Department of Quantum Materials

Max Planck Institute for Solid State Research

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The Sir Martin Wood Prize Lecture

Discovery and functional analysis of novel retinal proteins

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Biography

2002: B.S. Department of Chemistry, Kobe University

2004: M.S. Department of Chemistry, Kyoto University

2007: Ph.D. Department of Chemistry, Kyoto University

2007-2009: Project Assistant Professor, Chemical Resources Laboratory,
Tokyo Institute of Technology

2009-2016: Assistant Professor, Nagoya Institute of Technology

2016-2018: Associate Professor, Nagoya Institute of Technology

2018-present: Associate Professor, The Institute for Solid State Physics. The University of Tokyo

Dr. Keiichi Inoue

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The Institute for Solid State Physics, the University of Tokyo

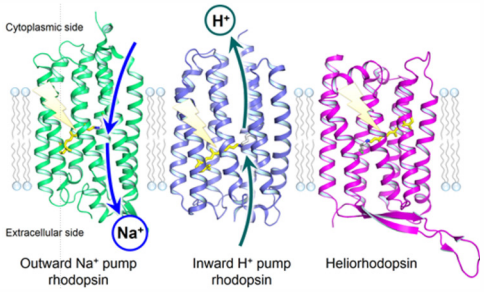
Monday 17th October 2022
4:15 pm, Lecture Hall 2D5

Microbial rhodopsins form a family of photoreceptive membrane proteins in unicellular microbes. In the 20th century, microbial rhodopsins were considered to have a limited range in species such as hyperhalophilic archaea. However, recent genomic and environmental metagenomic analyses identified many thousands of microbial rhodopsins from diverse microorganisms, such as bacteria, archaea, algae, fungi, and even giant viruses, which use sunlight energy for various biological events.

We studied the molecular functional mechanisms of various microbial rhodopsins by time-resolved laser spectroscopy and vibrational spectroscopy to reveal their structure-function correlation. All microbial rhodopsins have the common chromophore, all-*trans* retinal, which isomerizes to 13-*cis* upon illumination. Our spectroscopic studies revealed that the protein moiety of each rhodopsin shows different structural changes in response to retinal isomerization, which leads to different biological function.

We also found many rhodopsin genes having widely different amino acid sequences compared with previously reported ones. As a result, light-driven outward Na^+ pump and inward H^+ pump microbial rhodopsins were newly identified, and their transport mechanism was also revealed.

In 2018, a new distinct class of rhodopsin was discovered by functional metagenomics, and it was named heliorhodopsin (HeR) meaning “the rhodopsin of the sun” in Greek. HeR has an orientation in membrane in which N- and C-termini face cytoplasmic and extracellular side, respectively. This is the opposite to all classical microbial rhodopsins. Furthermore, bestrhodopsin, which is a natural fusion protein between 1 or 2 microbial rhodopsins and bestrophin, forms a gigantic 700 kDa pentameric complex, also found in marine algae in 2022. Bestrhodopsin transports ions through the central pore of the bestrophin domain and it is regulated by the rhodopsin domains in a light dependent manner. The variety of rhodopsins is expected to continue to expand, and many new insights about the essence of protein functionality will be obtained by studying them.



Associate Professor Inoue was awarded the Sir Martin Wood Prize at the Millennium Science Forum which took place in November 2019. The Millennium Science Forum was established in 1998 to promote scientific exchange between Britain and Japan and recognize the work of outstanding young Japanese researchers. The prize is named after Sir Martin Wood, founder of Oxford Instruments

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