Anatomy, School of Med., Univ. of North Carolina, 1920–24; Prof. and Head of Anatomy Dept., 1940–49, Prof. emeritus, 1949—. Carleton Putnam: B.S., Princeton, 1924; L.L.B., Columbia, 1932; author of *High Journey, a Decade in the Pilgrimage of an Air Line Pioneer* (1944), *Theodore Roosevelt* (a biography) (1958); *Race and Reason* (1961).

2. Professor George states: "Experience has shown that Negroid peoples have the desire to utilize the products of a high culture but they seem not to possess the combination of human qualities necessary to originate them. Nowhere in the world have they demonstrated that they have the creative capacities (the intelligence, the industry, the drive and the persistence) to make a civilization; nor is there an advanced civilization in any area where there has been a high degree of absorption of Negro genes into a white population." [In "The Biology of the Race Problem," prepared by Commission of the Governor of Alabama, 1962 (pp. 73–74)]
3. Professor George states: "When the Justices of the Supreme Court abandoned former legal precedents and the historic meaning of the constitution, and based their decision in *Brown v. Board of Education* upon 'science' and the opinions of 'authorities' they inevitably made the validity of their ruling dependent upon the truth and validity of their scientific material. This should have been subjected to critical examination and was not. . . . As a contribution to presenting such evidence and for the purpose of weighing the merit of dogmas built up and imposed upon the public as the basis for revolutionary social and political programs, it is the object of this study to ask certain questions of a fundamental biological nature and to see what answers are given by the facts as discovered and reported by the most credible scientists. Some of these questions are:
"1) Are babies born equal in the biological sense, or are there significant differences between them before environment plays a part in molding them?
"2) What is the mechanism of biological inheritance?
"3) Is the difference between the White and Negro races primarily a 'paint job' or are there differences of such fundamental nature and significance that they should be taken into consideration in deciding upon social and educational policies involving the relations of the races?
"4) Are significant differences in individuals and in races hereditary or are they produced anew in each generation by environmental influences?
"5) What should we expect to be the long range results of a program that would lead to racial amalgamation?" [*Ibid.*, pp. 1–2]
4. Mr. Putnam states: "I do not believe that ever before has science been warped by a self-serving few to the deception and injury of so many." [C. Putnam, *Race and Reason* (Public Affairs Press, Washington, D.C., 1961) p. 22]
5. The definition of race provided by S. M. Garn in *Human Races* (Thomas, Springfield, Ill., 1961) is appropriate here: "A race in man, as in any living form, is a population, a population of men, women and children, of fathers, mothers, and grandparents. . . . Members of such a breeding population share a common history, and a common locale. They have been exposed to common dangers, and they are the product of a common environment. For these reasons, and especially with advancing time, members of a race have a common heritage."
6. *Race and Science* (Columbia Univ. Press, New York, 1961).

MEETING REPORTS

National Academy of Sciences: 100th Anniversary Program

In celebrating its 100th birthday last week, the National Academy of Sciences also celebrated the greatly increased range of human knowledge of this and other galaxies, of the earth, and of the nature of life: a century's harvest to which its members, some of the most eminent men of American science, had made important contributions.

The anniversary also marked a great change of another sort. Abraham Lincoln was the president who signed the Act of Congress that established the National Academy, and the best indication of the intimacy of Lincoln's interest in the matter is the story of how, often sleepless in the darkest year of the Civil War, he visited the North Tower of the Smithsonian to watch Joseph Henry's midnight experiments and even held the lantern.

The light from the tower was misunderstood: the story goes on that excited citizens rushed to the White House to say that the scientists in the Smithsonian (where the Academy then met) were signaling to Confederate troops encamped on the other side of the Potomac. In its dominance in the affairs of men, science may have reached the point where a myth or two is inevitable; the tale of the public alarm at the light from the tower should serve reasonably well.

There could scarcely have been a more impelling symbol of how much the power of American science and the power of American government have increased, and of how much the relation between the two has changed over the century, than the major event of the Academy's birthday party: that moment in Constitution Hall when President Kennedy, flanked by the National Academy Council, confronted an assembly of more than one-half of the living members of the Academy and their distinguished guests representing the scientific achievements of most of the other nations of the world.

The President spoke of the "wholehearted understanding today of the importance of pure science" and then went on to devote much of his speech to the applied problems on which he hopes science will work. Missing from his list was the most expensive and most debated of American society's current objectives: the $20 billion program to land men on the moon.

The Academy anniversary came at a time when Congress is no longer viewing requests for increased support for science with enthusiasm, and this new severity is reinforced by old public misgivings about the scientific enterprise—a doubt perhaps only temporarily alleviated by the aroused feelings that followed Sputnik.

Despite the economic abundance that has followed on the heels of scientists' urge "just to know, to find or perhaps make order out of the otherwise chaotic jumble of immediate experience," as I. I. Rabi put it in the final lecture of the Academy's program, the community has not felt really at ease with these wise children who never grow up. "Like children, who in all innocence and high excitement bring a dangerous spider into the house and frighten the wits out of the elders," Rabi said, "the scientist emerges with a smallpox vaccine or an atomic bomb."

The hard matter of choice intruded at the Academy's birthday party when Linus Pauling said, at the end of a brilliant summary of the decisive role of molecular architecture in living systems, that the "only thing we lack to make an enzyme is the money."

Pauling, the only man to win both the Nobel Peace Prize and the Nobel Prize in science, called the project to land a man on the moon "a pitiful demonstration" as a vast gamble for prestige and said that it would be possible "to answer 1,000 interesting and important questions about the human body for every one question answered about the moon. But we can't get the engineers or the money to build the computers and x-ray equipment we need to take our analyses of molecular architecture farther."

The Academy's three-day review of the advance of science amounted to a demonstration of the price of choice should this be forced on basic research by the high cost of space and military hardware. Most of the papers were summaries of what is known or reasonably well established about the history of the universe and the nature of matter and of life, according to a program structure planned by the Academy's past president, Detlev Bronk.

Vigorous Life Sciences

The vitality of research in the life and behavioral sciences was much in evidence. Especially interesting lectures were delivered in the session on the determinants and evolution of life; perhaps the vigorous character of present work on cellular mechanisms can best be indicated by reporting Tracy Sonneborn's discussion of cellular differentiation.

The now well-known chemical evidence that cellular differentiation is the result of changes in activity of the genes has been reinforced by a substantial amount of visible evidence obtained by microscopic examination of large chromosomes, Sonneborn said. He reviewed some of this evidence and then went on to outline a second major principle of cellular differentiation, which he called "cytotaxis" (literally cellular ordering or arranging): the hypothesis that new cellular structure is ordered by pre-existing structure.

In perhaps the most provocative half-hour of the entire Academy program, Sonneborn told how he had supported this possible second principle by work with a paramecium (*P. aurelia*) which is capable of sexual reproduction and therefore open to breeding analysis.

"The current major hypothesis that an active gene dictates the sequence of amino acids in a polypeptide and that, directly or indirectly, this determines everything else—a sort of automatic self-assembly—may have important limits," Sonneborn said.

Cytotaxis as an additional explanatory principle rests on the demonstration of "critical cases in which cellular differentiations are reasonably well shown to be independent of differential genic action. The needed test case is one in which the cells differ, not in the kinds, but in the cellular arrangements of proteins, i. e., in the arrangements of the parts of a cell."

While such structural differences have been experimentally created and studied by Tartar, Suzuki, Curtis, and others, Sonneborn said these studies lacked the final critical step—"genetic analysis that would definitely answer whether differences in genic action were excluded."

Working with the ciliate Paramecium with a precise surface structure composed by repeating structural units, experimenters were able to change the structural pattern by the manipulation of mating and fused cells to produce cells with two or three mouths and gullets in various positions or two or three anuses or with one or more rows of surface units inverted. This work was done in collaboration with Dippell and Biesson.

The changes are neither fatal nor corrected by the cell's genic action. "The bizarre cells are quite viable; the imposed differences persist; and they are as a rule inherited by both daughter cells. What amounts to nuclear transplantation in both directions between these and normal cells, as well as standard Mendelian breeding analysis showed unambiguously that these hereditary cell differences are not due to differences in either the genes present or in genic action."

Inversion of a row of surface structural units, including ciliary bases and the fibers emerging from them, was followed for 700 cell generations.

Sonneborn said that cytotaxis as a determinant of the differentiation of organelles and other cellular structure had analogies in the growth of crystal structure and was probably illustrated by the work of Schmitt, Edds, Weiss, and others, on the varied structural features of collagen and other cellular substances, and by Luck's evidence that mitochondrial structure perpetuates itself.

Sonneborn also told about the discovery of an apparently immortal and infectious RNA, formed by a known gene in a paramecium and called a "metagon" by its discoverers, Gibson and Beale of the University of Edinburgh. The metagon was discovered in a mate-killer paramecium. On extraction, the metagon was chemically analyzed as RNA.

In the killer paramecium, the RNA metagon persists even when the gene that makes it (M) has been replaced by an allele (m) that cannot make it. After about 10 generations or less, random distribution results in only one

Robert Phillips for National Academy of Sciences

Academy past president Detlev Bronk is shown speaking to the centennial convocation. President Kennedy is at left.

or no metagons per cell. Cells with only one pass it along to one of the two daughter cells at each fission, and this has continued as long as it has been followed.

While the RNA metagon does not multiply (or multiplies only weakly) in the paramecium, Gibson, working in Sonneborn's laboratory, recently introduced it into "another, not even closely related, cell (*Didinium*), and found that it then multiplies fast and is still doing so." Gibson did this by feeding the metagon-carrying paramecia to the larger protozoa. Although the mechanism of this multiplication is not yet known, this behavior obviously suggests viral characteristics.

In summarizing evidence for control of genic action as a major principle of cellular differentiation, Sonneborn said that work in this field had for a long time been hampered by the completely wrong assumption that "all genes act all the time." On the contrary, the work of Beermann has recently shown that in a multicellular organism only about 10 percent of the genes in a given cell are acting at any one time.

At the same session, Neal E. Miller developed a broad picture of how emerging new methods in the behavioral sciences are relating knowledge of neurochemical bases of behavior, the force of cultural conditioning, and mechanisms of human learning.

"There may be certain critical periods in childhood during which experiences may have an especially profound and long-lasting effect. These observations have been supported by recent experimental studies on mammals. Female rats restrained from grooming themselves during a certain period of infancy do not show normal nest-building in later life and will eat, instead of care for, their young. . . . Bottle-fed sheep do not develop gregariousness, but become isolated to graze alone. That genetic factors are also involved, however, is shown by the fact that not all mammals become as gregarious as sheep.

"The critical periods involve the interaction of developing innate patterns with learning."

Miller said that the finding that handling infant rats increased their rate of physical development and their ability at certain learning tasks, interpreted at first as an effect analogous to expressions of human parental affection, was now known to be a stress reaction, mediated by neurochemical links from the hypothalamus to the pituitary and thence to the adrenals. If injected at certain critical periods of development, minute amounts of hormones, ineffective at other times, have permanent effects on the rat's physiological development, which in turn profoundly affects behavior. Inquiry as to whether such infant stresses have permanent effects on human development has found positive correlations between such primitive practices as skin-scarring, lip- and ear-piercing, and mean height, a correlation remaining when such height-influencing factors as genetic stock, diet, and sunshine have been controlled.

The Nature of Matter

The symmetry perceived by Einstein in the laws of nature was apparent in both Eugene P. Wigner's arresting discussion of a new or dynamic concept of invariance and Geoffrey Chew's report that enough knowledge of the properties of the many nuclear particles is accumulating to promise arrangement of these in an order something like the periodic table of elements.

And while Wigner said that the physicists, at least temporarily, had given up the search for a single explanation of the forces variously observable as gravity, electromagnetism, fusion of nuclear particles, and transformations such as beta decay, they nevertheless seemed to be making progress in identifying major types of interactions in each of the last two classes and in recognizing more than one group of invariance principles, with each group limited in application to a specific type of interaction. In the new way of regarding invariance as dynamic rather than geometric described by Wigner, there was the sense that physicists may be close to the discovery of a new order or pattern in the fundamental relationships.

"Our universe is . . . on a one-way road already ten billion years in length," said Jesse L. Greenstein, who reviewed the history of galaxies.

The nebulae recently located by radio telescopes at a distance of some 2-4 billion light years from the earth, Greenstein said, are extraordinarily luminous objects whose nature is not clear.

"Their light is almost certainly variable, suggesting small size. If the small size is proved correct, we require an unknown, enormous supply of energy from a very small volume. Chain reactions of supernovae would barely suffice, even in a very densely crowded group of stars. . . . Either an unknown new type of super supernova, an enormously massive star, or some unknown storehouse of energy is required to explain these great explosions."

The most memorable event of the final Academy session on the nature of the scientific enterprise was the lecture by Robert Oppenheimer. On the difficult matter of how and when scientists should speak on "common and public questions", Oppenheimer said:

"If I doubt whether professionally we have special qualification on these common questions, I doubt even more that our professional practices should disqualify us, or that we should lose interest and heart in preoccupations which have enobled and purified men throughout history, and for which the world has great need today."

Oppenheimer, perhaps the American scientist who has paid the highest price for his role in increasing the light from the tower, received the greatest ovation of the three-day session: a moving recognition by his colleagues of a quality of character even rarer than first-order scientific achievement.

Oppenheimer dealt with the need for wider comprehension of scientific knowledge and of its limits. "I do think it would be good if in talking with our friends in other ways of life we could count on a greater recognition of the quality of our certitudes, where we are dealing with scientific knowledge that really exists and to which we are party, and the corresponding quality of hesitancy and doubt when we are assessing the probable course of events, the way in which men will choose and act, to ignore or to apply, to make hypertrophic or nugatory the technological possibilities recently opened."

Other Academy members who gave papers were: William A. Fowler, H. H. Hess, George Wald, Victor F. Weisskopf, George E. Palade, E. L. Tatum, G. Evelyn Hutchinson, Ernst Mayr, Jerome B. Wiesner, J. B. Fisk, and Fred L. Whipple.

Chairmen of the four scientific sessions were: Roger Revelle, Melvin Calvin, Theodosius Dobzhansky, and George B. Kistiakowsky.

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