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MAX DELBRÜCK

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Max Delbrück, one of the outstanding scientists of this century, died March 10, 1981. Born in 1906, Max was the youngest of seven children. His father, Hans Delbrück, was a distinguished historian and professor at the University of Berlin. Max grew up in a formidable academic environment. The Delbrück neighbors included the Bonhoeffer, Harnack, and Planck families. Although the Delbrück family was intellectual and academic, science was not within their sphere of interest. Max early developed an interest in, really a passion for, astronomy that, if not encouraged, was at least tolerated by his family. His mother made him a special robe for his nightly vigil on the porch with his telescope.

In 1924 Max started at the university at Tübingen intending to study astronomy. His academic studies were rather peripatetic. He was at Tübingen for only one semester, then he went to Berlin, then to Bonn, then back to Berlin, and finally to Göttingen, where he wrote a thesis on the quantum mechanical theory of the lithium molecule. His interest had shifted from astronomy to astrophysics to theoretical physics. He didn't consider his thesis outstanding.

After receiving his PhD in 1929, he spent a year in Bristol, England before getting a Rockefeller Fellowship to work in Copenhagen with Niels Bohr, and then in Zürich with Wolfgang Pauli. It was during this period that Max's interest in biology was aroused. He was attracted by Bohr's speculations concerning the implications of Werner Heisenberg's uncertainty principle for an understanding of the nature of life. Thus, when his fellowship expired in 1932, he took a job in Berlin as assistant to Lise Meitner, in part because it was near the Kaiser Wilhelm Institute for Biology where he subsequently spent much of his time.

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His job with Meitner was to provide theoretical support for Hahn's and Meitner's experimental studies on neutron bombardment of uranium. Like everyone else at the time, Max failed to see the first evidences of nuclear fission among Hahn's and Meitner's results, perhaps because his interest had shifted to biology and to his "moonlighting" activities with N. W. Timofeeff-Ressovsky and K. G. Zimmer at the Kaiser Wilhelm Institute. These studies were attempts to determine properties of the gene from its sensitivity to ionizing radiation. This work was highly technical and not widely known among biologists, but was later referred to in the 1940s in Schrödinger's widely-read little book *What is Life?* (4). Max thus gained a reputation for his work, at least among the readers of the Schrödinger book, many of them physicists wishing to move into biology. It was not until the 1940s and early 1950s, however, that Max helped many physicists make the transition to biology.

In 1937 he was again given a Rockefeller Fellowship, this time to support his study of biology at the California Institute of Technology. He accepted the fellowship, not only because of his desire to pursue his interest in biology, but also because he realized that his academic future in Germany was not promising owing to his outspokenness at Nazi indoctrination camps. At Caltech he spent a short time trying to learn the intricacies of *Drosophila* genetics from A. H. Sturtevant and Calvin Bridges, but soon discovered bacteriophage, the organism that was to occupy him for the next 15 years, and began his collaboration with E. L. Ellis to define the life cycle of a bacterial virus.

His fellowship expired in 1939, but the Rockefeller Foundation helped him get a job at Vanderbilt University and paid half his salary. It was during this period that his collaboration with S. E. Luria, T. F. Anderson, and A. D. Hershey began. The phage workers had begun spending summers at Cold Spring Harbor Laboratory in 1941. The first Cold Spring Harbor phage course was offered in 1945.

In 1947, Max accepted a professorship at Caltech and moved back to Pasadena, which was to be his home for the rest of his life. Although Pasadena became his home, he retained a strong interest in German science. He visited Germany frequently after the war and was for two years (1961–1963) director of the Institut für Genetik at the University of Cologne, an Institute he helped to found.

In the early 1950s, as the field of phage genetics grew, Max's interest in it waned and he made a major change in his research efforts to the nature of the primary transducer processes of sense organs, as manifested in the taxis of the fungus *Phycomyces*. He pursued this research interest to the end of his life.

Undoubtedly, his greatest research accomplishments were the collaborations with Ellis and later with Luria and others on bacteriophage growth and the nature of the mutation process in bacteria. These studies laid the foundation from which the fields of bacteriophage and bacterial genetics grew. What is significant about this work is not so much what was learned as how it was learned. New quantitative approaches to the study of microorganisms were developed—methodologies that allowed the analysis of individual as well as population phenomena and that did not confuse the two. This approach is exemplified by the Luria-Delbrück fluctuation analysis of mutational events in bacterial populations (3). Virtually all bacteriophage and virus experiments now performed are variations on the one-step growth experiment originally perfected by Ellis and Delbrück (2).

It is difficult to appreciate the importance of these contributions, since they are now an integral part of how we conceptualize the behavior of microbial populations. Max's early training in particle physics no doubt helped him in developing these methods. For his bacteriophage work, he received many honors and awards, among them the Nobel Prize in Physiology or Medicine in 1969.

However, Max's major contribution to science was most likely his influence on the numerous scientists with whom he worked. He was considered the father of the phage field and to many he was indeed a very strong and influential figure. He set a vivid example in his quest for scientific understanding, an example that could be, on occasion, unnerving. I can recall seminars (including my own) that Max interrupted with, "I don't understand a word you are saying. Start all over again." His sometimes brusque manner arose from a deep and persistent quest for understanding. His presence at a seminar or meeting insured its success, for his questions were always penetrating and led to meaningful discussions. To Max science was serious business. He had no patience with dilettantes or entrepreneurs. Nor did he care for the busy-work that constitutes so much of scientific activity. If experiments did not help one toward answering the deep questions, for instance the mystery of gene replication, they were not worth doing. He would say just that. He was inclined to make quick and sometimes erroneous judgments; for a time he believed lysogeny was an experimental artifact. Yet often these judgments stimulated others to productive work. The book *Phage and the Origins of Molecular Biology* (1), a collection of articles by molecular biologists close to Max and written for his 60th birthday, contains many anecdotes that document Max's powerful influence on his scientific friends.

Yet his serious dedication to science was but part of a larger appreciation of human values and the quest for understanding. He gave his Nobel award

to Amnesty International, and in his later years spoke out increasingly about the limitations of science.

From this description, Max may appear as a formidable figure and, indeed, he may have appeared so to some, yet those fortunate enough to know him even slightly found him to be a compassionate and sociable man. He loved large parties and practical jokes, and he will be long remembered by the countless postdoctoral students and visitors that he and his wife, Manny, befriended. They opened their home to these wayfarers and customarily whisked them off on camping trips to the desert.

That is how I wish to remember Max: on a camping trip to Double-Surprise Canyon in the Chocolate Mountains above the Salton Sea, with a motley band of hikers, some barely off a plane from Germany or Japan. After an arduous all-day hike through a maze of canyons, Max is finally leading us toward the relative comfort of our campsite. Someone complains about the pace Max is setting. Max does not relent. He simply replies with one word, "Courage," and continues the journey onward.

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