

THE ROCKEFELLER INSTITUTE, NEW YORK: A NEW GRADUATE UNIVERSITY

By L. J. F. BRIMBLE

History and Constitution

IN the United States, it was considered that up to 1900 the growth of medical science had not kept pace with the physical sciences, despite the constantly increasing rate at which medical research had been carried on in American universities. Therefore, Mr. John D. Rockefeller accepted the expressed opinion of his adviser, Frederick T. Gates, that "medicine could hardly hope to become a science until it should be endowed, and qualified men be enabled to give themselves to uninterrupted study and investigation, on ample salary, entirely independent of practice". As a result, the Rockefeller Institute for Medical Research was founded in New York during 1901 by Mr. Rockefeller "to conduct, assist and encourage investigations in the sciences and arts of hygiene, medicine and surgery, and allied subjects, in the nature and causes of disease and the methods of its prevention and treatment, and to make knowledge relating to these various subjects available for the protection of the health of the public and the improved treatment of disease and injury . . . to use by any means . . . including research, publication, education, and the establishment and maintenance of charitable and benevolent activities, agencies and institutions appropriate thereto . . .".

The original Board of Directors, comprising William H. Welch (president), T. Mitchell Prudden, L. Emmett Holt, Theobald Smith, Christian A. Hertter, Herman M. Biggs and Simon Flexner first set out to study the availability of adequately trained younger men in universities for the furtherance of medical research. The first rented buildings, at 127 East 50th Street, were directed by Simon Flexner, and there investigations in pathology, bacteriology, physiology and biological chemistry were conducted, thus immediately establishing medicine as a science. Later, Mr. Rockefeller purchased the land overlooking East River in York Avenue at 66th Street which now forms the present campus of the Institute. There he had built a laboratory, now known as Founder's Hall (Fig. 1) which was completed in 1906, and this provided space for experimental surgery and experimental biology in addition to the subjects already mentioned.

In 1908, Mr. Rockefeller provided further funds for the establishment of a hospital and isolation pavilion (Fig. 2). This was opened in 1910 with Rufus Cole as director. To this day, only patients of special scientific and medical interest are admitted on the recommendation of a panel of medical men. There they receive exceptional treatment and excellent service and nursing. In return for this they may be looked upon as contributing their diseases for the benefit of medical learning, for no payment is allowed, whether they be rich or poor.

At the same time, a Corporation was set up with increased powers. It included a Board of Trustees as well as the original Board of Directors, the name of the latter having meanwhile been changed to Board of Scientific Directors. The first president of

the new Corporation was Frederick T. Gates (adviser to Mr. Rockefeller), and on his death in 1929 he was succeeded by Mr. John D. Rockefeller, jun., who, after twenty-one years service, was followed by his son, Mr. David Rockefeller. As time passed, further generous gifts were made by Mr. John D. Rockefeller and his son (Mr. John D. Rockefeller, jun.).

In 1914, a Department of Animal Pathology was established for the Institute near Princeton University under the directorship of Theobald Smith, who was succeeded in 1930 by Carl TenBroek. In 1931, research in plant pathology was also introduced, so that now the Institute could rightly claim to cover all the main groups of living things. In 1951, the work of the laboratories of animal and plant pathology at Princeton was transferred to the campus in New York.

Simon Flexner retired from the directorship of the Institute in 1935, and he was followed by Herbert S. Gasser, who remained in charge until 1953, when he was succeeded by Thomas M. Rivers. Both Dr. Gasser and Dr. Rivers are now directors emeriti of the Institute, and both still have rooms there.

The year 1953 saw extensive re-organization of the Institute, and Dr. Detlev Wulf Bronk was appointed first president of the Rockefeller Institute of Medical Research. Dr. Bronk is also president of the U.S. National Academy of Sciences, chairman of the National Research Council, and one of America's leading physiologists. He has been professor of physiology in Cornell University and professor of biophysics and director of the Johnson Foundation, University of Pennsylvania. Eventually he became president of the Johns Hopkins University (1948-53) before transferring to the Rockefeller Institute. He is a foreign member of the Royal Society. It has not taken very long to prove that the Institute was indeed fortunate in the election of Dr. Bronk.

In 1953, the Boards of Trustees and of Scientific Directors were merged into a single Board of Trustees which now has fifteen members. They are laymen of distinction in public affairs and men of outstanding scientific achievement, in the ratio of about one to one. These include: Mr. David Rockefeller (chairman), Dr. Detlev Bronk, Prof. R. F. Loeb, Prof. G. H. Whipple, Prof. William J. Robbins, Prof. Philip Bard and Prof. Vincent du Vigneaud.

At present, the staff of the Institute includes twelve members emeriti, all of whom have earned international reputations for their researches in the life sciences; twenty-nine members and professors; seven affiliates; nineteen visiting professors, including such authorities as Lord Adrian of Cambridge (physiology), Prof. T. Dobzhansky of Columbia (zoology), Prof. L. Edelstein of Johns Hopkins (humanistic studies), Prof. Ragnar Granit of Stockholm (neurophysiology), Dr. L. J. Haworth, director of the Brookhaven National Laboratory, Prof. J. G. Kirkwood of Yale (chemistry), [the late] Prof. K. V. Linderström-Lang, Carlsberg Laboratory, Copenhagen (chemistry), Prof. A. M. Monnier of the University of Paris at the Sorbonne (functional physiology), Prof. I. I. Rabi of Columbia (physics), Prof. William J. Robbins,

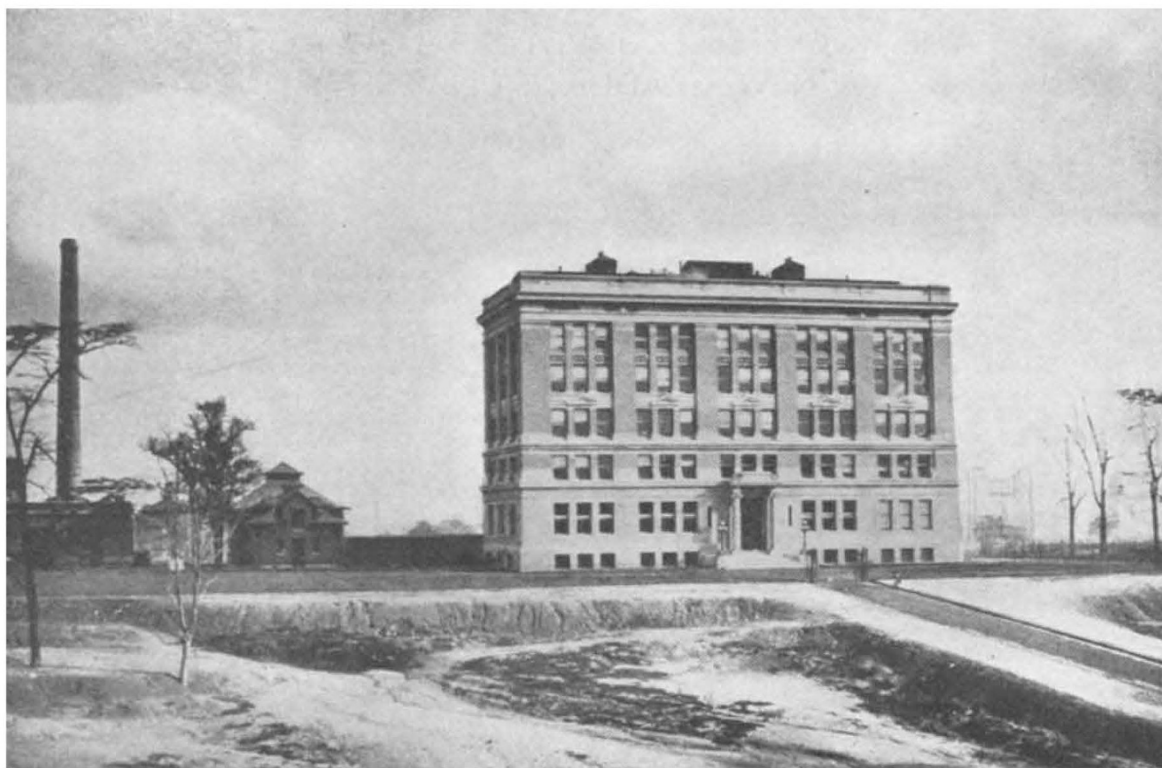


Fig. 1. The Rockefeller Institute for Medical Research as photographed in 1906. Founder's Hall, the only building then in existence

formerly of Columbia (botany), etc.; twenty-four associate professors; thirty-two assistant professors; sixty-two research associates; and forty guest investigators. Prof. Frank Brink is dean of graduate studies, and graduate fellows will this year number 65.

After about fifty years activity, and in order to include graduate education in the natural sciences with special emphasis on the life sciences, the charter of the Institute was amended in 1954 so that it could become part of the University of the State of New York with authority to grant the advanced degrees of doctor of philosophy, doctor of medical sciences, doctor of science (*honoris causa*) and doctor of laws (*honoris causa*). Thus the Institute assumed the status of a graduate university; there are, of course, no undergraduates. It cannot be said, therefore, that the Rockefeller Institute, as a university, is a one-sided affair, for all students have already had those educational and other benefits associated with a full university course before being admitted.

In 1954, the fiftieth anniversary of the opening of the first laboratory, three new buildings were opened, so that then there were Founder's Hall, Welch Hall, Simon Flexner Hall and Theobald Smith Hall, and the Hospital. Since that date, other buildings have been erected and are in use, whereas others are undergoing completion. These are an auditorium, a huge laboratory building, a faculty-visiting scientists social centre, a graduate residential hall, a building for seminars and conferences and a President's House. These buildings and the superb landscaping of the campus (Fig. 3) have been rendered possible by gifts from the estate of Alfred H. Caspary and from Mr. John D. Rockefeller, jun., Mr. David Rockefeller and the United States Public Health Service.

In 1958 the charter of the Institute was amended to change its name from that of Rockefeller Institute for Medical Research to the Rockefeller Institute—a wise decision in view of the comprehensive researches in the life sciences which are now being carried out there.

The current market value of the Institute's endowments is more than 160 million dollars. At present, no more than seventy-five students are to be admitted, at the rate of about twenty each year, to read for the degree of doctor of philosophy or doctor of medical science, so that here we have an aggregate body, a community of scientific scholars, living and working under ideal conditions—a place where they can work, think and dream, away from the sometimes excessive demands made by administration and teaching. The students are few, the faculty (staff) are many. Their creature comforts are catered for in an environment at once functional, beautiful and serene.

The entire organization is of a flexible and personal nature, built around individuals rather than departments, thus allowing the maximum freedom for research and study. The subjects at present being pursued are diverse: they include animal pathology, biochemical genetics, biochemistry, biophysics, biosynthesis, cytology, developmental biology, ecology, general physiology, genetics, history of science, immunology, mathematics, medicine, neurophysiology, parasitology, pathology, physical and organic chemistry, physiology of reproduction and plant pathology.

This academic institution must be unique. It is essential that the graduate students fortunate enough to be accepted be capable of self-directed study. Teaching is mainly done in seminars, tutorial conferences and in faculty research laboratories. The

first three months of each initial academic year are devoted to lectures, seminars and discussions in many fields of natural science. Each week a topic in basic science is discussed by one or more members of the staff. Thus, at the outset of his career the student is enabled to develop a broad foundation of competence in many related fields of science and to grasp the connexions of his special field of research with other aspects of science. Thereafter, the educational programme is designed to suit the needs and interests of each individual student. As soon as the student has formulated a significant problem for investigation, he is encouraged to begin research either independently or under the direction of one or more members of the faculty, knowing full well that extraordinary physical facilities for research are at his disposal.

Moreover, in close proximity to the Institute are opportunities for satisfying interests in the theatre,

art, literature, music and other branches of science, and fellowship stipends are of a magnitude to permit students to take some advantage of these (see, for example, *Nature* of May 16, p. 1365). Truly, an international centre of research and culture, for, as the supervisor of one of the Halls remarked: "These students and research workers are also men and women". They look not only inside but also outside the Institute for full development and—the main aim of education—complete living.

First Convocation

The first Convocation of the Rockefeller Institute as a graduate university was held during May 21–22. It opened with a luncheon attended by about three hundred guests, including members of the Rockefeller family, some other prominent Americans and distinguished scientific and academic guests.



Fig. 2. Aerial view of the Rockefeller Institute and its Campus

Top left is the handsome pile of the New York Hospital and Cornell University Medical College, and immediately below this (on the left-hand edge of the photograph) is the corner of Memorial Hospital, behind which is the Sloan-Kettering Institute for Cancer Research. The arrow indicates Theobald Smith Hall of the Institute, behind which is the President's Residence—a beautiful home built in contemporary American style and commanding a magnificent view of East River. Passing to the right are: Flexner Hall; Founder's Hall (see Fig. 1); behind this on the lower slopes facing the River is Welch Hall; the Hospital. On the extreme right are the new laboratories which are nearing completion. Next to this, and facing York Avenue, is the Graduate Students' Residence Hall. Further to the left are Caspary Hall and Abby Aldrich Rockefeller Hall (both included in one building), in front of which is the dome-shaped Caspary Hall Auditorium

In the afternoon, four commemoration addresses (to be published in later issues of *Nature*) were delivered by: Dr. Detlev Bronk, president of the Institute and of the U.S. National Academy of Sciences; Dr. Douglas M. Knight, president of Lawrence College, one of America's leading undergraduate colleges; Lord Adrian, Master of Trinity College and vice-chancellor of the University of Cambridge; and Dr. Henry A. Moe, secretary-general of the John Simon Guggenheim Memorial Foundation and president of the American Philosophical Society.

A reception and dinner were held in the evening, followed by a concert in the auditorium of Caspary Hall. This concert was given by a section of the New York Philharmonic Orchestra conducted by Carlos Surinach. Apart from one item, the pieces played were by contemporary composers—all American except for one Japanese and one Mexican. Introductory remarks by the conductor and the presence of some of the composers rendered this musical occasion one to be happily remembered, for the presentation was exquisite. Even he without an ear for music or he who usually cannot understand or appreciate the modern musical idiom could not help but be impressed by such a full-blooded and enthusiastic performance.

Dancing followed inside and outside the Abby Aldrich Rockefeller Hall under a full moon.

The proceedings on the following day were initiated by the first graduation of this new university—a completely honorary graduation, for the first so-called 'earned' graduation was to be held a few weeks later. The degree of doctor of laws (*honoris causa*) was conferred on the highest academic officers of six of the oldest universities in Europe and the Americas and on Mr. John D. Rockefeller, jun. With the exception of the last-named, the recipients were presented in order of age of the institution they represented.

Dr. G. G. Forni, rector of the University of Bologna, was presented by Prof. R. Dubos, professor of pathology and microbiology in the Institute. Bologna is the oldest of Europe's universities: by tradition it was founded in 1088, though the names of some teachers in Bologna have survived in parchments dating from 1067. By the year 1200, Bologna had some 10,000 students, most of them from foreign lands. Throughout the centuries, this University has been able to count among its alumni such great names as Dante, Petrarch, Copernicus, Malpighi, Margagni, Spallanzani, Galvani and Marconi.

Dr. T. S. R. Boase, president of Magdalen College and vice-chancellor of the University of Oxford, was presented by Prof. G. W. Corner, historian of the Institute. Oxford is the oldest university of the English-speaking world, dating from the reign of Henry II, when, in 1167, foreign-born scholars were driven from Paris. As pointed out by Prof. Corner: "in the year 1649, three hundred and ten years ago, a handful of scholars, vanguard of the new era in experimental science, founded the Philosophical Club, cradle of the Royal Society, exemplar of our National Academy of Sciences". Oxford has been called the 'home of lost causes'; but this is only another way of saying that she is for ever the home of a cause our world must never lose—the cause of liberty to study, think and teach with untrammelled mind in the free city of the spirit.

Lord Adrian, Master of Trinity College and vice-chancellor of the University of Cambridge, was pre-

sented by Prof. Peyton Rous, professor emeritus of pathology and microbiology in the Institute. Cambridge also dates back to the twelfth century, and was granted its charter during the reign of Elizabeth I. Oxford and Cambridge "have gone forward side by side throughout almost seven hundred years and have been competitors along most of the way, however impersonal their scholars. Together they emerged from Scholasticism, changed with the Reformation, weathered the Puritan Revolution, the Georgian Era; and yet despite all vicissitudes neither has gained superiority over the other when viewed in the sharp light of the present. Where else does such a state of affairs obtain amongst old universities? Can it be that the love of the English people for contests under fair terms has extended far beyond boat races that almost subconsciously, by giving and taking in a myriad ways, they have maintained the great rival universities in balanced power?"

Dr. J. L. Barandiaran, rector of the University of San Marcos, Lima, Peru, was presented by Prof. R. E. Shope, professor of animal pathology in the Institute. The University of San Marcos was founded in 1551 by royal decree issued by Charles V of Spain. Since that time, it has developed a distinguished record as a centre of intellectual leadership.

Dr. Nabor Carrillo, president of the National University of Mexico, was presented by Prof. Paul A. Weiss, professor of developmental biology in the Institute. This University was also founded in 1551 by Charles V of Spain. It now has a large number of students and teachers working on what must be one of the most beautiful and impressive campuses in the world.

Dr. N. M. Pusey, president of Harvard University, was presented by Prof. A. E. Mirsky, professor of general physiology in the Institute. Harvard, the oldest college in the United States, was founded in 1636 with a gift of £400 from the General Court of the Massachusetts Bay Colony. In the same year, John Harvard, of Emmanuel College, Cambridge, and a Puritan immigrant, bequeathed to the seminary £780 and 260 books; the College was then re-organized, and in 1639 was named Harvard College. Such alumni as Lowell, Longfellow, Agassiz and Emerson have left their stamp on that University; and such presidents as C. W. Eliot, A. L. Lowell and J. B. Conant influenced the entire course of American education.

Owing to his indisposition, the degree of doctor of laws (*honoris causa*) was conferred on Mr. John D. Rockefeller *in absentia*. His son, Mr. David Rockefeller, received the insignia of the degree, after a moving citation by Dr. Detlev Bronk. John D. Rockefeller was born on January 29, 1874, and in 1901 he married Miss Abby Greene Aldrich. They had one daughter and five sons—John D. 3rd, Nelson A. (now governor of New York), Laurance S., Winthrop and David (chairman of the Board of Trustees of the Institute). His life has been devoted to the philanthropic and civic activities of the Rockefeller family, particularly those designed to advance human welfare and those furthering international, inter-faith and inter-racial concepts. He has been active in the organization, administration and policy development of these activities and has made many of them financially possible. He was associated with his father in the creation and development of the Rockefeller Institute for Medical Research in 1901, the General Education Board in 1902, the



Fig. 3. View of the new campus area of the Rockefeller Institute, looking toward New York Hospital. On the left is the Graduate Students' Residence Hall and, on the right, one of the Institute's older laboratory buildings (Flexner Hall)

Rockefeller Foundation in 1913 and the Laura Spelman Rockefeller Memorial in 1918. The last two were merged in 1928. Thus father and son have, as Dr. Bronk said, "been unequalled in their sympathetic understanding, their selfless service, and the scope of their unrestricted, generous gifts in support of scholars and their corporate institutions".

Dedication of New Buildings and Campus

Five new buildings and the North and South Campus were dedicated during the afternoon of May 22. Of necessity in New York, though the buildings are large and spacious, the total area of the campus is comparatively small. This has much to recommend it; for the tendency among some modern universities is to spread themselves over huge areas, thus rendering intercommunication inconvenient if not exhausting.

Caspary Hall contains an auditorium to hold five hundred, numerous seminar and conference rooms, and rooms for the Board of Trustees and senior administrative officers concerned with the educational activities of the Institute. The auditorium is dome-shaped, and its furnishings are of striking beauty. The acoustics are excellent.

Abby Aldrich Rockefeller Hall contains social halls, refectory, library, meeting rooms and private dining rooms for the friendly association of members of the faculty and their families. It also provides living quarters for visiting scientists so that this building

may become an international scientific centre for meetings and the exchange of ideas. The air-conditioned residential suites leave nothing to be desired, and the library, refectory and lounges are adorned by some impressive, though controversial, examples of modern American art.

The President's House likewise fosters the development of the Institute as a centre of scientists in a great international city.

The Students' Residence Hall is designed to meet the needs of the most fastidious.

The South Laboratory (Fig. 2) is a huge building which will soon be offering comprehensive facilities for research in many fields.

The campus is charmingly landscaped (Fig. 3).

Of the older buildings, Founder's Hall, Flexner Hall and Theobald Smith Hall are devoted primarily to the housing of 109,000 sq. ft. of laboratories, most of which have been reconstructed and re-equipped within the past ten years. The Hospital, of fifty-six beds, serves as a laboratory for the study of the physiology of man and certain of the diseases which afflict him. Greenhouses provide approximately 10,000 sq. ft. of facilities for botanical research.

Welch Hall contains a library of more than 40,000 volumes, including an unusually fine collection of scientific periodicals. In this building there are also a large faculty dining hall, another for the women of the administrative, secretarial and technical staffs, and social rooms for both groups.

Other buildings comprising the Institute are the Jacques Loeb Laboratories in the Marine Biological Laboratory at Woods Hole, Mass., for those wishing to study marine organisms. Special facilities are also available in the research laboratories of the New York Botanical Garden for those members of the faculty who desire to use the extensive resources there.

Because of increasing dependence of modern scientific research on adequate technical facilities, many supporting services are maintained in order to facilitate and make more effective the work of the Institute. For example, the Animal House contains 40,000 sq. ft. of quarters for animals ranging in size from mice to horses. There are well-equipped shops for the construction of instruments and electronic equipment; whereas shops for machine work and cabinet work make possible the construction and maintenance of all laboratory equipment. Central facilities for electron microscopy, spectroscopic determinations, microanalyses, X-ray studies, photographic work and media preparation are among the many aids maintained for the general use of the various laboratories.

Publications

The Rockefeller Institute Press was established in 1958 and now publishes *The Journal of Experimental Medicine*, *The Journal of General Physiology* and *The*

Journal of Biophysical and Biochemical Cytology. Reprints of recent publications are issued periodically as volumes of *Studies*. Events of general interest are published in *The Rockefeller Institute Quarterly*. Monographs and scientific texts are to be published by the Rockefeller Institute Press in association with Oxford University Press.

The celebrations of the first Convocation of the Rockefeller Institute were rounded off by a pleasant garden party in the grounds of the President's House.

In announcing his resignation from the presidency of the Board of Trustees of the Rockefeller Institute in 1950, Mr. John D. Rockefeller, jun., said he had always regarded "this enterprise as the most significant and the most permanent of any that my father established". It is certainly true that the world of scholarship, and especially of science and medicine, owes a great debt of gratitude to the Rockefeller family: particularly through the Rockefeller Institute is the world indebted to John D. Rockefeller, his son John D. Rockefeller, jun., and his son David Rockefeller.

To Dr. Detlev Bronk the world of science and learning will tender their congratulations and express deep admiration for his almost superhuman efforts to further the development and advancement of the Rockefeller Institute and especially for the foundation of this new graduate university.

EVOLUTIONARY SYSTEMS—ANIMAL AND HUMAN*

By PROF. C. H. WADDINGTON, C.B.E., F.R.S.
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THE major advance in the theory of biological evolution since Darwin's day has been the rise of Mendelian genetics. It is scarcely an exaggeration to say that when Darwin wrote biology possessed no theory of inheritance. Since then, the existence of more or less discrete hereditary factors has been discovered, their position in the cell ascertained to be on the chromosomes in the nucleus, and the behaviour of these chromosomes analysed in great detail both in normal and in various more or less unusual conditions.

The whole of this complex of phenomena which are concerned with the manner in which hereditary determinants are passed on from one generation to the next may be referred to as the 'genetic system'. From the point of view of evolutionary theory three main points have emerged concerning it. The first is that the existence of discrete hereditary determinants safeguards variation against being lost if dissimilar animals cross-breed, as Darwin feared it might¹. Indeed the fact that during the greater part of the life-cycle of most animals and plants the hereditary factors are present in the diploid condition implies that most organisms carry within them much greater potentialities for variation in their offspring than would appear at first sight. The second point, which is one that we owe primarily to the insight of Darlington², is that the genetic system itself can be regarded not only as an agent but also as a subject of

evolutionary change, which is to say that the genetic system itself evolves. This I shall return to later.

The third point concerns the origin of new variation. It is essential to any theory of evolution that there must be some mechanism by which new variation is brought into being. Darwin was driven to speculate as to what this mechanism might be. In the absence of any understanding of how hereditary qualities are transmitted, he made no pretence that he had found a solution fully satisfactory to himself, although he was somewhat tempted by the theory, usually associated with the name of Lamarck, that characters acquired by organisms in the course of their lifetime might be transmitted to their offspring. Later experimental investigations have shown that in general this is not so.

Our knowledge of the genetic system, which is very extensive and detailed, forces us to the conclusion that the origin of new hereditary variation is to be found only in alterations and rearrangements of the atomic groupings out of which the hereditary factors of the chromosomes are composed. These alterations follow rules of stability which are still entirely unknown to us, but which must be properties of the hereditary molecules themselves and have little or no relation to the precipitating events by which the alterations were stimulated. One of the most firmly based doctrines of modern genetics is that mutation is a random process. I do not wish to challenge this, but I shall suggest later that some care is necessary in interpreting the word random.

* Substance of the Woodhull Lecture delivered at the Royal Institution on February 27.