

# COMMEMORATIVE LECTURE

## Reaction Mechanism of Bovine Heart Cytochrome Oxidase

Shinya Yoshikawa

*Division of Biochemistry, Department of Life Science, Himeji Institute of Technology, Himeji, Hyogo, Japan*

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As I mentioned at the awards ceremony a little while ago, the work for which I have received the Keio Medical Award is not something that I have been able to accomplish alone; it has involved the cooperation of many scientists. Dr. Tsukihara is Professor of the Institute for Protein Research, Osaka University, and specializes in X-ray crystallography. Dr. Kitagawa and Dr. Ogura, who is here today, work with techniques such as resonance Raman spectroscopy. Dr. Itoh works in my laboratory, mainly on the crystallization of cytochrome oxidase. In addition, we of course need money for our research, and our supporters in this regard have been Core Research for Evolutional Science and Technology (CREST) and New Energy and Industrial Technology Development Organization (NEDO).

On a personal note, I have written here that the research environment is extremely important to me. This is the tenth year since the establishment of the Department of Life Science at the Himeji Institute of Technology, and we are fortunate that a very energetic group of researchers has gathered there. The atmosphere we have is indescribably free and non-restrictive. It is difficult to find words that express how very important the atmosphere at the Himeji Institute of Technology has been to me in carrying out my research.

I have also been fortunate to have had outstanding teachers, and I wish to mention, at first, Dr. Kazuo Okunuki, under whom I studied in graduate school. Unfortunately, he passed away this last May, at the age of ninety-one. Thinking back, I realize that to this day my research has been an ongoing investigation of the theme that was assigned to me as a graduate student in Dr. Okunuki's laboratory. I feel that Dr. Okunuki was important in teaching me what scholarship is all about. Perhaps I could have been a better student and learned more, but I did learn to some extent what scholarship is

all about. The other teacher I wish to mention taught me the importance of chemistry in the study of cytochrome oxidase. I am talking now about Prof. Winslow Caughey, who is currently Professor Emeritus at Colorado State University. In any case, these are the two men I consider to have been my most important mentors.

I wish now to talk about my research. Since we seem to have in the audience today people who are not specialists in the fields of medical chemistry and biochemistry, I will first present a brief introduction on cytochrome oxidase.

As you all know, living organisms eat food and burn it using oxygen, producing carbon dioxide and water as byproducts. The energy that is liberated during this process is used to form ATP from ADP and inorganic phosphate. Since energy is needed to form ATP from ADP, energy is in turn released when ATP returns to inorganic phosphate and ADP. ATP is an extremely important product. Energy in various forms is required for an organism to live, and the energy used in most reactions and necessary physiological processes is supplied almost entirely by ATP. For this reason, ATP is sometimes referred to as the "energy currency."

The combustion of food with oxygen, however, is slightly different from a car burning gasoline in order to run. The most important difference is that no heat is generated when food is burned with oxygen. Energy is liberated without generating heat.

As I just said, the way an organism uses oxygen during this process, for example, how it uses oxygen to burn glucose, one of the main sources of energy, differs from the way a car burns gasoline. An organism uses a variety of roundabout methods to obtain energy without generating heat. This is one such process, where combustion is achieved not through a direct reaction with oxygen but by first adding water to produce CO<sub>2</sub>.

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Reprint requests to: Dr. Shinya Yoshikawa, Department of Life Science, Himeji Institute of Technology, Kamigohri, Akoh Hyogo 678-1297, Japan