Carbon dioxide emission reduction through bioprocess

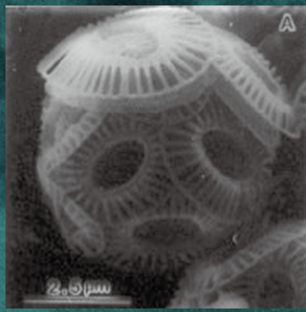
— That's my motivation for my research —

Professor,
School of Engineering
Graduate School of Integrated Sciences for Life

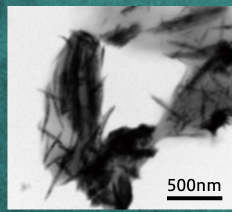
OKAMURA Yoshiko

Field of specialization

Biomineralization, microbial genome



Calcareous alga (Coccolithophore) bearing coccoliths (calcite) instead of cell walls.



Recombinant *E. coli* harboring tellurite reducing activity formed tellurium crystals.

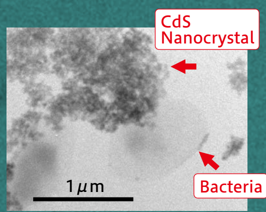
When I was assigned to the laboratory 30 years ago, the first thing my professor said to me was, "In the 100 years since the industrial revolution, the concentration of CO_2 in the atmosphere has increased by 70 ppm. At this rate, it will reach 400 ppm in less than 100 years!" (It was 350 ppm at that time). And I started a biomineralization study to see how much CO_2 could be reduced by photosynthesis and calcification using calcareous algae. Photosynthesis is carbon neutral (the CO_2 converted into organic matter is equal to the CO_2 produced by the use of organic matter), but calcification (the CO_2 precipitated as the calcium carbonate) is a carbon reduction.

I am currently researching bacteria that convert metal ions into compound crystals. My big dream is to find bacteria that can synthesize crystals with the same properties as semiconductor crystals and to replace the semiconductor manufacturing process with bioprocesses in the future, which may significantly reduce CO_2 emissions. Semiconductors are becoming increasingly important in a digitalized society, but reducing CO_2 emissions during the manufacturing process is also an important issue. Should we give up on dreams when they seem impossible? Since I became a researcher 30 years ago, CO_2 has increased by another 70 ppm. If no one does anything, not only will nothing change, it will also get worse and worse.

Faculty members of the Program of Biotechnology of the Hiroshima University Graduate School of Integrated Sciences for Life are developing technology to maximize the fermentation capabilities of microorganisms. We have succeeded in converting CO_2 into organic acids through fermentation and are currently conducting research to convert them into raw materials for chemical products (substances produced through chemical synthesis). Until now, biotechnology has been limited to substances that microorganisms can synthesize, but now that genomic DNA information has become big data, we have entered a new phase where we can use DX and AI technology to create biosynthetic pathways for the substances on demand and soon produce synthetic microorganisms. My other research involves discovering the useful biocompound genes from the genomes of unknown microorganisms and synthesizing new gene sequences based on the genome information. Since many unknown microorganisms are difficult to culture, only a small amount of DNA can be obtained, just enough to determine the genome sequence. Therefore, we need to develop new technologies to synthesize DNA from sequence information. My research style is backcasting, so I first define what I want to make and then synthesize new DNA sequences from large data sets.

The idea of using CO_2 as a resource has been around for a long time, but it was just a dream of some scientists. However, it is now possible to convert CO_2 into ethanol and to make polyester, which is commonly used in clothing, from ethanol. Making things from CO_2 without using petroleum will ultimately lead to carbon reduction. The world is on track to achieve this feat by 2050. I would like to continue my research with the next generation of researchers toward a future where products can be made from CO_2.

Bacterial samples were collected at seashore. Different bacteria will be isolated from same samples depending on the student doing the work. Professor Okamura says, "The fact that there are endless patterns and diversity makes bioresearch both difficult and interesting."



〈Background photo〉
Cadmium recovery by bacterium. It can form cadmium sulfide quantum dots.

Scholarship system for female graduate students in science and engineering fields

Hiroshima University Fellowship for Female Graduate Students in Science and Technology

Female doctoral students (D1 to D3) who are motivated to play an active role in science and technology fields are selected as STEM Female Research Fellows and receive stipends (equivalent to living expenses) and research funding. With the fellowship, we provide an environment where students can concentrate on their research. Furthermore, we also provide support to master's degree students who have the desire to advance to the doctoral program, and if students receiving support advance to the doctoral program at our university, they are guaranteed STEM Female Research Fellow positions.