Laboratory of Biomolecular Science and Reaction

Institute of Scientific and Industrial Research

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The goal of this laboratory is to elucidate various biological phenomena based on interactions (reactions) between biomolecules and to develop technologies based on their operating principles, thereby contributing to bio-related industries, especially in the development of pharmaceuticals. Specifically, we will investigate the odor/smell discrimination mechanism of human olfactory receptors, the active site of enzymes containing built-in coenzymes structure and catalytic reaction mechanisms, the intracellular and intercellular material transport mechanisms, and the bacterial two-component signal transduction mechanisms.

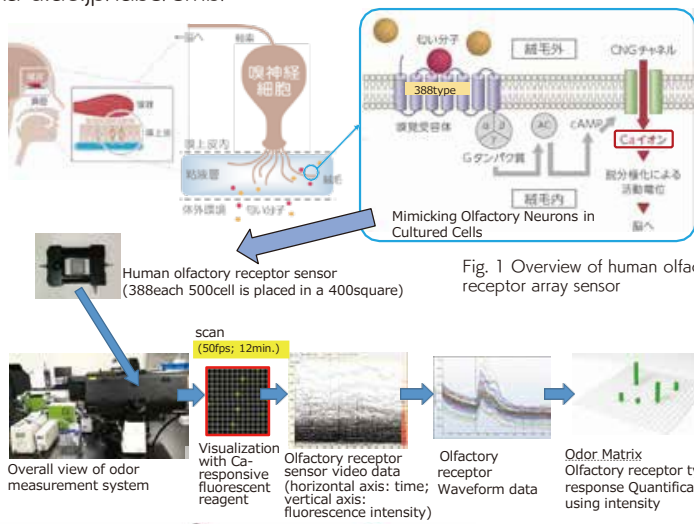

Fig. 1 Overview of human olfactory receptor array sensor

Analysis of odor/scent discrimination mechanism of human olfactory receptor group

Although humans express only about 400 types of olfactory receptors, they can discriminate tens of millions of odors and fragrances. The mechanism of this discrimination is thought to be based on pattern recognition by a group of olfactory receptors with fuzzy odor/smell molecule recognition ability (the concept of olfactory receptor repertoire), but the details of the recognition mechanism are completely unknown. Therefore, we developed a cell array sensor in which all human olfactory receptors are expressed in human-derived cells, and each olfactory receptor-expressing cell is aligned on a glass slide. This reproduces the human olfactory epithelium, in which olfactory sensory neurons expressing human olfactory receptors are present in the nasal cavity. Using this sensor, the responses of all human olfactory receptors can be measured comprehensively and in real time under the same conditions, not only for simple odors but also for complex odors. If the response intensity of each olfactory receptor is analyzed for a wide range of odors and fragrances, it will be possible to elucidate the odor/fragrance discrimination mechanism (human olfactory receptor repertoire) in the human sense of smell ahead of the world. In addition, it is particularly important to emphasize that the response patterns of each olfactory receptor (named odor matrix) output by this cell array sensor can be used to identify all odors and fragrances (from simple to complex odors) perceived by the human sense of smell, with a total of approximately 400 dimensions. It is the only one of the five human senses that has lagged behind in the digital transformation of human olfactory information, and we believe that it will be a fundamental technology for VR and AR in the near future.

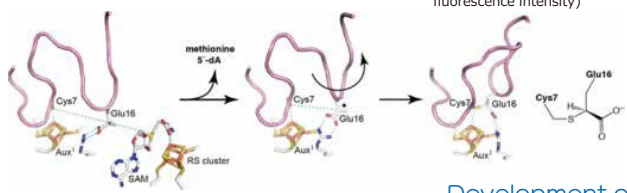

Figure 2 Mechanism of cyclic peptide formation by Rajika SAM enzyme containing iron-sulfur clusters in its active center.

Reaction mechanism and cofactor formation mechanism of built-in coenzyme-containing enzymes

In enzymes such as copper amine oxidase and quinohemoprotein amine dehydrogenase, post-translational modification results in the formation of a built-in cofactor covalently attached to the peptide. The mechanism of the post-translational modification and the reaction mechanism of the active enzyme have been elucidated using structural analysis techniques, including neutron structural analysis, as well as reaction kinetic analysis. We are focusing on the analysis of novel radical enzymes that create intramolecular cross-links in the former.

Molecular Mechanisms and Physiological Significance of Intracellular and Intercellular Material Transport

The spatiotemporal arrangement of components plays an extremely important role in the formation of order in living organisms. Transmission of materials and information inside and outside the cell is carried out by the dynamic trafficking of cellular membranes. We aim to understand how the dynamics of this membrane is realized by molecular devices and how they play a role in the higher physiological functions of multicellular organisms, using the phenotype of genetically engineered mice as an indicator.

Development of novel antimicrobial agents targeting the bacterial two-component signaling system

We are analyzing the two-component signaling system that exists universally in bacteria and molds and is involved in the response to external stimuli, and developing antimicrobial agents that target histidine kinase, the core of the system, based on its three-dimensional structure.

We are only looking for students who truly love research and have the will to work as biotech researchers in academia or industry. We also focus on industry-academia collaboration activities and have implemented some of our research results in society.

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