LINUS PAULING

Nobel Prizewinner

The 1954 Nobel Prize in Chemistry goes to the chairman of Caltech's Division of Chemistry and Chemical Engineering for his research into the nature of the chemical bond and the structure of proteins.

Dr. Linus Pauling, Professor of Chemistry, chairman of the Division of Chemistry and Chemical Engineering, and director of the Gates and Crellin Laboratories at Caltech has been awarded the 1954 Nobel Prize in chemistry by the Swedish Royal Academy of Science.

The award is based on Dr. Pauling's "research into the nature of the chemical bond (the forces that hold molecules together) and its application to the elucidation of the structure of complex substances"—probably referring to his researches into the structure of silicate minerals, metals and alloys, other complex inorganic substances, complex organic compounds, and proteins.

The prize, established by the will of the late Alfred Nobel, Swedish inventor of dynamite, includes a diploma, the Nobel gold medal and a cash prize of approximately $35,000. Dr. Pauling has been invited to Stockholm to receive the award in person, from King Gustav Adolph of Sweden, on December 10.

Dr. Pauling is the fourth Caltech faculty member to receive a Nobel Prize. In 1923 the late Robert A. Millikan, Professor of Physics and chairman of the Caltech Executive Council from 1921 to 1945, received the Nobel Prize in physics for his work on the determination of the electronic charge. In 1933 the prize in medicine and physiology went to the late Thomas Hunt Morgan, Professor of Biology and chairman of the Division of Biology from 1928 to 1944, for his research on heredity. In 1936 Carl Anderson, a Caltech alumnus and Professor of Physics here since 1939, won the physics prize for his discovery of the positron.

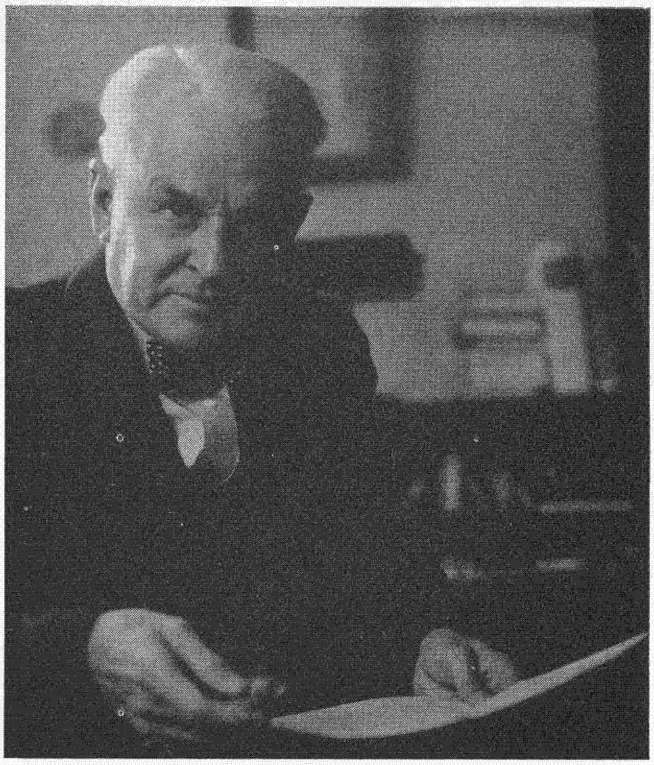
Edwin M. McMillan, another Caltech alumnus (BS '28, MS '29), now Professor of Physics at the University of California at Berkeley, shared the 1951 prize in chemistry with his colleague at UC, Glenn T. Seaborg, for their joint discoveries of six radioactive elements used in the development of atomic energy.

Linus Pauling was born in Portland, Oregon, on February 28, 1901. Both his father and his maternal grandfather were druggists—though this had little to do with his later interest in chemistry, for both men died when Linus was about 9 years old.

He was 11 when he first showed an interest in science, by starting an insect collection. A year later he was an avid collector of rocks and minerals, poring over

THREE FORMER NOBEL PRIZEWINNERS

On Caltech's Faculty



The late R. A. Millikan—1923 prize in physics

mineralogies borrowed from the public library, and copying down tables of the properties of minerals, blow-pipe reactions, luster, streak, and hardness, so that he could identify the minerals he picked up around Portland.

He was first introduced to chemistry at the age of 13 when a school friend, Lloyd Jeffress (now Professor of Psychology at the University of Texas), showed him a couple of chemical experiments. Linus was fired with such enthusiasm that, with the aid of an old chemistry book of his father's, he set up a laboratory of his own in the basement at home, and used it constantly, until he went off to college.

He was 16 when he entered Oregon State College. After two years as a student, he spent one year at the college as a full-time assistant in quantitative analysis. He then returned for two more years of study, and got his BS in chemical engineering in 1922.

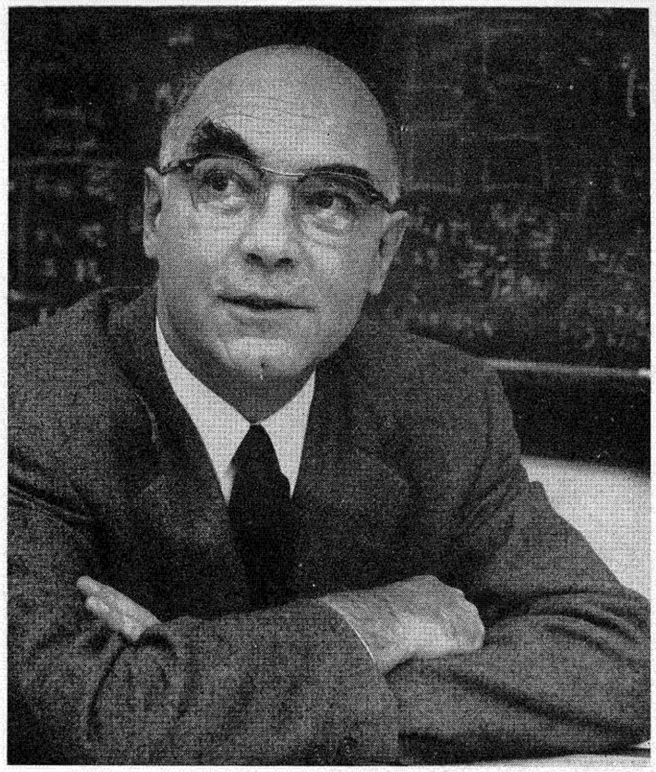
In the fall of 1922 Pauling came to Caltech, on a teaching fellowship, to do graduate work under Arthur Amos Noyes, the distinguished physical chemist who headed the Division of Chemistry here. By then he was interested in the field of atomic structure in relation to the chemical and physical properties of substances. At Noyes' suggestion he began research, with Professor Roscoe G. Dickinson, on the determination of the structure of crystals by X-ray diffraction, at the same time studying and carrying on several researches in theoretical chemistry.

After he got his PhD in 1925 Pauling was still so interested in the physical aspects of chemistry that he considered becoming an atomic physicist. He stayed on at Caltech for eight months as a National Research Fellow, then, on a Guggenheim Fellowship, spent a year and a half in Europe, doing post-graduate research with some of the great theoretical physicists—Arnold Sommerfeld in Munich, Niels Bohr in Copenhagen, and Erwin Schrödinger in Zurich—on the application of quantum mechanics to the problems of the structure of molecules and crystals.

But chemistry was still his chief interest and he came back to Caltech in 1927 as Assistant Professor of Chemistry. He was made a full professor in 1931, when he was only 30 years old. In that same year he was named the first winner of the American Chemical Society's Award in Pure Chemistry, given for the most distinguished research of the year by a young man not over 30.

In 1933 he was elected to the National Academy of Sciences—the youngest member of that distinguished organization at that time. In 1936 he was elected to membership in the American Philosophical Society, and in 1937, after the death of Arthur Noyes, Pauling suc-

The late Thomas Hunt Morgan—1933 prize in medicine



Carl Anderson—1936 prize in physics

ceeded him as chairman of Caltech's Division of Chemistry and Chemical Engineering and director of the Gates and Crellin Laboratories.

His broad fields of interest have covered all branches of chemistry—extending into experimental and theoretical physics in one direction, and into biology and medicine in the other. His work can be conveniently divided into two periods. Up to 1933 his experimental work comprised the determination of the structures of crystals and of gas molecules by the diffraction of X-rays and electrons, respectively, and his theoretical work included the discovery of basic principles concerning the nature of the chemical bond and the structure of molecules.

Throughout the second period, from 1933 to the present, he has devoted himself largely to applying these principles to the problem of the structure of proteins.

In 1934, after having worked for some time with fairly simple molecular structures, such as metals and inorganic compounds, he become interested in an organic substance whose molecule is large and complicated—hemoglobin, the protein that makes red blood cells red. The hemoglobin molecule has a molecular weight of 68,000 (as compared with 18 for water, for instance,) and it contains about 10,000 atoms of carbon, nitrogen, hydrogen, oxygen, sulfur, and other elements.

The hemoglobin molecule is involved in carrying oxygen from the lungs to the tissues. In studying the magnetic properties of hemoglobin, Pauling found that in venous blood the hemoglobin is attracted by a magnet, but in arterial blood it is repelled. This led to a study of the chemical bond between the hemoglobin and the oxygen which it picks up in the lungs, and to considerable new knowledge about the structure of the hemoglobin molecule.

This work on hemoglobin led Pauling to consider the chemical aspects of the field of immunology, and he began to try to understand, in terms of the chemical bond, how antibodies neutralize bacteria, viruses and other antigens to produce immunity. In 1940 he published a theory of the molecular structure of antibodies.

Pauling and his Caltech co-workers went on from the investigation of hemoglobin and antibodies to study other molecular giants that originate in the living system. By 1950 Pauling's applications of fundamental structural principles to the problems of protein structure, carried out in close collaboration with Professor Robert B. Corey, resulted in the prediction of specific configurations of the oxygen-hydrogen-nitrogen-carbon chains that form the backbone of protein molecules. In achieving the first accurate descriptions of the physical characteristics of protein molecules, Pauling and his co-workers opened a new chapter in the investigation of these substances.

Proteins comprise the principal substance of all living material. There are thousands of different kinds of proteins in the human body. Unlike the molecules of most other chemical substances, which consist of a score or two of individual atoms, protein molecules are made up of thousands—sometimes millions—of individual atoms, each occupying a specific place in the architecture of the molecule.

The first great advance toward an understanding of protein structure was made in 1900 when the German chemist Emil Fischer found that proteins are composed of simpler substances known as amino acids. These were found to be linked together into larger groups known as polypeptides.

The problem of determining the structure of proteins then became one of finding the sequence of various amino acids in the polypeptide chain and the way in which the polypeptide chain is coiled.

Protein studies

Instead of trying to study the complicated proteins directly, Pauling and his co-workers, for more than 15 years, have been studying the structure of the amino acids of simple peptides, and of other simple substances related to proteins. By using the information obtained in this way they have been able to predict the essential atomic structure of several proteins, including those found in bone, muscle, and red blood cells.

During the past two years Dr. Pauling has been working on the structure of collagen, the protein that occurs in tendons, bone and skin. It is one of the most important proteins in the human body, for it gives strength and toughness to tissues. There is evidence now that many diseases, such as arthritis, involve some abnormality in the manufacture or structure of this protein.

Pauling and his associates have already found that sickle-cell anemia, a hereditary disease of the blood, arises from abnormalities in the structure of the hemoglobin molecule. Knowledge of the atomic structure of proteins, therefore, promises to be extremely valuable in medical research.

Professor Arne Tiselius, vice-president of the Nobel Foundation, and himself a former chemistry winner, has termed Pauling's achievements "a major contribution to protein chemistry, a field where the slightest theoretical advance can have important consequences in explaining the nature of diseases and bringing a cure for them."

Chemical honors

Dr. Pauling's work has brought him the highest honors that the field of chemistry has to offer. In addition to the Award in Pure Chemistry of the American Chemical Society, which he won in 1931, he has received:

1941—the William H. Nichols Gold Medal of the New York Section of the ACS.

1946—the Willard Gibbs Medal of the Chicago Section of the ACS.

1947—the Davy Medal of the Royal Society of London, and the Theodore William Richards Medal of the Northeastern Section of the ACS.

1948—the Presidential Medal for Merit for his outstanding services during the war to the Explosives Division, the Chemistry and Rocket Divisions, and the Committees on Medical Research and Internal Ballistics of the National Defense Research Committee.

1949—the presidency of the American Chemical Society.

1951—the Gilbert Newton Lewis Medal of the California Section of the ACS.

Academic honors

He has received honorary degrees from 11 universities: including Oregon State, Princeton, Chicago, Cambridge, London, Yale, Oxford, Paris, Toulouse, Tampa and New Brunswick.

He is the author, or co-author, of five textbooks and of close to 300 scientific papers in the fields of chemistry and physics. And, to top off all this professional activity, he is still enthusiastically teaching Caltech's course in freshman chemistry.

Dr. Pauling was married in 1923 to Ava Helen Miller, who was one of his chemistry students at Oregon State. The Paulings live in Pasadena, and have four children: Linus, Jr., 29, is now Resident in Psychiatry at Queens Hospital, Honolulu; Peter, 23, was graduated from Caltech in 1952 and is now doing graduate work at Cambridge University in England; Linda, 22, was graduated from Reed College in Portland, Oregon, last June, and is now also studying at Cambridge; Crellin, 17, is a freshman at Reed this year.

Pauling's statement

When he received notification this month that he had been given the Nobel Prize, Dr. Pauling said:

"The award of the Nobel Prize is a great honor, and I appreciate deeply the action of the Royal Swedish Academy of Science in selecting me to receive the 1954 Prize in chemistry. I am deeply appreciative also of the contributions made by my outstandingly able collaborators in the Gates and Crellin Laboratories of Chemistry of the California Institute of Technology to the work for which the Prize was awarded. I have been fortunate in having been for 32 years a member of the staff of this Institute, where there are unusually favorable conditions for carrying on scientific research.

"I have lived through the interesting period of initial development of the modern science of molecular structure, which might be called molecular architecture. Thirty-two years ago detailed structures were first determined for simple molecules, such as the water molecule. Now the structures of complex molecules, containing thousands of atoms, are being determined. I think that in the next few decades knowledge of the molecular structure of drugs and also of proteins and other constituents of the human body will lead to significant progress in biology and medicine."