The Cultural Values of Science
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Mr. President and Distinguished Members of the Academy,

First of all, please accept my heartfelt gratitude on this splendid occasion for having been honored with the appointment as academician of the world's most prestigious Pontifical Academy of Sciences. I do appreciate the members of the selection committee who recognized my lifelong accomplishments in the area of chemistry. I feel particularly honored to be the sole member who has currently been elected from Japan.

Born in Kobe, Japan, I was educated at Kyoto University to complete my bachelor and then master degrees and immediately became an Instructor at the same university. In 1968 I was invited by Nagoya University to chair a newly created laboratory of organic chemistry. Since then I have stayed there to teach and to conduct research for more than 30 years, while I have been warmly guided and encouraged by many colleagues worldwide. Then, fortunately, I was awarded the Nobel Prize in Chemistry last year.

I am a chemist. One of the major characteristics of our science is that we can design and synthesize any molecules at will, thereby generating a diverse array of molecular functions. We are very proud that our accumulated knowledge can now convert natural resources, including petroleum and biomass, to various chemical substances of a high-added value, thereby contributing to human welfare. Chemistry can generate high values from almost nothing.

My major research interest is in the molecular chirality or handedness. For many molecules, right-handed and left-handed shapes are possible, which are called enantiomers. Two enantiomers are mirror images of one another and have identical free energy. The difference is small indeed. These subtle differences, however, become distinct when these are involved in biological or physiological phenomena. Right-handed and left-handed molecules often smell and taste different from each other. The structural difference between them becomes a serious problem in the administration of pharmaceutical drugs. A compelling example of the relationship between pharmacological activity and molecular handedness was provided by the tragic administration of thalidomide to pregnant women in the 1960s. Right-handed thalidomide has desirable analgesic properties; however, left-handed thalidomide is teratogenic and induces fetal malformation. The actual thalidomide drug, unfortunately, was a 50:50 mixture of right- and left-handed molecules. Such problems should be avoided at all costs.

However, selective chemical synthesis of right-handed or left-handed molecules, called asymmetric synthesis, remained extremely difficult for many years. Early in 1851, some 150 years ago, Louis Pasteur claimed that 'Dissymmetry is the only and distinct boundary between biological and nonbiological chemistry. Then, symmetrical physical or chemical force cannot generate molecular dissymmetry'. Scientifically speaking, this is not true. However, this statement remained valid from a practical or technical point of view until 20 years ago. Therefore, access to pure right- or left-handed compounds has indeed relied largely on biotechnology using microorganisms that contain natural enzymes. However, since biological methods allow for access to only a limited class of substances, an efficient chemical means toward this goal is needed.

We could solve this long-standing problem by inventing efficient man-made molecular catalysts which consist of a metallic element and a chiral organic molecule. In 1966, we discovered the general principle which is now widely practiced in research laboratories and industry. Later we developed a general method to synthesize a wide range of chiral compounds by simply adding a hydrogen molecule to organic substances. Such accomplishments, together with the efforts of other scientists worldwide, have changed the chemist's dream to reality. Application of our original and versatile chemistry has allowed us and other people to achieve a truly efficient synthesis of organic molecules of theoretical and practical importance. Our methods have in fact been utilized for the large-scale production of certain fragrances, antibiotics, and antibacterial agents. Such invention has dramatically changed the processes of chemical synthesis of pharmaceuticals, agrochemicals, flavors, and fragrances among others. The growth of this core technology has given rise to enormous economic potential in the manufacture of precious chemicals. I am very pleased to be involved in contributing to the initiation and progress of this significant scientific realm.

Thank you very much.