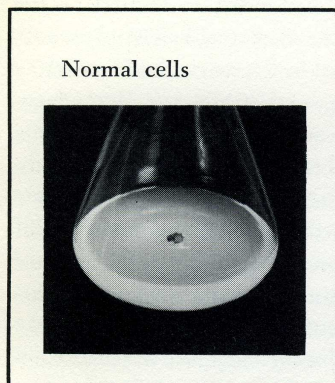
Yet even these supplements were not enough to enable normal cells to grow on the culture medium. One more plant hormone, 6-furfurylaminopurine, which acts synergistically with the auxin to promote growth accompanied by cell division, is required in addition to the compounds listed above for growth of normal cells. Thus we see that the fully altered tumor cell can manufacture for itself several growth-promoting substances that its normal counterparts require for growth but cannot make; the slower-growing tumor cells are able to produce these substances but not in adequate amounts for optimal growth. The results of this series of tissue culture experiments are summarized in the illustration on the opposite page.

UNFASTIDIOUS TUMOR CELLS

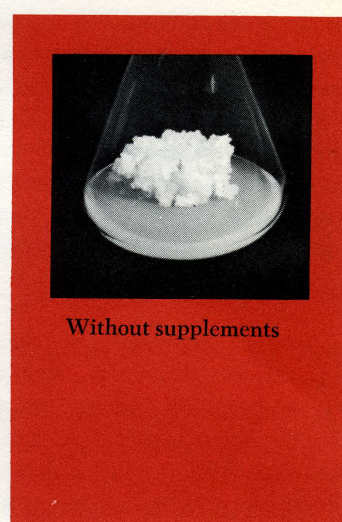
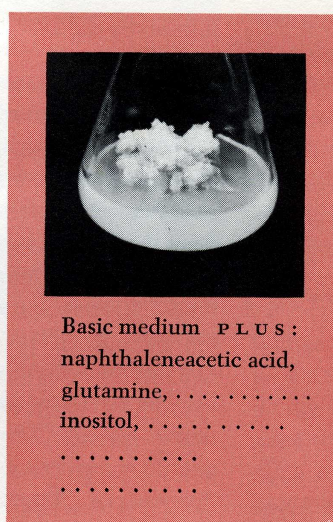
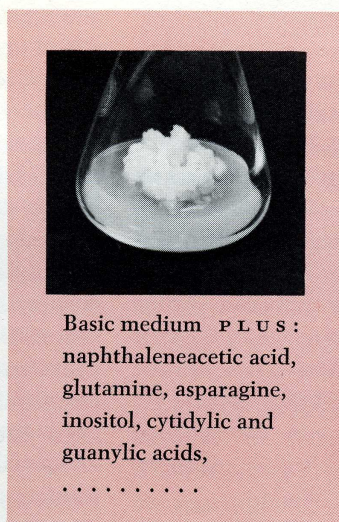
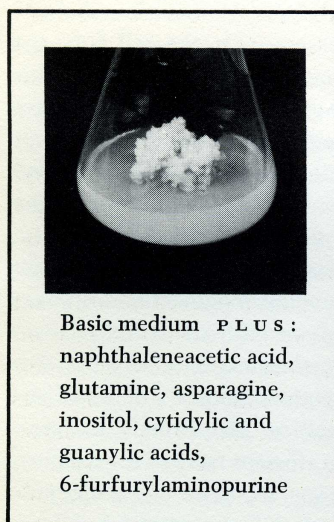
From these studies Braun concludes that as the crown gall tumor cell becomes more autonomous, its requirements in terms of externally supplied growth factors become less exacting. Evidently as a result of the transition from the normal cell to the fully altered potentially malignant tumor cell, a series of quite distinct but well defined growth-substance-synthesizing systems becomes progressively and per-

Growth of Normal Cells and Tumor Cells on Basic and Supplemented Media

CELLS GROWING ON BASIC MEDIUM ONLY



SAME CELLS ON SUPPLEMENTED MEDIA



Normal cells can be converted in the crown gall disease into tumor cells having three definite growth-rates as shown in the upper photographs. These three growth-rates result from the progressive release of systems that enable the altered cells to synthesize from a basic nutrient medium substances supporting growth. Normal cells cannot synthesize these substances, but when the missing substances are provided, the normal or partially altered cells grow at the same rate as the fully altered tumor cells (lower photographs). Based on Proc. Nat. Acad. Sci. 44, 4, p. 347, 1958.

manently activated. The extent to which this series of growth-substance-synthesizing systems is activated within a tumor cell determines the rate at which the cell type will grow. In considering the significance of these facts, Dr. Braun has indicated that it is likely that the entire area of metabolism concerned with growth and cell division becomes progressively activated as a result of the transformation of a normal plant cell to a tumor cell.

In the course of evolution, primitive relatively undifferentiated cells, which were capable of providing all of their needs

from simple substrates, began to organize into colonies and become specialized. As a result of this process they lost their capacity to grow except under the most precisely regulated conditions. The tumor cell, however, appears to have reverted to the primitive, more or less self-sufficient state. As Dr. Braun put it in a recent report, "A primitive area of metabolism, which is characteristic of free-living unicellular organisms and on which has been superimposed, during the course of evolution, the conservative and precisely regulated metabolism characteristic of differ-

entiated cells of higher organisms, appears again to predominate as a result of the alteration of a normal plant cell to a tumor cell."

It is a commonly accepted belief that the malignant animal cell is an irreversibly altered cell type. The typical crown gall tumor cell of plants, like malignant animal cells, also appears to be a permanently altered cell that reproduces true to type and against the growth of which there is no control mechanism in the host. The question as to whether this new pattern

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of synthesis found in the tumor cell results in an irreversible loss of the normal pattern concerned with differentiated function or whether it simply suppresses or overwhelms the normal pattern has recently been investigated by Braun.

In studying this question he considered the two most likely possibilities: (1) a genetic change involving somatic mutation at the nuclear gene level which was accomplished by the bacteria in some reproducible way, and (2) some self-replicating change in the cytoplasm of the cell. Recently Dr. Braun devised an ingenious experiment that enabled him to decide between the two possibilities. He reasoned that if the change were the result of a gene mutation, it would persist no matter how fast the affected cells divide; if it involved some separate self-replicating cytoplasmic system, it was possible that very rapid cell division could outstrip the growth-stimulating mechanism, diluting it among so many cells that it would gradually cease to affect any of them.

RETURN TO NORMALITY

In this investigation Dr. Braun used a type of tumor known as a teratoma which occurs in certain plant species when cells which possess highly developed regenerative capacities are altered to tumor cells. Tumors of this type possess a pronounced capacity to organize highly abnormal leaves and buds, and they have their counterparts in animal pathology. Normal cells at the apex of a rapidly growing plant shoot divide very rapidly, far faster than do most tumor cells. Since abnormal tumor shoots developed from teratoma induced by crown gall bacteria, Braun forced the cells at the apex of such shoots into very rapid division by a series of graftings to healthy plants. As a result the tumor cells gradually recovered and ultimately became normal in every respect. Thus it appears that the nuclear gene mutation hypothesis can be ruled out. Instead the results suggest that cytoplasmic changes (which may, however, be more or less under the control of the nuclear genes) are responsible for the continuity of the tumorous properties from one cell generation to the next.

In interpreting these results Dr. Braun has suggested that even in the tumor cell the normal, highly evolved systems of

nutrition and synthesis exist but are overwhelmed by more primitive and less fastidious systems. This situation commonly shows high degrees of stability in the tumor cells, but it may be reversible under certain special conditions. If this were found to be true of tumors in general, it would have the most far-reaching implications for it would mean that the malignant cell is not, as is commonly believed, hopelessly and irreversibly altered. A return to normality of such cells could be achieved if conditions could be defined that would permit the controlled manipulation of these alternative areas of cellular metabolism.

CURRENT INVESTIGATIONS

With this we bring our account of Dr. Braun's work almost to the present. It remains to suggest the lines of current work in his laboratory and to indicate some of the investigations of growth phenomena in general that are in progress there. Perhaps Dr. Braun's most urgent question now is to discover precisely how the biosynthetic systems become activated during the transition from a normal to a tumor cell and how those systems again become blocked as the tumor cell recovers and becomes normal. These very fundamental questions are being studied in collaboration with Dr. Henry N. Wood.

For several years one of Dr. Braun's colleagues at the Institute, Dr. Tom Stonier, has been attempting to discover the nature of the tumor-inducing principle elaborated by the crown gall bacterium *Agrobacterium tumefaciens*. Evidence has been obtained which indicated that the bacteria release bacteriophages, and some strains were found to produce an antibiotic substance. Among either of these classes of agents, that is, viruses or antibiotics, it has not yet been possible to find the tumor-inducing principle. Other bacterial products and extracts are also being tested.

Dr. Ulrich Näf and Dr. Ross Pringle have been engaged for the past several years in studying another aspect of the way in which naturally occurring chemical substances influence cell differentiation and organ formation in plants. A decade ago it was reported in Germany that extracts of certain tissues of ferns stimulated the formation of the male sex organ.

It was believed that those extracts exerted their effects through nonspecific growth inhibition. Näf investigated this phenomenon in detail and found that the promotion of male sex organ formation by the extract was due to a specific chemical substance present in the extract rather than to nonspecific growth inhibition. Here, then, is a unique example of a relatively simple chemical substance that is capable of directing in a highly specific way an orderly process of growth and development. Näf has studied various physiological aspects of the induction process with significant results. For example, he has found that the inducing substance appears to exert its effects by unblocking a metabolic chain in the cell with the resultant development of the male sex organ. The block itself appears to result from the diffusion of a substance or substances to the cell from the growing region of the plant. Dr. Näf has also found that different biologically active substances are effective in different groups of ferns. This and other evidence has led him to consider the possibility that the molecule of the inducing substance may, during the course of evolution, have undergone a gradual modification in structure concomitant with structural changes in receptor molecules. It is here that Dr. Pringle's chemical studies will be of decisive importance. Dr. Pringle has now developed an efficient method for the purification of one of these inducing substances. The purified material has been found to be one of the most potent naturally occurring biologically active materials yet described. Less than one part of the inducer in 10 billion parts of water is required to cause a competent vegetative cell to differentiate into the male sex organ. Even this biological activity can be enhanced by adding very small quantities of salts of certain higher fatty acids to a solution containing the inducing substance.

STRUCTURE AND ACTIVITY

Although not enough of the biologically active substance has as yet been obtained to make possible determination of its chemical structure, a number of its important properties have been defined, and the structure of that part of the substance essential to its activity is now known.

Because of its relative simplicity this experimental system represents a beautiful model for studies on growth and develop-

ment. Attempts are being made to learn how a relatively simple chemical substance can cause a vegetative cell to so alter its metabolic pattern as to develop into an organ, one of the cells of which gives rise to many motile sperm cells.

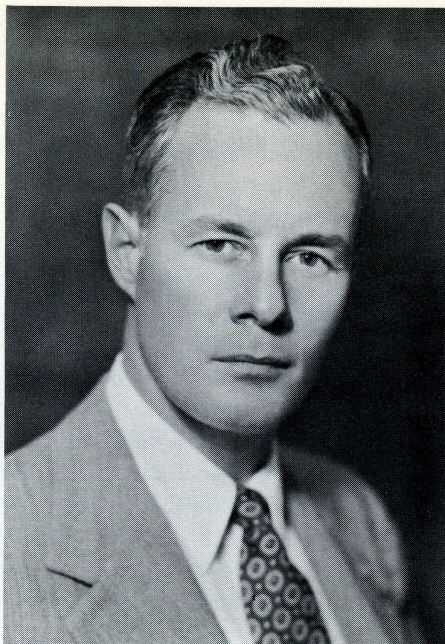
Bruce Voeller, a graduate fellow working in Dr. Braun's laboratory, has been pursuing his own investigations of growth and development in ferns. What occurs at the apex of a budding shoot is of great interest because at that embryonic region most of the appendages found in the mature plant, such as leaves, buds, and scales, are initiated. Voeller has chosen ferns for his studies because in them the apex is unusually large. Thus surgical removal of cells and certain physiological studies are easier than with other plants. Mr. Voeller has learned something about the mechanism that controls the unrolling of the tightly coiled fronds of fern leaves. Growth hormones produced by the young leaflets in a frond regulate its unrolling, and these same substances control the growth and expansion of the frond.

We have shown the far-reaching significance of what would at first sight seem esoteric and obscure preoccupations with the ways of certain plants and their diseases. It is evident that scientific investigation has gone far in at least one dimension toward the realization of Tennyson's poetic fancy when he wrote:

"Little flower—but if I could understand
What you are, root and all, and all in all,
I should know what God and man is."

FIFTY YEARS AGO AT THE ROCKEFELLER INSTITUTE

IN THE SPRING of 1910 Institute workers began tissue culture research. In 1908, Ross G. Harrison at Yale had announced cultivation of tadpoles' nerve cells outside the body. Alexis Carrel sent an assistant, Montrose T. Burrows, to work on warm-blooded animals under Harrison's supervision. Burrows began with chick embryo tissues, some of which contained heart muscle. To his surprise these cells began to contract rhythmically, thus yielding the first discovery of Carrel's tissue culture program, that is to say proof that the heart beat results from intrinsic conditions in the muscle cells.



J. RICHARDSON DILWORTH, newly elected Trustee, is President and Director of Rockefeller Brothers, Incorporated. Before he joined them in 1958 Mr. Dilworth was a partner in the investment firm of Kuhn, Loeb & Company.

Mr. Dilworth, who is 43 years old, is senior financial adviser to the Rockefeller family. Graduated from Yale University in 1938 and from Yale Law School in 1942, he is now a Fellow of the Yale Corporation. Upon completion of Law School, Mr. Dilworth entered the United States Navy as an Ensign. He is now Lt. Commander, U.S.N.R. (Ret.).

His numerous board memberships include the Chase Manhattan Bank, the International Basic Economy Corporation, Transoceanic-AOFC Ltd., of Toronto, The Carbon Limestone Company, The Rockwell Manufacturing Company, and Youngstown Sheet and Tube Company. Among Mr. Dilworth's other affiliations are the Community Service Society, of which he is President and Trustee, the Provident Loan Society, of which he is Trustee, the Association for the Aid of Crippled Children, the Council on Foreign Relations, the Newcomen Society, Phi Beta Kappa, and Pilgrims of the United States.

Mr. Dilworth married Elizabeth McKay Cushing in 1940, and they now have two boys and two girls.

LIBRARY OF SCIENTIFIC FILMS GROWING

A LIBRARY OF SCIENTIFIC films of value for teaching and research is being accumulated at the Institute. The techniques of microcinematography and time-lapse photography, often combined, make possible visualization of biological phenomena that can be seen in no other way. A significant example is the film, "The World of the Microbe," which was purchased in connection with Dr. Dubos's Christmas Lectures last year. In this film, made by Tokyo Cinema, the process of phagocytosis and the subsequent destruction of the phagocyte by tubercle bacilli are dramatically seen in time-lapse photographs covering nearly 100 hours. Another film purchased recently for the collection is on William Harvey and the Circulation of the Blood, narrated by Sir Henry Dale.

A charming and informative Russian film on the life of penguins has been given to the Rockefeller Institute Film Library by Dr. Norman Stoll, who received it from Academician E. N. Pavlovsky, Director of the Zoological Institute of

the Soviet Academy of Sciences in Leningrad.

The film, which was shown last year to the members of the Society of the Sigma Xi at the Institute, was made during the Soviet IGY expedition to the Antarctic. It was provided with an English sound track for showing at the XVth International Congress of Zoology in London in 1958, where Dr. Stoll, President of the Rockefeller Institute Chapter of the Society of the Sigma Xi, first saw it. Later, through Dr. Pavlovsky, he arranged to borrow a copy for showing at the Institute. In response to Dr. Stoll's praise of the film, and in memory of their pleasant acquaintance formed at the London Congress in 1958 and at another in Copenhagen in 1953, Dr. Pavlovsky sent the film with his compliments.

In addition to direct acquisition of films by gift or purchase, many have been borrowed or rented and a few produced in our own laboratories. A collection of catalogues and references to films of likely interest at the Institute has been compiled to assist individuals in supplementing their teaching programs with the best material available in motion pictures today.

MUSICAL LIFE AT THE INSTITUTE

If I had my life to live over again I would have made a rule to read some poetry and listen to some music at least once every week...the loss of these tastes is a loss of happiness, and may possibly be injurious to the intellect as well... This atrophy of tastes, which Sir Charles Darwin mourned in himself at the age of nearly 70, may be spared those at the Rockefeller Institute.

The completion of Caspary Auditorium and various other new facilities at the Institute have fulfilled a desire of many to have music available on the campus. A carefully designed music practice-room in the basement of Caspary Hall has been much used, as has the more public piano in the lounge of Abby Aldrich Rockefeller Hall. A splendid electronic music system is in frequent use in the lounge, and hi-fi systems of one sort or another are almost as common as books in the Graduate Students Residence Hall. Some of the students have arranged a Folk Singing Group, and they keep each other well-informed regarding musical events elsewhere in the city.

Our chief musical performances have been those in the auditorium of Caspary Hall. Three of them, given during the 1958-1959 academic year, have already been noted in the pages of the *Quarterly*. Dr. Theodore Shedlovsky, of the faculty, arranged a concert by the Zimblet Sinfonietta (members of the Boston Symphony Orchestra). In addition to its musical excellence, this performance showed how incredibly well the acoustical design of the auditorium is adapted to musical performances. Next was a performance by the Amor Musicae, among whom was Reba Paeff Mirsky, wife of a member of the faculty. The compositions that she played on the harpsichord, the clavichord, and the virginals would have been far too delicate to be appreciated in most concert halls. The Convocation Concert last year presented an ensemble of musicians conducted by Mr. Carlos Surinach and a percussion group from the Manhattan School of Music.

The interest in these concerts led some of the more enthusiastic music-lovers at the Institute to organize for this year two series of four concerts each. Institute faculty, students, staff and employees sub-

scribed to the series. The programs for the series of Rockefeller Institute Concerts have been selected largely with a view to presenting works which, for one reason or another, are rarely heard in the concert hall—chamber works, for example, and unusual instrumental combinations. Compositions rich in melodic sonority were sought, but works by several contemporary composers were also included.

Four of the concerts in the series were presented by the New York Chamber Soloists, a group of well-known young artists, who achieved a high level of spirited musical performances in programs seldom heard from conventional ensembles. Pre-classical, classical, and some modern works for harpsichord, piano, flute, oboe, tenor, and strings were played by groups of from four to six musicians. The Amor Musicae group also presented a concert in the new series. Professor Paul Weiss of the Institute faculty arranged for Mr. Joseph Szigeti to give one of the concerts. Mr. Szigeti, a world-famous violinist known for his musicianship, presented an all-Bach solo program, a rare musical event. He will return to play an unscheduled all-Prokofiev concert.

One of the Rockefeller Institute Concerts was given by the Lyric Trio, composed of Robert Mann, violinist with the

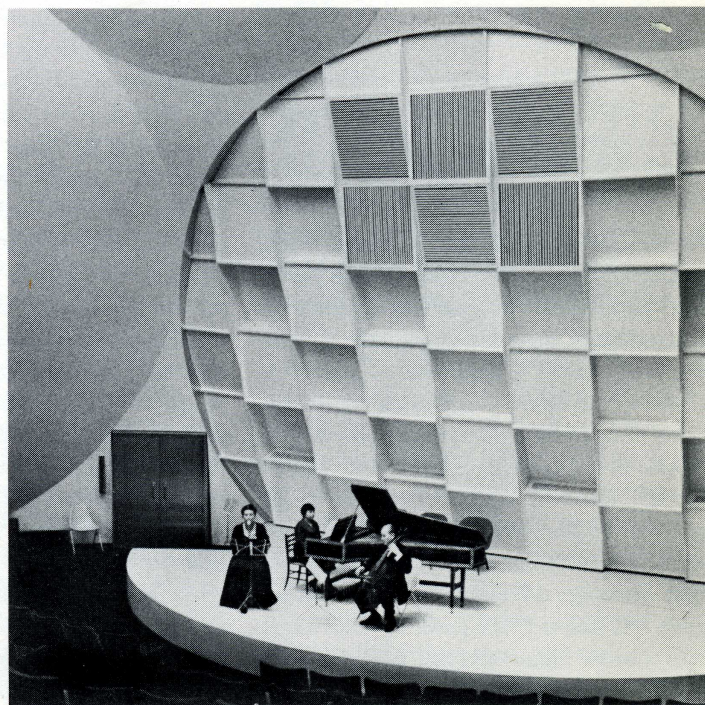
Juilliard Quartet, Leonid Hambro, the well-known New York pianist, and Lucy Rowan, narrator. They presented sonatas by Mozart and Beethoven and a series of fairy tales set to music. Mr. Hambro will return on May 15th with Harvey Shapiro, cellist, playing sonatas by Beethoven, Brahms and Grieg.

A series of three musical programs is also being presented in Caspary Auditorium this spring by the Contemporary Music Society and the Institute. The first of these, presented with the co-operation of the Manhattan Percussion Ensemble, was broadcast on WNYC and WNYC-FM. The second presented the Brink-Pinkham Duo (violin and harpsichord), music for tape recorder, and the Low Madrigal Singers. The final concert, celebrating the seventy-fifth anniversary of Wallingford Riegger, is to be given on April 27th.

Music has even found its way into the guest lecturer series. Last year Leopold Mannes, one of the inventors of the Kodachrome process and Director of the Mannes School of Music, presented a lecture on the relation between musical tempi and physiological rhythms. In exchange, Dr. Vernon Brooks of the Institute faculty lectured at the Mannes School on the physiology of hearing. The exchange exemplifies very well the mutual interests of science and the arts which has given music so prominent a place in the non-professional activities at the Institute.

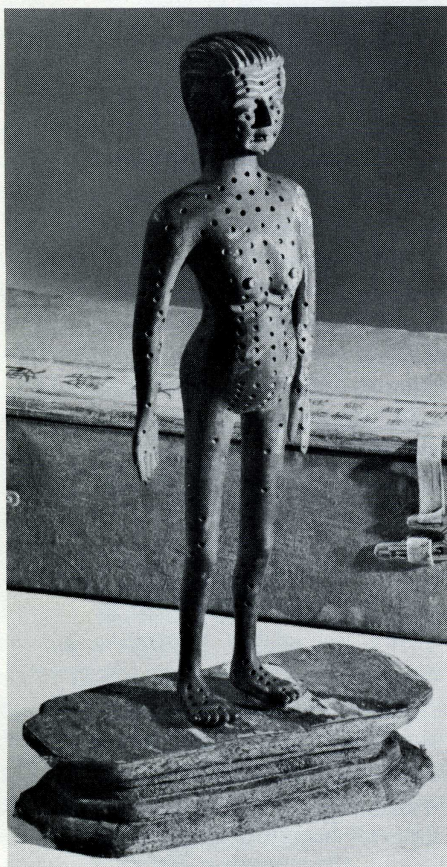
Members of the Amor Musicae in the auditorium of Caspary Hall: Claudia Lyon, recorder, Reba Mirsky, harpsichord, Janos Scholz, gamba.

PHOTO BY SZASZ



DR. OPIE ON NATIVE CHINESE MEDICINE

"WHAT WE LEARN about the Chinese people is sometimes so different from anything we know about ourselves, that we may be doubtful if it is really true, and often it is not." With this piquant observation Dr. Eugene Opie opens a book he is preparing on native Chinese medicine. He has been fascinated by this strangely persistent ancient and unscientific field since he visited the Peking Union Medical College in 1939. Even then, native medical practices based on traditions millenia old were regaining ground they had lost in 1915 under the enlightened decrees of the Chinese republic. Today the Communist regime in China in an astonishing political gambit has espoused native medicine, which is flourishing again. Medical education in China today includes such pro-



A common technique in Chinese native medicine is acupuncture, the insertion of needles, often deep within the body, for treatment of every imaginable ill. The bronze figure shown above is one of many prepared in 1793 by the Imperial Medical Bureau as a guide to points of entry of the needles. The case, an imitation of a book, contains commentary written on its inner covers. From Dr. Opie's collection.

cedures as the treatment of acute appendicitis by inserting a needle deep into the right leg, a technique called acupuncture.

Dr. Opie, former Member of the Rockefeller Institute and now an Affiliate, has collected many examples of the strange instruments and texts of the native medicine. He has also pondered the reasons why rarely useful and often harmful practices have persisted so stubbornly in the face of modern medicine.

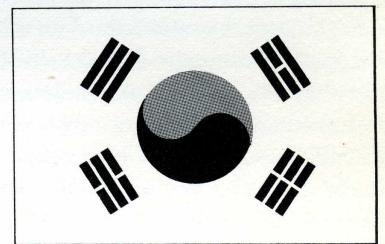
One of the reasons he sees is that the native medical practice, however ineffective, is better adjusted to the social and economic necessities of a large part of the Chinese people than is Western medicine. The equipment is simple (he purchased a set of acupuncture needles in what would correspond here to a hardware store), the drugs are on the whole readily available (for example, live tadpoles are swallowed as a contraceptive), and training is brief. Thus, in a country where even today there is only one adequately trained physician for every 10,000 people, itinerant practitioners bring at least the illusion of medical attention to the whole population.

But a deeper reason for the persistence of traditional medicine lies in the fact that it rests upon ancient metaphysical presuppositions that underly the world-view of peasant and scholar alike in the Orient today. Predominating in this view is the ancient doctrine of Yang and Yin, the two opposing principles or essences that enter into everything. Thus, not only do they determine the contrast between heaven and earth, light and dark, heat and cold, etc., but the human body is assumed to be made up of these oppositions. A fantastic speculative system of anatomy and physiology has been erected on this foundation.

The Yang and the Yin are represented in one of the most well-known of Chinese symbols. Even the flag of the Republic of Korea is designed about it. On that national emblem there appear characters known as the Pau Kua, which are also derived from the idea of the Yang and Yin. A solid line corresponds to the Yang, masculine or positive principle, and a broken line to the Yin, feminine or negative principle. Various mixtures of Yang and Yin can thus be represented by combining three lines, broken or unbroken, from which eight

trigrams can be formed. Four of these, "all-Yang, all-Yin, and two intermediates," are shown on the Korean flag below. A more elaborate version of the same idea appears in the 64 hexagrams of the *I Ching*, or Book of Changes, which according to tradition has been in use for four millennia.

According to the *I Ching* everything in the universe is related to everything else. If at a given moment, the disposition of the Yang and Yin could be discovered, the state of everything else could be deduced. Thus, by throwing six sticks which represent the Yang and Yin, the predominating hexagram can be discovered, and with the help of the *I Ching* an interpretation of, for example, a given illness, can be obtained. Dr. Opie remarks that the text of the *I Ching* is written in language which no English translation has made intelligible. Medical diagnosis (and divination in general) therefore remain haphazard.



FLAG OF THE REPUBLIC OF KOREA

Yet the lore of the Yang and Yin and the Pau Kua are part of the daily life of a large part of the Chinese people. Dr. Opie recalls that a Chinese professor whom he met in Peking told him that he had been taught the names of the eight trigrams of the Pau Kua when he was five years old. They decorate household objects of every description and are on charms of brass or jade that can be bought anywhere.

All this makes somewhat more clear the attitude of the Chinese Communists towards traditional medicine. By insisting that students of Western medicine study traditional practices, and by elevating the status of the native medicine, the Communists have aligned themselves on the side of an ancient and powerful national tradition while weakening the force of a "Western innovation." Sound medical practice in the immediate future in China may therefore be faced with the necessity of discussing its diagnoses and procedures behind a façade of traditional mumbo-jumbo. It is fortunate, therefore, that these ancient practices are so vaguely defined.

The Trustees

LINDSLEY FISKE KIMBALL

AN UNDERGRADUATE major in mathematics who did graduate research in sociology, no more suitable man could have been elected Treasurer of the Rockefeller Institute than Dr. Lindsley F. Kimball. For he also has had experience in business, once qualified as a certified public accountant, and he has been an officer in various philanthropic organizations for over 35 years.

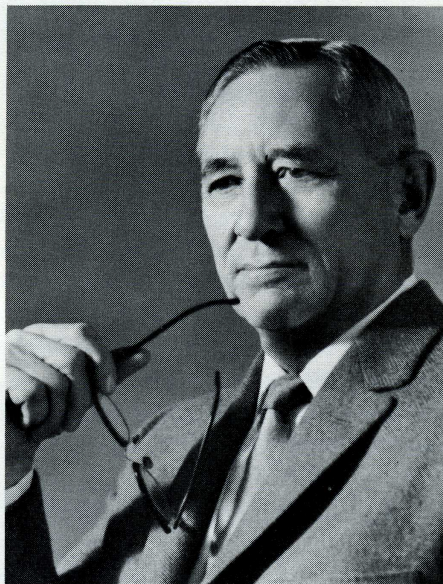
Dr. Kimball was elected to the Rockefeller Institute's Board of Trustees in 1947. Two years later he became Vice President of the Rockefeller Foundation, and since 1953 he has been that organization's Executive Vice President. In 1951 he was also elected Vice President and Director of the General Education Board.

A native of Brooklyn, Dr. Kimball studied mathematics at Columbia University, graduating with an A.B. in 1917. He enlisted in the Navy in 1917 and was commissioned an ensign the following year after he impressed his ship's officers by solving the set of differential equations relating the list of the ship and yards in range to give an immediate correction for firing the turret guns. Naturally he became fire-control officer aboard his ship, the flagship *Seattle*, and he developed a mechanical device to give the solution to the list-range problem.

When he returned to civilian life. Dr. Kimball determined to enter a career in business. With logic that would today be termed operations research he studied the membership of the Boards of Directors of the leading firms in New York, chose the man with a maximum number of memberships, arranged an introduction, and offered himself as a man who knew nothing but who was willing and able to learn. Thus it was that he became associated with the Underwood Typewriter Company, first in the Comptroller's Office, but soon as assistant to the vice president in charge of foreign business. It was during this period that Dr. Kimball studied accounting, which has protected him from becoming befuddled by the intricate movements of large sums of money through

corporate and philanthropic channels.

In 1925 Kimball became a member and chief executive of the Brooklyn Council of the Boy Scouts of America, an organization with which he had been associated almost since it was established in 1908. Characteristically, he decided that to be effective in this sociologically important institution his education needed to be supplemented. He began graduate study in the School of Sociology and Economics at New York University, obtaining his Ph.D. degree in sociology in 1930. His thesis, entitled



"Character Education," was based on an appraisal of the Boy Scout organization, a group with which he was still associated.

Upon the organization of the Greater New York Fund in 1938, as a fund-raising organization for local hospitals and health and welfare agencies, Dr. Kimball resigned from the Boy Scout organization to work as the Fund's Director of Corporation and Special Gifts. As personal representative of Walter S. Gifford, Chairman of the Board of the Fund, Dr. Kimball embarked on a study of the policies and practices with respect to charitable giving of large corporations in the metropolitan area, which in many cases resulted in the recognition of the need for corporate policies regarding gifts. It was through this study that Dr. Kimball came to the attention of Mr. John D. Rockefeller, Jr.

In 1942 Dr. Kimball became consultant to the President of the United Service Organizations, Inc., Mr. Chester Barnard. In 1943 he joined the staff of that organization, becoming its President in 1945.

In 1946, in recognition of his work with the USO, Dr. Kimball was awarded the Medal of Merit by the President of the United States. In 1951, after the outbreak of the Korean War, the USO was reactivated, and Dr. Kimball served as its president until 1952.

In 1947 Dr. Kimball became personally associated with Mr. John D. Rockefeller, Jr., in matters of philanthropic and corporate interest. One of the first assignments he undertook was to study the relation of the Institute's Division of Plant and Animal Pathology at Princeton to the New York laboratories. Since that time Dr. Kimball has served not only the Rockefeller Foundation and the Rockefeller Institute but also the General Education Board, the Sealantic Fund and the Sleepy Hollow Restoration. On July 1, 1960, Dr. Kimball will resign from the Rockefeller Foundation and the General Education Board to become consultant to the Rockefeller Brothers Fund. Another of his new undertakings is to serve as Chairman of the Program Development Committee of the Community Blood Council of Greater New York.

Dr. Kimball has been associated with innumerable other philanthropic, civic, and welfare activities. Among them are the United Negro College Fund, the Brooklyn Children's Aid Society, the Welfare Council of New York City, the Coordinating Committee of the American Red Cross—New York, the Distribution Committee of the New York Community Trust, and the National Urban League.

Early in his career, Dr. Kimball considered the ministry, and his interest in religious matters has always been serious and active. He was a charter member of the Congregational Church of Manhasset, Long Island, and he has been a Sunday school superintendent for forty years. Dr. Kimball was a member of the President's Committee on Religion and Morals in the Armed Forces from 1948 through 1950. He has also been vice-chairman of the North American Administrative Committee of the World Council of Christian Education.

In 1926, soon after he became head of the Brooklyn Council of the Boy Scouts, Dr. Kimball married Maude Ryder Kowenhoven, the daughter of one of the original settlers of Brooklyn. They have two sons, Richard Tappan and Dean Fiske.

MISCELLANY

Revelle Gives Sigma Xi Lecture

On January 26, 1960, Professor Roger Revelle of the University of California was lecturer at the second dinner and public lecture meeting of the Society of the Sigma Xi at the Institute this academic year. Professor Revelle, who is Director of the Scripps Institute of Oceanography at La Jolla, lectured on "Exploring the Deep Pacific." Members of the Chapter and their guest lecturer enjoyed a buffet supper in Welch Hall suited to the tastes of a Californian oceanographer: lobster thermidor with white wine.

TV Symposia at the Institute

For the third season the Rockefeller Institute made available Caspary Auditorium for the CBS News Television symposium series "The Great Challenge," moderated this year by Mr. Howard K. Smith. On March 27th Governor Nelson Rockefeller, Thomas K. Finletter, former Secretary of the Air Force, Marquis Childs, columnist, and Victor L. Butterfield, Presi-

dent of Wesleyan University, discussed the question: "Can We Improve our Education for Leadership?" On April 3rd the question "How Can You Get Things Done in a Democracy?" was discussed by Robert L. Heilbroner, author, Senator Henry M. Jackson of Washington, Major General John B. Medaris, former commander of the Army's Ballistic Missile Agency, and Dr. Henry M. Wriston, Chairman of President Eisenhower's Commission on National Goals. The topic for April 10th, "What Role Can the Mass Media Play in Producing Effective Democratic Leadership?" was discussed by Frank Pace, Jr., former Secretary of the Army, Leo Rosten, adviser to *Look* Magazine, Fred W. Friendly, CBS television producer, Gilbert Seldes, Director of the Annenberg School of Communications at the University of Pennsylvania, and Marguerite Higgins, correspondent for the *New York Herald Tribune*.

Rocket Society Space Forum

A forum on U. S. space technology was held in Caspary Auditorium by the New

York section of the American Rocket Society on the evening of February 25, 1960. Dr. Simon Ramo, Executive Vice President of Thompson Ramo Woolridge, Inc., presented a keynote address on "The Sixties: Showdown Period for U. S. Space Technology." A discussion by a panel of experts followed, moderated by T. F. Walkowicz, Associate of Laurance Rockefeller. Panel members were: Joseph G. Gavin, Jr., Chief Missile Engineer, Grumman Aircraft Engineering Corp., Armand G. Erpf, General Partner, Carl M. Loeb, Rhoades & Co., Todd G. Alexander, Partner, Anchincloss, Parker & Redpath, Courtland D. Perkins, Chairman, Department of Aeronautical Engineering, Princeton University, and Richard Witkin, Aviation Editor of *The New York Times*.

Frank Horsfall Assumes New Post

Dr. Frank L. Horsfall, Jr., Vice President for Clinical Studies and Member and Professor, resigned effective April 1st to become President and Director of Sloan-Kettering Institute for Cancer Research. Dr. Horsfall first came to the Rockefeller Institute in 1934 from Montreal General Hospital. In 1937 he joined the staff of what is now the Rockefeller Foundation Virus Laboratory, returning to the Institute in 1941 as Member.

FACULTY ACTIVITIES

Academic Appointments

LEE D. PEACHEY
Assistant Professor in the Department of Zoology, Columbia University.

WILLIAM H. STEIN
Visiting Professor in the Department of Biochemistry, University of Chicago.

Lectures, Conferences and Symposia

EDWARD H. AHRENS, JR.
Visiting Lecturer, Charles H. Best Institute, University of Toronto.

Visiting Lecturer, University of Iowa School of Medicine.

CARL BERKLEY
Address on "Medical Electronics," January Stated Meeting of the Medical Society of the County of Kings and Academy of Medicine of Brooklyn.

DETLEV W. BRONK
Address, Dedication of Mental Health Research Institute, University of Michigan.

MERRILL W. CHASE
Guest Lecture on "Fundamental Questions in Hypersensitivity," Buffalo Academy of Medicine and the Buffalo Allergy Society.

ARPAD CSAPO
Main Lecture, Macy Conference on Physiology of Prematurity, Princeton, New Jersey.

RICHARD DAVIS
Participant, Symposium on Parathyroid Research Trends, Rice Institute.

RENÉ J. DUBOS
Participant, Meeting of Advisory Board of the Massachusetts General Hospital, Boston.
Lecture on "Adaptability for Survival and Growth," Golden White House Conference on Youth, Washington, D. C.

RICHARD M. FRANKLIN
Informal discussant, Gustav Stern Symposium on Perspectives in Virology II, New York.
Participant, Sixth Annual Seminar on Animal Cells and Animal Viruses, Berkeley, California.

FRANK L. HORSFALL, JR.

Mayo Foundation Lecture.

Essayist, Practitioners' Society.

Lecture, Montreal Medico-Chirurgical Society.

Walter M. Brickner Memorial Lecture, Hospital for Joint Diseases.

KARL MARAMOROSCH

Opening Address, Second Conference on Medical Mycology, New York Academy of Sciences.

Co-Chairman, Conference on Aspects of Insect Endocrinology, New York Academy of Sciences.

Guest Lecturer, University of Coimbatore, Madras State, India.
Los Banos Lecture, Agricultural College, University of the Philippines.

Participant, Joint Symposium on Coconut Diseases, Ministry of Agriculture and National Science Development Board, Guinobatan, Albay, Philippines.

DAN H. MOORE

Lecture, Rudolf Virchow Medical Society.

GEORGE E. PALADE

Eastman Memorial Lecture, Rochester University School of Medicine and Dentistry.

Lecture, Dartmouth Medical School.

KEITH R. PORTER

Lecture, Institute of Humanistic Studies for Executives, University of Pennsylvania.

Lecture, Second Conference on Mechanisms of Cell Division, New York Academy of Sciences.

HOWARD RASMUSSEN

Invited speaker at Rice Institute Symposium on "Recent Trends in Parathyroid Research."

HOWARD A. SCHNEIDER

Invited paper, Sixth Annual Nutrition Conference, Wayne State University College of Medicine, Detroit, Michigan.

RICHARD E. SHOPE

Chairman, Session of the Gustav Stern Symposium on Perspectives in Virology II.

Chairman, Symposium on Eastern Viral Encephalomyelitis, University of Pennsylvania School of Veterinary Medicine.

PHILIP SIEKEVITZ

Participant in Lecture Series, "Molecular Control of Cellular Activities," University of Michigan Institute of Science and Technology.

PAUL A. WEISS

Dedicatory Address at groundbreaking ceremonies, University of Oklahoma Medical Research Institute.

Medical School Lecture, University of Montreal.

Claude Bernard Lecture, University of Montreal.

Introductory Lecture to series on "Molecular Control of Cellular Activities," Institute of Science and Technology, University of Michigan.

Society Elections

FRANK L. HORSFALL, JR.

Fellow, Montreal Medico-Chirurgical Society.

PHILIP SIEKEVITZ

Member, Harvey Society.

Other Appointments and Distinctions

EDWARD H. AHRENS, JR.

Member, Scientific Advisory Committee, The Nutrition Foundation.

FRANK L. HORSFALL, JR.

Chairman, Research and Engineering Advisory Panel, Department of Defense.

Member, Board of Trustees, Sloan-Kettering Institute for Cancer Research.

KARL MARAMOROSCH

Virologist, Food and Agriculture Organization of the United Nations, The Philippines.

PHILIP D. MCMASTER

Member, Editorial Advisory Board, *International Review of Experimental Pathology*.

PETER K. OLITSKY

Consultant to the Department of Bacteriology, Greenwich Hospital, Connecticut.

EUGENE L. OPIE

The Medal of the New York Academy of Medicine.

KEITH R. PORTER

Consultant, National Science Foundation.

FLOYD RATLIFF

Member of Psychobiology Advisory Panel, National Science Foundation.

RICHARD E. SHOPE

Member, Research Advisory Council, American Cancer Society.
Chairman, Section of Pathology and Microbiology, National Academy of Sciences.

INSTITUTE MENTION

New Appointments to the Faculty

DR. THOMAS P. ASHFORD, Surgical Resident at the University of Utah College of Medicine, has been appointed a Guest Investigator to work with Dr. Porter.

DR. M. A. ATAMER, former Hematologist at the Institute of Medical Research, Toledo Hospital, Ohio, has been appointed a Research Associate in Dr. Zworykin's laboratory.

DR. HAROLD F. DEUTSCH, Professor of Physiological Chemistry at the University of Wisconsin Medical School, was appointed a Guest Investigator in Dr. Stanford Moore's laboratory for February, March, and April.

DR. ROBERT M. FAUVE, who was an Assistant in the laboratory of Dr. A. Delaunay at the Pasteur Institute, Garches, France, has been appointed a Research Associate and will work with Dr. Dubos.

DR. MICHAEL FISCHBERG, a Guest Investigator working with Dr. Weiss and conducting a seminar at the Institute, is on sabbatical leave from Oxford University where he is John Wilfred Jenkinson Memorial Lecturer and Director of Embryological Laboratories.

- DR. TOKUHIKO HIGASHI, on leave from the Department of Biochemistry, University of Tokyo Faculty of Medicine, is working as a Guest Investigator with Dr. Gottschall in Dr. Dubos's laboratory.
- DR. MYRON C. LEDBETTER, formerly Assistant Plant Anatomist, Boyce Thompson Institute, has been appointed Guest Investigator to work with Dr. Porter.
- DR. RACHELE MAGGIO, who has been appointed a Guest Investigator to work in the Cytology laboratory with Dr. Siekevitz, is on leave from the University of Palermo, where she is an Assistant Professor in the Department of Comparative Anatomy.
- DR. BARBARA PETRACK has been appointed a Research Associate to continue the work she began with Dr. Lipmann as a Guest Investigator.
- DR. ROBERT P. SCHEFFER, a new Guest Investigator in Dr. Braun's laboratory, is on sabbatical leave from Michigan State University where he is an Associate Professor.

Faculty Terminations

- DR. GEORGE ACS, Research Associate in Dr. Lipmann's laboratory, resigned on January 31, 1960, to take a position in the laboratory of Dr. Heinrich Waelsch at Columbia University.
- DR. STUART ELLIOTT, Guest Investigator in Dr. McCarty's laboratory, returned on January 17, 1960, to the University of Cambridge where he is Assistant Director of Research in the Department of Animal Pathology.
- DR. SAMSON R. GROSS, Assistant Professor in Dr. Tatum's laboratory, resigned January 31, 1960, to join the Department of Bacteriology at Duke University Medical Center.
- DR. ROBERT C. KING, Guest Investigator in Dr. Porter's laboratory, left the Institute on February 29, 1960, to become Associate Professor in the Department of Biology at Northwestern University.
- DR. RAUL D. MACHADO, Guest Investigator in Dr. Porter's laboratory, left at the end of February to return to the Jardim Botanical de Rio de Janeiro.
- DR. CLAYTON RICH, Assistant Professor in Dr. Archibald's laboratory and Associate Physician to the Hospital, resigned March 30, 1960, to join the faculty of the University of Washington Medical School in Seattle.
- DR. PHILLIPS W. ROBBINS, Assistant Professor in Dr. Lipmann's laboratory, resigned on January 31, 1960, to become Assistant Professor in the Biology Department at Massachusetts Institute of Technology.

Visiting Professors in Residence

- DR. JOSEPH B. BIRDSSELL, Professor of Anthropology, University of California, January 10-16, 1960.
- DR. ALEXANDER VON MURALT, Professor of Physiology, University of Bern, March 12-30, 1960.
- DR. TSUNEO TOMITA, Professor of Physiology, Keiyo University School of Medicine, January 29-March 12, 1960.

Guest Speakers

- J. D. FULTON, National Institute for Medical Research, London, February 9, 1960.
- MANFRED VON EIGEN, Max-Planck-Institut für Physikalische Chemie, Göttingen, March 1, 1960.

Guest Seminar in Human Biology

- SAMUEL NATELSON, Chief of Biochemistry Department, Roosevelt Hospital, March 2, 1960.

New Grants and Contracts

From the United States Public Health Service:

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| For studies on the characterization of certain α_2 -proteins in human serum by Dr. Bearn | \$16,221 |
| For a study of the excitability of pyramidal tract cells by Dr. Brooks | \$15,700 |
| For Dr. Cohn's investigation of virulence factors of staphylococci | \$17,605 |
| For study of the turnover of plasma lipids in diabetic ketosis by Dr. Dole | \$30,093 |
| For Dr. Holman's study of abnormal immune responses in lupus erythematosus | \$37,985 |
| For Dr. Lipmann's work on biosynthetic mechanisms | \$68,650 |

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| For a study of nitrogen compounds and nerve action potential by Dr. Lorente de Nó | \$27,565 |
| For investigation by Dr. Maramorosch of the effects of viruses in tissues | \$3,220 |
| For studies on the cell surface of group A streptococci by Dr. McCarty | \$9,361 |
| For etiological studies of mammary carcinoma by Dr. Dan Moore | \$43,700 |
| For Dr. Moore's work on viruses and cancer literature and information sources | \$9,665 |
| For Dr. Moore's training program in anatomical sciences | \$33,642 |

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| For Dr. Stein's work on chemical structure and enzymic activity of proteins | \$65,895 |
| For research by Dr. Tamm on virus-induced alterations in animal cells | \$42,169 |
| For cinemicrography of cell interactions in culture by Dr. Weiss | \$12,834 |
| For a study of recurrent conditioning in the spinal cord by Dr. Wilson | \$9,011 |

From the American Cancer Society for Dr. Braun's study of the physiological and biochemical basis for autonomous growth of plant tumor cells

\$1,150

From the Health Research Council of the City of New York for a five-year project on the nature and mechanism of action of peptide hormones by Dr. Rasmussen

\$59,100

From the Myasthenia Gravis Foundation for study by Dr. Brooks of the limiting factors of transmitter release at the neuromuscular junction

\$2,000

From the Population Council for Dr. Csapo's work on the mechanism of the maintenance and termination of pregnancy

\$12,960

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Inquiries, comments and suggestions should be addressed to Mr. Charles I. Campbell, Editor,

THE ROCKEFELLER INSTITUTE QUARTERLY, 66th Street and York Avenue, New York 21