

Achievement Report 2008

This is the second year of the Global COE Program entitled “Frontier Biosciences: Strategies for survival and adaptation in a changing global environment,” led by Professor Ko Shimamoto. The program has continued successfully from last year. Its aims, which are being accomplished under close international cooperation, are to 1) promote scientific activities which will contribute to our understanding of how organisms survive and adapt in a changing global environment, 2) train young scientists who will make internationally recognized achievements in the future, and 3) contribute to society’s quest for solutions to global food and environmental problems. At the end of 2007, three new Special Research Groups were established. All three groups initiated their research activities this year and are already accumulating substantial results which are covered in this Achievement Report.

I Research Programs

GCOE International Symposium



The Third Global COE International Symposium, on cell signaling, was held on November 13-14, 2008 in Millennium Hall, NAIST. The aim of the Symposium was to foster international and regional research co-operation, particularly between the tripartite working group comprising the Institute of Genetics and Developmental Biology, Chinese Academy of Sciences (CAS-IGDB, China), the College of Biological Sciences, University of California, Davis (UCD-CBS, USA) and NAIST’s Graduate School of Biological Sciences (NAIST-BS, Japan). Eleven eminent international scientists, including four from overseas and two from NAIST, were invited to give presentations on their current research. The theme of the Symposium concerned various biological phenomena that are based on cell signaling: cell movement and adhesion, planar polarity, molecular transport within the cell, intracellular signal transduction, apoptosis, self-incompatibility in plants, pollen tube attraction, and genome-wide analysis of protein phosphorylation. Approximately 380 participants attended the Symposium, including students from the preceding GCOE International Student Workshop who presented their work in a poster session.

Professor Shimamoto opened the Symposium, beginning a two-day meeting filled with presentations of interesting new findings, each followed by questions from the



audience that often stretched the timetable. In her closing remarks, Professor Carol Erickson (UCD-CBS) reviewed the international activities that have taken place between CAS-IGDB, UCD-CBS and NAIST under the GCOE program - including this Symposium and the International Student Workshop - and encouraged further interaction and co-operation in the future.

GCOE International Mini Symposium (International Workshop)

Two workshops titled “GCOE Workshop with a world distinguished scholar” were held to stimulate active discussions related to the studies of NAIST’s young researchers.

GCOE Workshop for Young Researchers with Dr. Scott Gilbert



A GCOE Workshop with the distinguished scholar Professor Scott Gilbert was held at NAIST on October 16, 2008. Prof. Gilbert is best known for his textbook *Developmental Biology*. In the Workshop, he provided a valuable chance to hear about developmental biology, evo-devo, environmental response and eco-devo. Seven young researchers from NAIST gave stimulating presentations on their current work on morphogenesis, organogenesis and body patterning during animal development. Approximately 40 participants attended the Workshop.

GCOE Workshop on Plant Photosynthesis and Environment

A GCOE Workshop with the internationally respected biologist and author of many influential articles and reviews in the field of plant photosynthesis and environment, Professor David Kramer of Washington State University, was held with elite researchers within Japan at NAIST on March 4, 2009.



Prof. Kramer is well known for his pioneering work on the regulation of electrochemical potential across thylakoid membranes in plant photosynthesis. This Workshop stimulated a lot of questions and discussions on theoretical and practical aspects of the measurement of electrochemical potential in plant leaves *in vivo*.

Hosting GCOE Seminars

A total of 81 seminars were held this year. Thirty-two researchers from home and 49 researchers from abroad (including 22 Japanese) presented their work.



Establishing GCOE Special Research Groups

All three new Special Research Groups were fully operational by the end of last year, and their initial results are summarized below.

Developmental Morphology Research Group: Associate Professor Mitsuhiro Aida, Assistant Professor Seiji Takeda

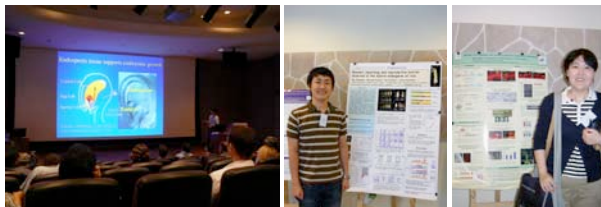
Our group is focusing on the function of the shoot meristem, a stem cell-containing tissue that plays a central role in the formation of shoot organs such as leaves, stems and floral organs. In *Arabidopsis*, shoot meristem initiation requires activities of the redundant transcription factors CUC1, CUC2 and CUC3. To understand how shoot meristem initiation is regulated, we identified a number of downstream genes whose expression is activated by CUCs and functional analysis of these genes is underway. One of them encodes a nuclear protein with unknown biochemical function, and we found that ectopic expression of this gene induced ectopic meristem formation in flower buds (Figure), indicating its pivotal role in meristem formation. By analyzing further the function of this gene and its interaction with CUCs and other downstream genes, we hope to understand the key mechanism that underlies the shoot meristem initiation.



(Left) Wild-type *Arabidopsis* flower.
(Right) Overexpression of a *CUC1* downstream gene causes abnormal flower phenotype.

Plant Reproductive Genetics Group: Associate Professor Tetsu Kinoshita, Assistant Professor Ryo Ishikawa

Our group aims to elucidate epigenetic phenomena during sexual reproduction and subsequent seed development in rice and *Arabidopsis*. In particular, we focus on the mechanism of genomic imprinting that is established by DNA demethylation before fertilization. As a result of differential epigenetic modification of parental genomes, imprinted genes are unequally expressed between the maternally and paternally derived alleles after fertilization in the endosperm. Recently, we found that a mutation in the *ALAC1* gene, a conserved histone chaperone gene, controls maternally expressed

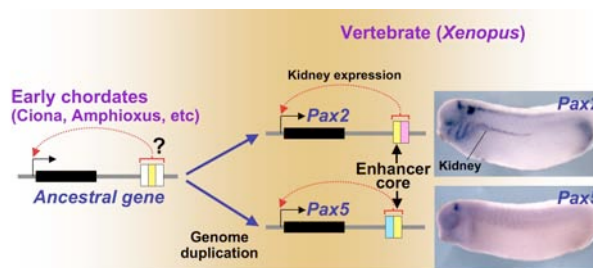


imprinted genes and affects DNA demethylation of those genes. In addition, several hypotheses including ours predict that this kind of epigenetic regulation provides a genetic framework for the post-hybridization

barrier in the endosperm. We are testing our working hypothesis using inter-species crosses in rice. These studies were presented at the EMBO Workshop on Genomic Imprinting, held in Singapore, as an invited talk and poster presentations (see pictures).

Developmental Genomics Research Group: Associate Professor Hajime Ogino, Assistant Professor Haruki Ochi

Vertebrate genomes have many paralogous genes that evolved from common ancestral genes by genome/gene duplication. Genes in a particular paralog group often show overlapping but distinct expression, implying that their *cis*-regulatory mechanisms are partially conserved. To reveal mechanisms that either generate or restrict *cis*-regulation diversity, we are studying the regulation of a group of paralogous genes, *Pax2/5/8*, that are involved in eye, ear, brain and kidney development, using high-throughput transgenesis technology in *Xenopus*. During this year, we discovered that the difference between *Pax2* and *Pax5* enhancer activities depends on gene-specific sequences flanking core sequences that are conserved between these two enhancers. This finding was presented at the 16th CDB meeting, *Cis*-sequence Regulation and its Evolution (September 29 - October 1, 2008, Kobe, Japan).



Employing Young Researchers from Overseas

This year, three new overseas researchers were hired, and a total of seven International Research Fellows are now pursuing their projects. As well as conducting research, the Fellows also participated in the Summer Camp (see section II, Summer Camp) where they helped to assess the students' performance and progress. One of the seven became an Assistant Professor at NAIST.



Hosting GCOE Colloquia

Twelve colloquia were held during the year, including four by researchers from UCD-CBS (Profs. Kazuhiro Shiozaki, John Roth, David Segal and Stacey Harmer) and two by researchers from CAS-IGDB (Profs. Xiaofeng Cao and Zhiheng Xu).



Inviting Distinguished Researchers

Three distinguished scholars were invited to exchange opinions with and give guidance to students and young researchers. They also gave colloquia to communicate their new research findings. Two meetings entitled "GCOE Workshop with an Internationally

Distinguished Scholar” were held for in-depth interactions with young researchers .

Sending Young Researchers to Overseas Laboratories

Three young researchers were sent to overseas laboratories for periods of two to four weeks. They focused on improving their English ability, promoting collaborative research and learning new experimental techniques.

Funding for Young Researchers

Research grants of JPY200,000- 1,500,000 were awarded to 40 assistant professors and International Research Fellows after their research projects had been evaluated.

Supporting Presentations by Young Researchers at International Conferences

Seventeen assistant professors and postdocs were given financial support to participate in international conferences in 10 countries. Two of them gave oral presentations.



II Education Programs

Funding Young Researchers and Students

Fifty-eight doctoral course students were employed as GCOE research assistants (RAs) this year. Nineteen outstanding students who were selected after an evaluation of their research projects, and ten privately funded overseas students, were employed as GCOE Special RAs. A total of nine GCOE postdoctoral fellows (PDs) were employed this year: two received extensions from last year and seven were new postdoctoral fellows who had just received their doctoral degree from NAIST-BS. Two of these nine GCOE-PDs were selected as GCOE Special PDs.

International Student Workshop



The second International Student Workshop was held at I&I Land in Shijonawate from November 10 to 13, 2008. A total of 31 graduate students (11 from UCD-CBS, 10 from CAS-IGDB, and 10 from NAIST-BS) participated in the Workshop. Students presented their studies in English and discussed each other’s research results. The three groups interacted strongly with each other, both academically and culturally. Students from the US, China, and Japan shared communal Japanese-style bedrooms, ate meals together and bathed together in public baths. During these four days in a secluded

environment, the students were able to establish close and friendly relationships and to enjoy stimulating cultural exchanges.

Summer Camp

The annual Summer Camp took place from August 27 to 29, 2008 at Awaji Yumebutai International Conference Center, where research presentations and discussions were held with 75 doctoral students, 27 pre-doctoral master's students, and 59 faculty members. As they were last year, all oral and poster presentations were in English. Lectures given by an invited speaker, Prof. Kozo Kaibuchi of Nagoya University School



of Medicine, and three assistant professors from NAIST-BS were also in English, so that the entire Camp resembled an overseas international conference. At the end of the Camp, a high-rating review was given by an external evaluation committee comprising Profs. Kentaro Inoue of UCD-CBS, XiaoFeng Cao and Zhiheng Xu of CAS-IGDB, and Takayuki Kochi of Kyoto University.

International Lectures (Intensive Course)

During the year, three lecturers were invited from UCD-CBS and Cornell University and they gave intensive seminars for two days to small groups of doctoral students.



International Seminar (Overseas Studies for Students)

Eight students received financial support to perform research in laboratories overseas. They achieved substantial results in communicating in English, contributing to joint research and learning experimental techniques.

International Seminar (English for Science and Technology)

Twenty-four students were sent to UCD-CBS and UCD's English Training Center in January and February to develop their listening and conversation abilities for scientific discussion. They received and participated in seminars at UCD, and conducted presentations and discussions in host laboratory seminars.

Supporting Presentations at International Conferences

Thirty-five doctoral students were given financial support to participate in international conferences in nine countries. Four of them gave oral presentations.



III International Network

Through the Global COE Program, NAIST-BS is developing strong interactions with UCD-BS and CAS-IGDB. In the International Student Workshop (section II, above), for example, 21 Chinese and US students presented their research, participated in discussions and exchanged their ideas with NAIST-BS students. Many internationally recognized researchers were invited to participate in workshops, colloquia, seminars and lectures at NAIST, all of which has laid a strong foundation for further international cooperation in the future.

IV Achievements

A total of 161 papers were published from NAIST-BS this year, and 153 were in English-language journals. Of the 161, 146



were published in peer-reviewed journals; several were published in very high-quality journals such as *Nature* and *Science*, and more than 18 were published in journals having impact factors above 9.0. Some of these papers received wider coverage in newspapers and television programs. Doctoral students were first authors of 31 papers. Altogether, 124 members of the School presented their results at overseas conferences this year, and 379 presentations were given at domestic conferences. Doctoral students gave 40 and 154 presentations at international and domestic conferences, respectively.