Laboratory of Supramolecular Functional Chemistry

Graduate School of Science

Professor Hiroyasu YAMAGUCHI hiroyasu @chem.sci.osaka-u.ac.jp

Assistant Professor Yuichiro KOBAYASHI kobayashiy11@chem.sci.osaka-u.ac.jp

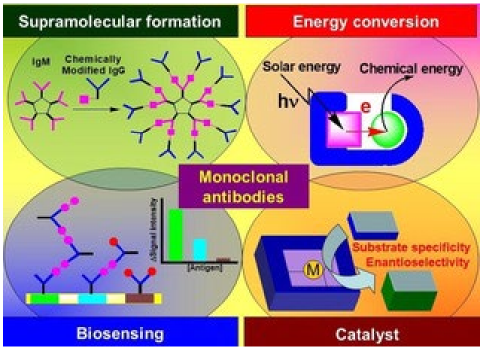
URL: http://www.chem.sci.osaka-u.ac.jp/lab/yamaguchi/

Biological systems express sophisticated and specific functions through various (intra- and intermolecular) interactions. On the other hand, functional molecules have been developed in artificial systems that are not found in biological systems. In this laboratory, we aim to create superior functional materials by combining the advantages of both biomacromolecules (especially monoclonal antibodies) and artificial polymers/low-molecular weight molecules, as well as materials with new functions that have never been seen before. Furthermore, we extract the structural essence of biomolecules at the molecular level, and design and synthesize alternative molecules and polymers. By creating materials that specifically integrate these molecules, we aim to create novel functions.

Creation of functionalized antibodies

The aim is to create new functional materials by introducing the excellent functions of biological systems into artificial systems.

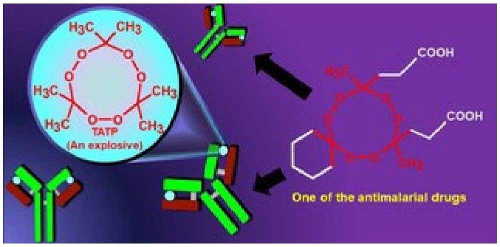
Our research focuses on antibodies with specificity. We have produced chemically homogeneous "monoclonal antibodies" as tailor-made proteins that bind to various functional small molecules. Using these antibodies, we have synthesized novel supramolecular complexes, and by harmonizing antibodies with artificial functional molecules, we have succeeded in imparting functions that could not be expressed by artificial molecules alone. Our goal is to create sensing systems that utilize the superior molecular recognition ability of antibodies, and energy conversion and catalytic systems that utilize the binding sites of antibodies as specific reaction control fields (Fig. 1).



(Figure 1) Functionalization of monoclonal antibodies

Development of a sensor element that specifically detects a certain substance

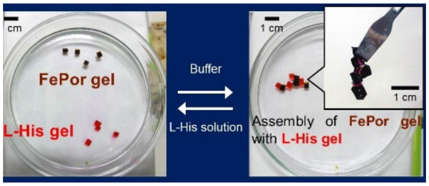
We have prepared a monoclonal antibody that binds to acetone peroxide (TATP), an explosive, by using a stable spirocyclic compound that has a similar chemical structure to TATP as a hapten. When this antibody was used as a sensing element in a biosensor based on the surface plasmon resonance method, TATP could be specifically detected (Fig. 2).



(Figure 2) Generation of monoclonal antibodies that bind to TATP (the compound on the right is the stable compound used as the antigenic determinant of the immunogen)

Functionalization of artificial materials incorporating biological components

In hemoglobin, peroxidase and cytochrome, proteins form complexes with cofactors to express functions such as oxygen transport, redox enzymes and electron transfer, respectively. The coordination of metalloporphyrins, which are cofactors, with certain amino acids in proteins plays an important role. We have synthesized hydrogels in which biogenic iron porphyrins and amino acids (L-histidine) were introduced into artificial polymers, and these hydrogels self-assemble through coordination bonds to construct a pH-responsive material adhesion system (Figure 3). More recently, we have also been studying the control of the function of cofactor-containing proteins by adhering and releasing hydrogels containing the proteins and cofactors, respectively.



(Figure 3) Self-aggregate formation between iron porphyrin gel (black-brown) and L-histidine gel (red staining)

If we can successfully hybridize molecules derived from living organisms and synthetic molecules used in artificial systems, we may discover new functions that were previously unknown.
Experience a new world.

Department of Biological Sciences
Graduate School of Science, Osaka University
1-1, Machikaneyama-cho, Toyonaka, Osaka
560-0043, Japan

TEL: +81-6-6850-5460
FAX : +81-6-6850-5457

Scan here for the lab's website >>