S-face

SFC makes the future through researches

Systems biology

elucidating the cardiogenesis

Hitomi Sano

×

VOL.
008/100
2015.Oct ISSUE
Japanese Color: MIKANCHA-iro

Giving back to society with the output of mathematical models

"What is life?" This is the eternal question that has been raised by bioscientists around the world, past and present, and the pursuit of the answer continues in our world even today.
In recent years, the field of life sciences has undergone surprisingly rapid changes and taken significant steps forward, including advancements in genome analysis and the birth of induced pluripotent stem (iPS) cells.
However, even such advancements in bioscience are built on a foundation of the results of quiet and steady fundamental research about individual cells and the dynamics of a single molecule.
One of the examples of such fundamental research is the establishment of mathematical models through systems biology, with a focus on cardiogenesis, being undertaken by Assistant Professor Hitomi Sano.

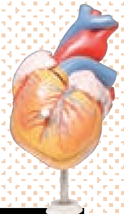
Focusing on the heart, which changes dramatically without ever stopping

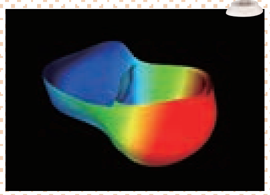
I specialize in systems biology, which is typically recognized as an academic field that seeks to understand life phenomena as a system. However, experts of this field have different research subjects and topics of interest. For this reason, the definition of "systems biology" itself differs depending on the expert. Nevertheless, this is precisely what we could describe as one of the characteristics of systems biology.
To me, systems biology is an academic discipline that takes cells as the subject of study, and explores the relationship between how the dynamics of the molecules such as metabolites and proteins and ions in cells maintain the functions of the cells. Hence, depending on the subject of study, there are also cases where we focus on how the dynamics of an organ contributes to the functioning of an individual, for example, to his/her health.
Specifically, I conduct research into the process in which the heart is created in the fetus of laboratory animals. The process in which a fetus, and the organs of a fetus, matures into the shape and size of an adult, is known as "development." I focus on the study of cardiogenesis, or how the heart is developed. My interest lies in the systems of the organ that we call the "heart," which plays the role of circulating blood around the entire body while undergoing dramatic changes in shape and size, yet never once coming to a stop.

Building mathematical models of cardiogenesis

The proteins that are specifically present in the cells that make up the heart of a fetus do not exist in the heart of an adult. However, these proteins have been known to reappear even in adults, in cases where the heart has experienced cardiac arrest or other problems.
Today, attempts are being made to transplant heart tissue created from induced pluripotent stem (iPS) cells, and clinical trials on human beings have commenced. We now know that the changes observed during the culturing process, in which the cells of the heart are reproduced through iPS cells, share many commonalities with the process of natural cardiogenesis.
In light of that, we considered that it would be possible to build a comprehensive cell model by building a mathematical model that replicates the process of cardiogenesis, and is able to describe the dynamics and system of artificial cells created from diseased hearts or stem cells. That is the project of building a comprehensive cell model that replicates the process of cardiogenesis, which I am currently working on.
Going forward, I aim to move forward on my work to build a mathematical model for cells by further strengthening my collaboration with the team at the Institute for Advanced Biosciences of Keio University in Tsuruoka City, Yamagata Prefecture, that is conducting metabolome analysis, said to be the most cutting-edge analytical technology, as well as the team at Fujisawa Laboratory for Advanced Biosciences that is conducting experiments using iPS cells.

Computer Simulation





The mathematical formula used to describe a single cell that makes up the heart stretches over 30 A4-sized pages. Based on this, the development of the heart is simulated by changing the constants and parameters.

Cooperation

By further strengthening collaboration with the Institute for Advanced Biosciences, a bioscience research institute established at the Tsuruoka Town Campus (Tsuruoka City, Yamagata Prefecture), and with the Fujisawa Bioscience Laboratory, she aims to move forward on building mathematical models based on OMICs data.

Output

A joint project in the field of design has commenced through an inter-disciplinary collaboration that is characteristic of the Keio University Shonan Fujisawa Campus (SFC). There are growing expectations toward the future development of this project, such as how 3D graphics are applied to academic output.

Giving back to society the output from my research work

The output of scientific research mostly appears as English papers that are submitted to internationally recognized academic journals. However, I have recently been considering the possibility of giving back to society the results of scientific research in formats other than as academic papers.
During the course of my doctoral studies, I was mentored for 1 year by the bioscientist, Professor Akinori Noma (in 2007, he was a professor at Kyoto University). He had often spoken of his desire to achieve a level of computer simulation that could provide the knowledge written in thick textbooks about bioscience, to everyone in a way that was easy to understand. Studying under Professor Noma taught me that there was also an educational aspect to the work of conducting computer simulations of complex life phenomena.
Hence, in the future, I aim to engage in numerical simulations that describe life phenomena in mathematical formula, and give back the results of these simulations to society not only through academic output, but also widely in other forms.
The findings obtained through physiological experiments that are used as reference in building mathematical models involve the injection of massive research funds. I believe that researchers engaged in bio-simulation research have the duty to integrate these findings into mathematical models and give back to society in a way that can be easily understood by everyone. As a part of that, I plan to participate in joint projects in the field of design in the future.

Profile
Hitomi Sano
Assistant Professor, Faculty of Environment and Information Studies, Keio University.
She has completed the Doctoral Program at the Graduate School of Media and Governance at Keio University. She is a member of the Physiological Society of Japan. Her specialization includes systems biology and bio-simulation.

Please visit S-face website for details!

There are more articles and video of Hitomi Sano.

S-face | Search

Keio Research Institute at SFC
Office of Research Development and Sponsored Projects,
Shonan Fujisawa Campus, Keio University
5322 Endo, Fujisawa, Kanagawa, 252-0882, Japan
Tel: +81-(0)466-49-3436
E-mail: info-kri@sfc.keio.ac.jp