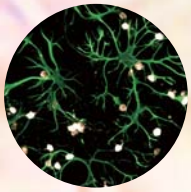
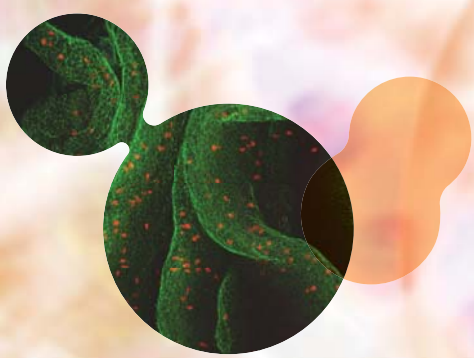




# GRADUATE SCHOOL OF BIOSTUDIES,

## KYOTO UNIVERSITY



2015

# INDEX

## GRADUATE SCHOOL OF BIOSTUDIES

# INDEX

# Greeting from the Dean of the Graduate School

**Dean: ISHIKAWA, Fuyuki, MD, PhD**

## ESTABLISHMENT AND HISTORY OF THE GRADUATE SCHOOL OF BIOSTUDIES

Life Science is the study of life in all of its forms and complexity. It encompasses the totality of life forms from viruses and bacteria to human beings, and its analyses involve molecules, genes, cells, tissues, living organisms, and eco-systems in diverse phases. Life is not a "molecular machine". Therefore, it is necessary to bring the context of life into the research effort. It requires using various approaches, various disciplines, and various fields of study. In addition, those who wish to excel in the life sciences must bring to their studies a strong sense of ethics. Biostudies researchers must be more than manipulators of molecules.

Those trained in specialized disciplines within agriculture, medicine, and pharmacology, where studies in the life sciences were traditionally pursued in the past, have independently contributed greatly to the current knowledge base. These accomplishments notwithstanding, it is manifestly essential for researchers to place their work within the whole framework of "Life" and to encourage each other as people who love life. With such needs and expectations both internally and externally, the Graduate School of Biostudies was established in 1999, to engage in 21st Century Life Science as a comprehensive science.

It has been 17 years since the school was established. In that time, we have accepted numerous students and have sent into society graduates who were raised to be outstanding researchers through the leadership of our former deans, Kanji Ohyama, Mitsuhiro Yanagida, Kayo Inaba, Eisuke Nishida, and Shin Yonehara. Simultaneously, we have published many cutting-edge research findings.

In 2001, we were selected as an educational base of the MEXT Center of Excellence Formation Project (COE). This experience lead us to be selected as one of the schools of the 21ST Century COE Program (21 世紀 COE プログラム) in 2002. Furthermore, we were selected as a school of the "Initiative Project for Attractive Education in Graduate School (魅力ある大学院教育　イニシアティブ事業)" and the "Support Program for Education Reformation of Graduate School (大学院教育改革支援プログラム)" in 2006 and in 2008, respectively.

We are proud of our educational program. With support from a variety of projects, we have been diligent to provide bold and efficient curriculums that reflect the students' feedback and discussions with teaching staff and administrators, who are passionate to improve the graduate education system. We attach particular weight to nurturing students' autonomous attitudes, allowing students to develop their own thoughts and originality, to have their own voice and points of view presenting their own ideas, and to solve problems with innovative approaches. New discoveries arising from their daily training should be shared at the global level. With this goal in mind, a foreign professor, who is a native English speaker and experienced in Life Science research, instructs students to improve their discussion, writing, and presentation skills. Students are encouraged to present their research at international meetings, and dissertations are now accepted in either Japanese or English.

Our research has been frequently cited and is ranked at the forefront of the global scene. Our faculty, who have diverse backgrounds, explore new directions of research, sharing their own knowledge, skills, and ideas with frank discussion in the appropriate forums of the public and research environment. We are actively collaborating with private/public sectors and are attracting competitive external public funding for research. At the same time, we strongly hope that the fruits of our research will contribute to social happiness.

Most of our laboratories are located at the South Campus and the North Campus, improving their research

and education in the respective research complexes. Despite the physical distance between the campuses, the graduate students and teaching/administrative staff communicate closely, while upholding the tradition that respects diversity and free-ranging inquiry. This has also engendered a friendly and lively atmosphere to encourage each other.

All in all, we are pioneering a new Life Science with hope and responsibility. We recognize our responsibility and are full of hope and confidence that we can reach our goals. Although we are still a young organization, or perhaps because we are a young organization, we will do our best to bring our school mission and the research fields listed below to fruition. We sincerely appreciate your further support.

## The three goals of the graduate school

**(1) Provide education for pursuing the new biostudies at the world's top level**

To meet the demands of the industry, college, research institutes and administrative organizations, individuals are educated in the life sciences and master the techniques for the society needs.

**(2) Train individuals to apply the new life sciences for the protection of the global environment and for human welfare**

Integrate the knowledge and technology in the old fields of science, agriculture, medicine and pharmacology, and nurture individuals who can contribute to the human society in the 21st century.

**(3) Nurture individuals who can understand the various vital phenomena of the living organisms as a systemic function, and pursue these systemic functions**

Nurture individuals who will be leaders in the human society to pursue their activities for the welfare and happiness of humans in the 21st century, where humans will be living in harmony with other living beings.

In order to meet the demands of the changing society in the 21st century, which will be impossible to cope with in the current research academic system for the life sciences, a new research and education system is installed to breakdown the walls that have hindered the research in the life sciences in the past. There are two courses in the Graduate School of Biostudies.

(1) The Division of Integrated Life Sciences: cell development, cell growth, genetic information and cell cycle regarded as a multicellular system, and the totipotency, the mechanism of signal transduction and the responses among the cell, living being and environment.

(2) The Division of Systemic Life Sciences: neuroscience, animal development and physiology, immunobiology and others.

## AIMS OF THE GRADUATE SCHOOL OF BIOSTUDIES

**(1) Training of individuals with the most advanced knowledge of the life sciences for the next generation**

The graduate student studies a higher level of life sciences beyond the structures of past life science-related fields at each undergraduate level to understand the integrated life sciences. The goal is to nurture a new type of individual with creative and innovative abilities to cope with the various unknown themes to be confronted by human beings in the next generation.

**(2) Training to establish self for society**

In the Graduate School of Biostudies, individuals are trained to make a healthy and fair judgment based on the academic background of the staff and their prospects for the future; and, establish a new system to evaluate the effects of education from multiple aspects from the past.

**(3) Activation and flexibility of staff in the human relations**

Research is pursued by each staff member independently to develop a new life science based on active exchange among the various laboratories in the graduate school.

**(4) Use of current post-doctoral system and evaluation of academic activities**

Full use should be made of the current system, to provide the increasing necessary number of instructors per student, for the intensive training to become life scientists at an international level, for true development of a new research field.

# Policy

## Admissions Policy

Mission and Desired Student Profile

As an advanced discipline that holds the key to the future of humankind, the life sciences are currently undergoing a major evolutionary change. The Graduate School of Biostudies was inaugurated in 1999 as the first independent school of its kind in Japan with the mission of accelerating this global trend, building a world-class center for research, and training the human resources to lead the life sciences field into the next generation. Our school has engineered a fusion of cutting-edge areas in several existing fields and harnessed the common languages of cellular and molecular biology and genetics that together articulate the principles of life. Furthermore, it has developed an integrated understanding of diverse life forms and the environments they help shape, and has launched innovative efforts in research and education that will define a new set of values for the future and dignity of life.

To meet the diverse expectations of society for advances in life science, which is becoming increasingly sophisticated and complex, the Graduate School of Biostudies endeavors to cultivate human resources with the following attributes.

1. Researchers ready to shed fresh light on, and discover, the fundamental principles of life and pursue world-class research in new areas of the life sciences
2. Researchers and advanced engineers committed to global environmental conservation and gains in human health, welfare, and well-being, and ready to make social contributions through roles in public and private research institutions
3. Educators and working professionals with a broad-based understanding of the varied phenomena of life in general and ready to make social contributions through roles in education, industry, the news media, and government

We seek students from a broad spectrum of backgrounds who share our values and desire to continue their education through our programs. We especially welcome students who are both knowledgeable and free of preconceptions, and possess the pioneering spirit to help propel the comprehensive and advanced branches of the life sciences into new territory, while appreciating the dignity of life.

## Curriculum Policies

1. The master's program provides a broad education spanning all domains of the life sciences, and cultivates a foundation of competence for occupations that demand research abilities and advanced expertise in specialized fields.
2. The doctoral program endeavors to impart cutting-edge specialist knowledge backed by diversified academic research, and to cultivate independent researchers who can perform well in an international setting. Additionally, it equips advanced professionals with the knowledge and skills required for occupations in specialized fields as well as the ability to integrate those strengths and assume leading roles.
3. Students develop the ability to accurately place their own research into perspective with their specialization, discuss and debate the findings and their significance in an international setting, and build frameworks for collaboration, as necessary.
4. The curriculum is organized and implemented so that students can apply broad visions to put their own research into perspective, build systems of knowledge, and pursue cross-disciplinary study unencumbered by existing fields of specialization. This approach lays the groundwork for the creation of new knowledge with which students will be ready to tackle unknown fields with a tireless spirit of innovation.
5. As they pursue their research at deeper levels, students develop the power to reflect on their own research with firm ethical integrity and a strong sense of responsibility, and continually inquire whether it is consistent with the harmonious coexistence of humanity and nature.

## Diploma Conferral Policies

1. To be eligible for a degree, candidates in the master's program must be: enrolled for a mini-

mum of two years; complete courses offered by the School, lab experiments, and practical training; and attend seminars offered by the laboratory to which they belong. Candidates need to acquire at least one credit hour in required subjects, nine credit hours in elective subjects, and 20 credit hours in lab experiments, practical training, and seminars. Candidates also must pass a thesis review and examination administered by the School. To pass the review, the thesis must be logically and consistently written, and must detail new discoveries or initiatives that will contribute to insights and advances in the life sciences.

2. As tangible benchmarks for successful completion of the master's program, candidates will be expected to demonstrate that they have acquired a wealth of scholarly knowledge and insight, research ability in their field of specialization, and the foundation of competence for occupations that demand advanced expertise.
3. Doctoral degree candidates must be enrolled for a minimum of three years as well as complete courses offered by the School and seminars offered by the laboratory to which they belong. Candidates need to acquire at least one credit hour each in required and elective subjects and eight credit hours in seminars. Candidates also must be granted research guidance approval and pass a dissertation review and examination administered by the School. The doctoral dissertation must be logically and consistently presented, and must detail new discoveries or concepts that contribute to understandings and advances in the life sciences.
4. As tangible benchmarks for successful completion of the doctoral program, candidates will be expected to show that they have acquired the skills and expertise to engage as independent researchers or lead careers in advanced professional occupations.
5. As another important criterion for consideration upon completion of their program of study, doctoral candidates will be evaluated to determine whether they have pursued their research with firm ethical integrity and a strong sense of responsibility, and have confirmed that their research contributes to the harmonious coexistence of humanity and nature.

Doctoral candidates that excel in their research performance may be deemed eligible for a one-year minimum enrollment requirement instead of the three-year minimum mandated in item 3 above.

# Education curriculum and How to enroll

## Educational Philosophy

We expect to develop the next generation of interdisciplinary leaders in the field of life sciences by providing the best academic research environment under the supervision of the finest graduate educators and PhD advisers. We emphasize the importance of the accomplishment of a research endeavor as well as academic performance in lecture, seminar, and laboratory practice. At the same time, the students are trained to discuss and debate scientific matters and research outcomes. Students are also trained to have a broad outlook and flexible thinking in life sciences, and are encouraged to travel to international scientific meetings.

## "Global Frontier in Life Science"

The Graduate Schools of Biostudies and Medicine offer "Global Frontier in Life Science", a joint educational program for Doctoral and Master's students as part of K.U. PROFILE (Kyoto University Programs for Future International Leaders: http://www.opir.kyoto-u.ac.jp/kuprofile/). This program, "Global Frontier in Life Science", is held entirely in English, including the entrance examinations, lectures, experiments, and discussions.

International as well as domestic students are welcome. In particular, the program welcomes those who show a respect for life and a desire to create a comprehensive and cutting-edge field beyond existing disciplinary boundaries in life sciences.

### 1) Doctoral Program in "Global Frontier in Life Science"

The two graduate schools hold independent entrance examinations for this program, and accept up to ten applicants. Our entrance examination for the Doctoral program is held in July. The guidelines for admission are posted in April on our web site (http://www.lif.kyoto-u.ac.jp/e/). The academic year starts on October 1st or April 1st for those who cannot obtain a "college student visa" by the end of September. Thus, applicants can select the starting date of either October 1st or April 1st in the next year. At the time of application, prospective students must identify which laboratory head will direct their doctoral research. Applicants can apply for only one lab. **Thus, applicants must contact the lab head and fully discuss potential research activities and availability before filing the application.**

Admission examinations for the Doctoral program consist of a documentation screening and an oral examination (interview) to evaluate applicants' knowledge of their field, research competency, logical thinking skills, and the ability to discuss science in English. **Please note that applicants are NOT required to be physically present in Japan for the examination.**

### 2) Master's Program in "Global Frontier in Life Science"

Our entrance examination for the Master's program is held in July. The guidelines for admission are posted in April on our web site (http://www.lif.kyoto-u.ac.jp/e/). The academic year starts on October 1st or April 1st for those who cannot obtain a "college student visa" by the end of September. Thus, applicants can select the starting date of either October 1st or April 1st in the next year. Applicants to the Master's program can apply for up to two labs in which they wish to conduct research. **Thus, applicants should familiarize themselves with faculty members' research interests and must contact lab head(s) to fully discuss prospective research activities and availability before filing the application**.

Admission examinations for the Master's program consist of: 1) a documentation screening and 2) an oral examination (interview). **Please note that applicants are NOT required to be physically present in Japan for the examination.**

## Lectures held in English for "Global Frontier in Life Science"

**1) Doctoral program**

**Offered by the Graduate School of Biostudies**

- Frontier in Life Science (1 credit : compulsory)
- Advanced English Discussion and Writing in Life Science I (1 credit)
- Advanced English Discussion and Writing in Life Science II (1 credit)

**2) Master's program**

**Offered by the Graduate School of Biostudies**

- Life Science : From Basics to Applications, from Molecular Biology to Systems Biology (1 credit : compulsory)
- Beginning Science (1 credit)
- Global Frontier in Life Science A (2 credits)
- Global Frontier in Life Science B (1 credit)
- Advanced Molecular and Cell Biology I (2 credits)
- Advanced Molecular and Cell Biology II (2 credits)
- Cancer Biology (2 credits)
- Basic English Discussion in Life Science I (1 credit)
- Basic English Discussion in Life Science II (1 credit)
- Cellular & Molecular Neuroscience (1 credit)

## Requirements for completing programs

**1) Requirements for completing the Doctoral program**

- "The Life-Science Special Exercises" (8 credits : compulsory)
- Common Compulsory Subject (1 credit)
- Common Elective Subjects (at least 1 credit)

For graduation, the student must have enrolled for at least three years and have completed at least 10 credits. It is also required to pass the probation and the examination (thesis defense) upon completion of a Doctoral thesis written under the supervision of faculty.

**2) Requirement for completing the Master's program**

- "The Life-Science Experiments and Exercises 1" (10 credits : compulsory)
- "The Life-Science Experiments and Exercises 2" (10 credits : compulsory)
- Common Compulsory Subject (1 credit)
- Common Elective Subjects (at least 9 credits)

For graduation, the student must have enrolled for at least two years and have completed at least 30 credits. It is also required to pass the probation and an examination upon completion of the Master's thesis written under the supervision of faculty.

# Features of Education

## Features of Education

From 2006 to 2007, we conducted the "Biostudies Career-Development Program" supported by the Ministry of Education, Culture, Sports, Science and Technology. From 2008, we have launched the "Program for Developing Pharmaceutical Strategists" as one of the projects of "Reforming Programs in Education" at Kyoto University. This program, in cooperation with the Graduate School of Pharmaceutical Sciences, is aimed to reform the educational system of graduate schools in our university. Launched in 2011, we are conducting a new program named "Global Frontier in Life Science". In 2012-2013, we were selected as one of the schools of the "MEXT Excellent Graduate School Hub Formation Project " and supported our Doctoral students with the subsidy. We are hoping that our students will understand the essential aspects of the programs and cooperate with us in achieving their goals.

## Outline of Reforming Programs in Education

**1) Lectures**

In our Master's program, the curriculum is designed to make the students systematically understand life science and its related fields. We offer an inherent lecture for understanding, revealing, and cultivating the relationship between life science and our society. In our Doctoral program, advanced courses in life science are offered in addition to the seminars at the lab where each student belongs. This program has been ongoing since 2006. We gear the program to provide the requisite knowledge and experience for the students' future careers in various fields of Industry, Government, and Academia, at home and internationally.

**2) Emphasis on English communication for life science, with support for attendance at international scientific meetings**

It is now very important to give seminars in English, especially scientific presentations at international meetings. Historically, however, the graduate schools in our country scarcely cared about the development of English communication skills for students. Our school has been emphasizing the development of communication skills in English. We encourage and financially support our students to give talks at international conferences abroad. We also give them advice for their presentation skills.

**3) Workshops organized by students**

Students in life science fields tend to stay in their labs because they are busy working at the bench. However, it is highly important to communicate with other students studying life science inside and outside of our school during the course of education. We encourage and financially support the students to organize and conduct workshops by themselves.

**4) Guidance by multiple supervisors**

Heretofore, students who were assigned to their laboratories studied under the supervision of one faculty member. However, it would be highly stimulating for the students if they could have opportunities to discuss their research and other matters with other faculty members. In our school, each student is strongly encouraged to consult with two additional supervisors for his/her current research and also career objectives. We hope that the practice widens their vision on life science and on their future plans.

**5) Global Frontier in Life Science (Program conducted in English)**

The Ministry of Education, Culture, Sports, Science and Technology launched the "Global 30" Project for Establishing Core Universities for Internationalization, for the purpose of selecting universities that will function as core schools for receiving and educating international students. In 2009, thirteen universities including Kyoto University were selected. These core universities are playing a major role in dramatically boosting the number of international students educated in Japan as well as Japanese students studying abroad.

# Description of Lectures held in English

## Master's Program

### Beginning Science

**(Lecturers: Uemura, Hejna)**

This class will cover the history of life science, the basic phenomena in this field, research methodologies, papers that impressed the lecturers themselves, seminars, and meeting other scientists, as the beginning of research. Moreover, rules of research and proper analysis of data will be discussed. Furthermore, to broaden students' views of their career path, and their future roles as scientists in the greater context of our society, we would like to discuss what Professionalism means, in terms of common sense, regardless of particular career objectives, and how to develop systematic and critical thinking skills.

### Life Science: From Basics to Applications, from Molecular Biology to Systems Biology

**(Lecturers: Hejna, Nagao, Kambe, Kumeta, Harada, Masuda)**

This class will be conducted entirely in English, and is designed to acquaint students with a broad range of research areas and methodologies, while encouraging students to consider the adaptability or combination of methods in other systems. Topics will range from a quick review of basic molecular biology techniques, to presentations on signal transduction, transport proteins, applications of fluorescence technology, genomewide screening, single-molecule imaging, systems biology, regenerative medicine, tissue growth and regulation, and the hot topic of RNA research. Discussion is also encouraged. The class is primarily for first-year Master's students. Other students, especially G30 students, are equally welcome.

### Global Frontier in Life Science A

**(Lecturers: Kakizuka and Others)**

Lectures in "Global Frontiers in Life Science A" will be held in English, and aim to provide basic and fundamental concepts, and knowledge in several different research fields in life sciences. Lecturers are mostly young scientists, who have recently started his or her own researches as lab heads in Kyoto University. In addition, the lecturers will provide their experience such as how they have found enthusiasm in life science research.

### Global Frontier in Life Science B

**(Lecturers: Hejna, Chisaka, Nishihama)**

International scientific communication is conducted virtually exclusively in English. Students in this class will be provided opportunities--and will be expected--to actively practice and refine their oral presentation skills in English. The class format will consist of medium-length (about 30 min.) student presentations (depending on enrollment and group discussions, in addition to impromptu exercises to further develop reading and listening comprehension. Each class will be a standard 90 min. class, scheduled from 10:30 am-12 noon. The class is meant to be a forum in which to improve English language fluency and presentation skills, and the content will cover current topics in bioscience.

### Advanced Molecular and Cell Biology I

**(Lecturers: Chisaka, Kumeta, Kengaku, Yonehara, Kakizuka, Hejna)**

This will be a lecture course with a limited number of students (up to 30). The students will be given 5-8 scientific papers to read. Special emphases will be on the biologists' way of thinking as well as the basic concepts on the gene/protein structure and function.

1. Logic and basic concepts in biology : How does a biologist work and what does a biologist know?
2. Methods in biology : What kinds of technique does a biologist employ?
3. Specific topics deal with the cell structure and function, the nucleus and central dogma

### Advanced Molecular and Cell Biology Ⅱ

**(Lecturers: Chisaka, Fukuzawa, Endo, Kumeta, Fujita, Kitajima, Hejna)**

This course is an intensive course to introduce the underlying cell signaling pathways and their mediators covering mammalian cells, plants and microbes. The final goal of this course aims to provide an overall knowledge regarding the diversity and significance of cell signaling events in response to various stimuli and physiological conditions, and the generality among species. The course will be held in combination with related paper discussion. Students interested in cell and molecular biology and cell signal transduction are encouraged to participate.

### Cancer Biology

**(Lecturers: Yoshimura, Ishikawa, Kakizuka, Kumeta)**

In this course, a wide variety of recent topics on cancer biology will be lectured by researchers working in different research fields and different countries. A Long-distance learning system combines Kyoto, Tsukuba and National Taiwan Universities to promote active interaction and discussion between lectures and students, as well as among students in different universities.

### Basic English Discussion in Life Science Ⅰ

**(Lecturer: Hejna)**

Despite having excellent English reading and writing skills, most students, even native-English speakers, need to improve their oral English communication skills in order to thrive in the new international scientific community. This class is designed to provide students with ample opportunities to practice scientific discussions in English, while reviewing elements of English grammar and style as they arise. An added benefit will be coverage of a diverse range of current scientific topics; students will begin to look critically at scientific data, and its presentation.

### Basic English Discussion in Life Science Ⅱ

**(Lecturer: Hejna)**

This class is designed to build upon existing reading and writing skills by developing strengths in oral presentation and discussion of science in English. Aimed at Master's students in particular, who may not yet have extensive research results to present, the class will consist of shorter (~30 min) student presentations, covering recent science news, methods, and technology. Students are expected to contribute to the class by commenting and raising questions, at the same time strengthening their ability to look critically at the way science is presented.

### Cellular & Molecular Neuroscience

**(Lecturers: Hejna, Uemura, Kengaku, Matsuzaki, Kakizuka, Oimuma)**

This course will be a joint course offered by the Graduate School of Biostudies and the University of California, San Diego, to provide cutting-edge lectures by world-class neuroscientists and journal presentations by students, to expand learning opportunities beyond the confines of a single campus. Lectures will be broadcast by live satellite links between classrooms in San Diego and Kyoto. The course is intended for advanced students. It is imperative that students should have a very solid background in neurobiology.Highly motivated Masters students will be admitted at the discretion of the course organizers.

## Doctoral Program

### Frontier in Life Sicence

**(Lecturers: Kageyama and others)**

Prominent leading scientists from several research fields of life science, especially those progressing astonishingly, will provide their research histories from their backgrounds to future prospects, to encourage young scientists to perform good science.

### Advanced English Discussion and Writing in Life Science Ⅰ

**(Lecturer: Hejna)**

Like it or not, career advancement depends upon the ability of a researcher not only to read and write English, but to converse fluently in English. These skills are crucial for presentations at international meetings, international collaborations, peer review of manuscripts, and professional networking. This course will allow you to further develop your English language skills by giving oral presentations. In addition, a homework writing exercise

will give you practice in writing a short document, such as an abstract, a cover letter, or peer review. Enrollment will be limited to just 3 students, to allow each student two 75-minute oral presentations, and ample opportunity for informal discussion in a low-stress environment.

### Advanced English Discussion and Writing in Life Science Ⅱ

(Lecturer: Hejna)

This class continues the development of presentation and discussion skills in English, as in Advanced English Discussion and Writing in Life Science I, with the longterm goal of preparing you for an international scientific career. This course will allow you to further develop your English language skills by giving oral presentations. Group discussions will be friendly, but objective. In addition, a homework writing exercise will give you practice in writing a short document, such as an abstract, specific aims, or peer review. Enrollment will be limited to just 3 students, to allow each student two 75-minute oral presentations, and ample opportunity for informal discussion in a low-stress environment.

## Division of Integrated Life Science

### Seminars on Gene Mechanism

This seminar outlines the principle concepts and related research methods and discusses current topics in Gene Biodynamics research. In addition, students report and discuss their own research data to improve their research work and presentation skills.

### Seminars on Cell and Developmental Biology

This seminar discusses the themes of Cell and Developmental Biology, Cell Recognition and Pattern Formation, and Cell Signal Transduction, and deepens understanding of the related areas. In addition, students report and discuss their own research data to improve their research work and presentation skills.

### Seminars on Plant Genes and Totipotency

This seminar discusses the latest developments in Molecular Biology (especially Genome Biology), Molecular and Cellular Biology, and introduces research on Cellular Totipotency at the Molecular, Cellular, and organismal level. In addition, students have exercises in problem-solving and discussions of new research.

### Seminars on Applied Molecular Biology

This seminar explains and discusses the latest issues regarding environmental response mechanisms in mammals or microorganisms, and the future direction of research applications.

### Seminars on Molecular Mechanisms of Responses to Environmental Stimuli

This seminar covers the latest issues regarding various internal and external biological responses, and areas in related fields with different points of view.

### Seminars on Molecular and Developmental Biology

This seminar focuses on how to bridge the gap between individual molecular activities and pathophysiological regulation of the dynamic life systems by using advanced single-molecule imaging and FRET technologies.

### Seminars on Mammalian Molecular and Cellular Biology

This seminar discusses the biological mechanisms of regulation related to carcinogenesis at the molecular, cellular, and organismal levels.

## Division of Systemic Life Science

### Seminars on Molecular and Systems Biology

This seminar discusses the solved and unsolved problems about the dynamic behaviors of DNA, proteins and cellular structures in live cells in order to deepen the students' understanding. Students report their research progress and adjust the direction through discussion.

### Seminars on Animal Development and Physiology

This seminar discusses the latest information regarding genetic regulation, from a broad perspective. In addition, we cover explains illnesses such as cancer caused by abnormal cell differentiation and proliferation, immunological disorders, genetic disorders, and lifestyle related diseases, outlining the research methods used to investigate the molecular biology and pathogenesis of adult diseases.

### Seminars on Molecular Mechanisms of Signal Transductions

Cancer, autoimmune diseases, and life-style related diseases can be caused by genetic abnormalities and aberrant response mechanisms. This seminar explains and discusses dysfunctional biological mechanisms of cell proliferation, self- / non self-immunological identification mechanisms, cancer, immunological disorders, genetic diseases, and biological mechanisms of adult diseases.

### Seminars on Functional Biology

This seminar explains and discusses the latest information about molecular mechanisms of the homeostatic regulation in physiological and pathological conditions.

### Seminars on Cultural and Social Aspects of Life Sciences

This seminar covers the theoretical research, the methodology of life science, bioethics, and the history of modern science.

### Seminars on Mammalian Regulatory Network

This seminar discusses the mechanisms of systemic biological cellular control, genetic response, carcinogenesis caused by viruses, the principle of immunological response; the structure and regulation of

genetic information responsible for such systemic functions are being analyzed using model animals.

# Outline and Composition of Departments

Research Laboratories in the Graduate School of Biostudies

We contribute for the improvement of future welfare and happiness of humankind

## DIVISION OF INTEGRATED LIFE SCIENCE

### ❖ Genetical mechanism

- Department of Gene Mechanisms
- Department of Molecular and Cellular Biology

### ❖ How multicellular organisms work

- Department of Cell and Developmental Biology
- Department of Plant Gene and Totipotency
- Department of Molecular and Developmental Biology

### ❖ How organisms interact with environments

- Department of Applied Molecular Biology
- Department of Responses to Environmental Signals and Stresses

## DIVISION OF SYSTEMIC LIFE SCIENCE

### ❖ How the brain and the body work

### ❖ How the body is built

### ❖ How the human diseases occur

- Department of Molecular and System Biology
- Department of Animal Development and Physiology
- Department of Signal Transductions
- Department of Functional Biology
- Department of Mammalian Regulatory Network

### ❖ Communications・Bioethics

- Department of Biostudies and Society

**Living organisms** — **Human beings**

**Genes and cells**

# DIVISION OF INTEGRATED LIFE SCIENCE

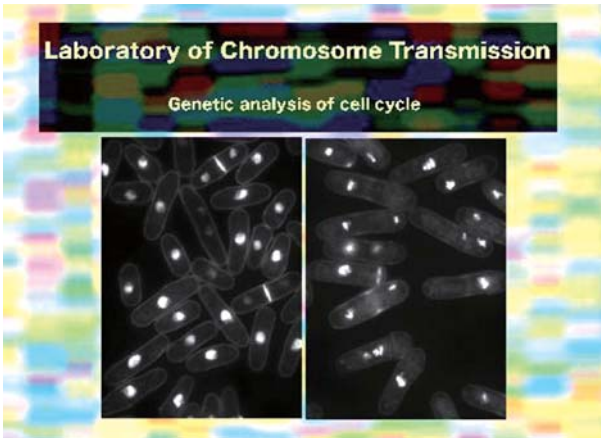
This division consists of 18 laboratories including six cooperative laboratories one from Radiation Biology Center, three from Institute for Virus Research, and two from Institute of Integrated Cell-Material Sciences (iCeMS). Fourty graduate students are accepted in the Master's Program annually, and 19 in the Doctoral Program. In this division, education and research are focused on the elucidation of basic mechanisms regulating the chromosome transmission, chromosome replication, RNA architecture, cell cycle, cellular transport, cell polarity, signal transduction, growth and development, developmental plasticity, bioconversion, and environmental adaptation. Experimental approaches are taken with microorganisms, plants, and animals. We pursue education and research to elucidate the molecular aspects of Integrative Life Science.

## Laboratory of Chromosome Transmission

■ Associate Professor **NAKASEKO, Yukinobu**

■ Main theme

We are focusing on analyzing the genes involved in regulation of chromosome function. Especially, the genes essential for mitosis have been studied. Fission yeast Schizosaccharomyces pombe is used as a model system. This yeast has all basic features essential for eukaryotic cell division. Many genes have been identified which regulate the cell cycle of this yeast. Also, their functions as well as their primary structure have been shown to be conserved among all eukaryotic cells. We are trying to characterize these genes and their functions by genetical approach. Elucidation of whole functional network of these genes is one of a goal in our research.




## Laboratory of Gene Biodynamics

■ Associate Professor **SHIRAISHI, Hideaki**

■ Main theme

We are interested in the mechanism of growth, development and evolution of photosynthetic microorganisms and currently focusing on the study of the edible cyanobacterium *Arthrospira* (*Spirulina*) *platensis*. *A. platensis* is a filamentous alkaliphilic cyanobacterium that has been traditionally consumed as food by people living along the shores of alkaline lakes in several regions in the world. Because it can be cultured under alkaline conditions where growth of other microalgae is suppressed, it can be produced in mass cultures outdoors as an almost single algal strain. Because of its easiness of mass culture, it is commercially produced in many subtropical areas in the world and consumed worldwide as food, food additives, and feed for animals and fishes. Since it exhibits many biologically interesting phenomena, we are currently focusing on the study of this cyanobacterium. Examples of our current research projects include developing tools for molecular genetic studies of *Arthrospila*, analyzing extracellular polysaccharides produced by it, and investigating the mechanism of its motility.

Filamentous cyanobacterium *Arthrospira platensis* and the aggregated exopolysaccharides produced by them

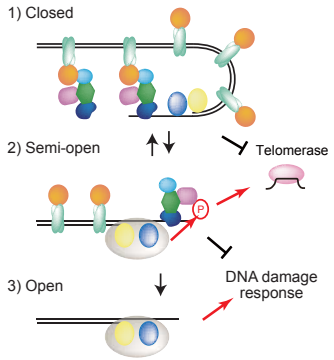
**http://kuchem.kyoto-u.ac.jp/seika/**

## Laboratory of Cell Cycle Regulation

■ Professor **ISHIKAWA, Fuyuki**
■ Assistant Professor **SADAIE, Mahito**

■ Main theme

Our research activity focuses on the molecular mechanism of the flow of genetic information. Chromosomes, the vehicle of genetic materials, show both faithful and flexible behaviors, in different time scales, from a single round of the cell cycle to the evolution of species, and in different conditions, such as development, aging and cancer. These apparently opposite behaviors of chromosomes can be explained by the need of genetic materials to be transmitted robustly. We are particularly interested in how functional domains of chromosome, such as telomeres, are established and maintained, and how chromosomes respond to external stimuli, as exemplified by the genetic instability found in cancer cells. We are trying to understand these questions by experimental approaches based on genetics, biochemistry, and molecular and cellular biology in various model systems, such as fission yeast, and mammalian cells.




Telomeres consist of DNA ends and the shelterin protein complex.
1) Long telomeres form a closed state competent to protect telomere ends. 2) Moderately short telomeres recruit telomerase to elongate telomere DNA. 3) Very short telomeres are deprotected, activating the DNA damage response. Phosphorylation of the shelterin protein regulate these processes. Yamazaki et al. Genes & Dev. 26:241 (2012)

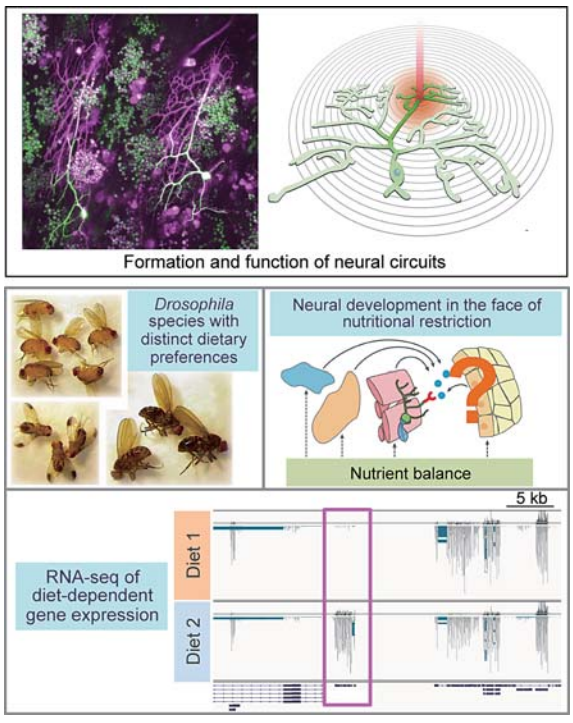
**http://www.fish.lif.kyoto-u.ac.jp/**

## Laboratory of Cell Recognition and Pattern Formation

■ Professor **UEMURA, Tadashi**
■ Assistant Professor **USUI, Tadao**
■ Assistant Professor **HATTORI, Yukako**

■ Main theme

We are interested in mechanisms that control animal development and behaviors in response to two categories of environmental inputs: nutrition and sensory stimuli. Diet is one of critical environmental determinants that affect developmental time and fitness. We are studying genetic programs for dietary responses of ecologically distinct *Drosophila* species that have different dietary preferences. We are also focusing on how developing neurons cope with nutritional restriction by using one subclass of *Drosophila* somatosensory neurons. By using the same neuronal subclass, we are dissecting operating principles of neuronal circuits that evoke selective behavioral outputs in response to sensory stimuli. To conduct these studies, we introduce a variety of molecular, cellular, genomic, imaging, and physiological approaches.




**http://www.cellpattern.lif.kyoto-u.ac.jp/**

# Division of Integrated Life Science

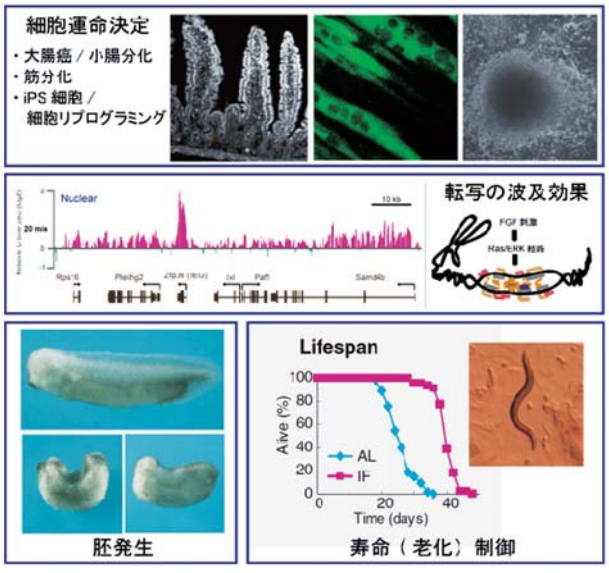
## Department of Plant Gene and Totipotency

### Laboratory of Signal Transduction

■ Professor **NISHIDA, Eisuke**
■ Assistant Professor **MIYATA, Yoshihiko**
■ Assistant Professor **KUSAKABE, Morioh**

■ Main theme

We are interested in identifying and elucidating molecular mechanisms that regulate cell proliferation, cell differentiation, cell cycle, aging and developmental processes. The current topics include 1) regulatory mechanisms and functions of the MAP kinase cascade pathways, 2) identification of novel signal transduction mechanisms, 3) molecular mechanisms for life span regulation, 4) roles of protein kinases in cell cycle progression and regulation, 5) growth factor signaling mechanisms in developmental processes, 6) regulatory mechanisms for mammalian circadian clock.




http://www.signal.lif.kyoto-u.ac.jp/

### Laboratory of Plant Molecular Biology

■ Professor **KOHCHI, Takayuki**
■ Lecturer **NISHIHAMA, Ryuichi**
■ Assistant Professor **YAMAOKA, Shohei**

■ Main theme

Research in this laboratory focuses on the adaptive regulation of growth and development to environmental conditions using model photosynthetic organisms. Topics include mechanism of photomorphogenesis and meristem development. We study molecular mechanisms of light sensing by photoreceptors and downstream genetic network of signal transduction. Approaches by molecular genetics and comparative genomics are taken with Arabidopsis and liverwort (*Marchantia polymorpha*). In particular, the genetic analysis of *Marchantia* is unique and efficient as its phylogenetically basal position in land plant evolution, haploid-dominant life cycle, and simple transgenesis. Genome analysis of *Marchantia* is also conducted in this laboratory.

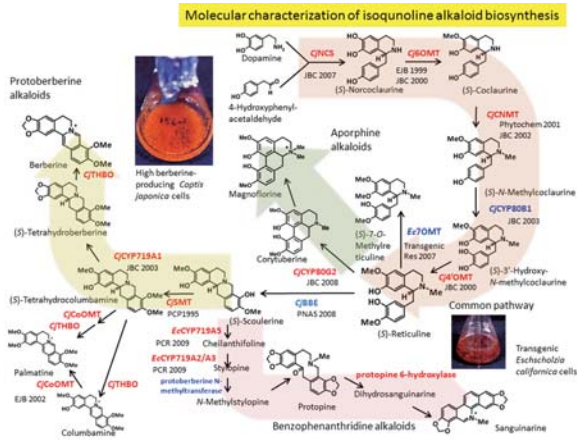

http://www.plantmb.lif.kyoto-u.ac.jp/

## Laboratory of Molecular and Cellular Biology of Totipotency


■ Professor **SATO, Fumihiko**
■ Associate Professor **ENDO, Tsuyoshi**
■ Assistant Professor **IFUKU, Kentaro**


■ Main theme

Molecular and cellular biological studies on totipotency in plant cells have been carried out in this laboratory using in vitro cultured cells and transgenic plants. Especially, cell/organ differentiation from undifferentiated cells, functional differentiations, e.g. secondary metabolite production, such as biosynthesis of isoquinoline alkaloids, oxygen evolving complex in photosystem II, cyclic electron transfer and gene regulation in chloroplast, have been investigated to understand the totipotent functions in plant cells. Development of novel genetic engineering techniques such as genome editing, metabolic engineering and synthetic biology of secondary metabolism for industrial application have been also investigated.




http://www.callus.lif.kyoto-u.ac.jp/

## Laboratory of Biosignals and Response

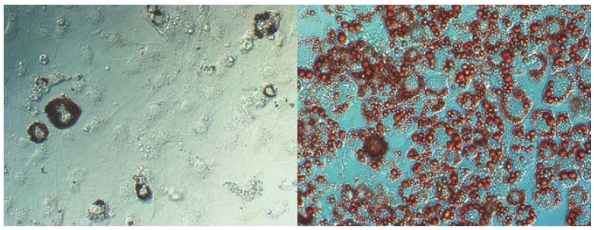

■ Professor **NAGAO, Masaya**
■ Associate Professor **KAMBE, Taiho**
■ Assistant Professor **MIYAMAE, Yusaku**

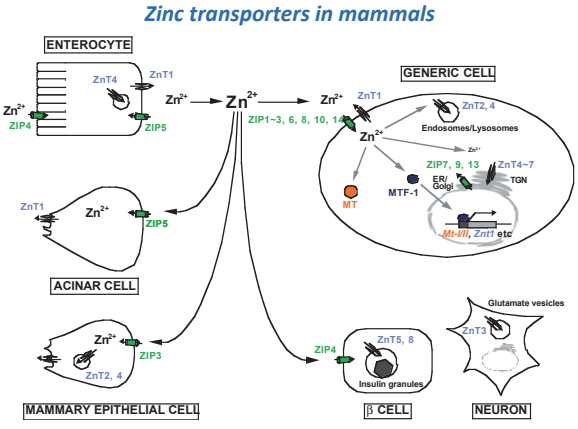

■ Main theme

Bio-prospecting, a research strategy searching for compounds that possess beneficial activity for health from natural sources, is one of the projects in this laboratory. Especially, at present, compounds that prevent hepatic fibrosis and replication of hepatitis C virus are the main targets of our bio-prospecting.

We are also studying how organisms perceive environmental signals and transduce these signals into changes in gene expression, focusing mainly on the molecular and cellular basis of zinc metabolism (such as uptake, storage, delivery, and maintenance of metal concentration in cells) in mammal.

Stimulation of lipid accumulation by plant extracts






http://www.seitaijoho.lif.kyoto-u.ac.jp/

# Division of Integrated Life Science

## Laboratory of Applied Molecular Microbiology

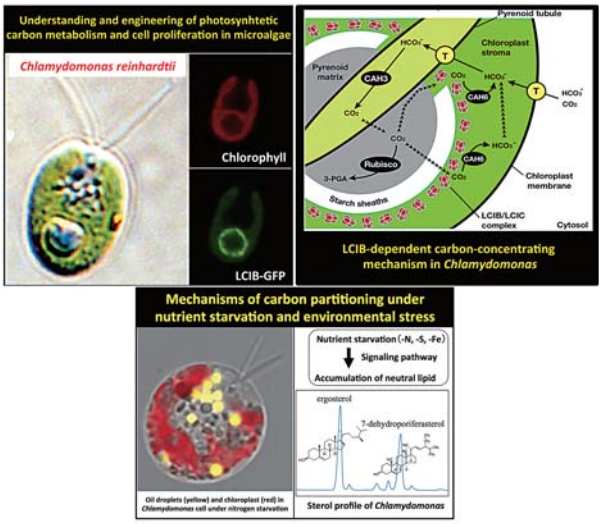
■ Professor **FUKUZAWA, Hideya**
■ Assistant Professor **YAMANO,Takashi**
■ Assistant Professor **KAJIKAWA,Masataka**

■ Main theme

We are focusing on the molecular bases of biological functions of microalgae contributing to production of food, biofuel and industrial materials, and also to environmental remediation by photosynthesis. Especially we employ a green alga, *Chlamydomonas reinhardtii*, as a model eukaryotic photosynthetic microorganism using its genomic information, mutants, and molecular/biochemical techniques.

The current projects are

(1) Molecular characterization of the carbon-concentrating mechanism supporting photosynthetic carbon fixation, biofuel production, and cell proliferation,
(2) Elucidation of regulatory systems controlling photosynthesis and carbon metabolisms by sensing environmental factors including changes of levels in $CO_2$ concentration, light and nutrient starvation.
(3) Metabolic engineering for production of industrial important fatty acids, glycerolipids and carbohydrates.
(4) Molecular control and signaling of sexual reproduction by nutrient starvation.




http://www.molecule.lif.kyoto-u.ac.jp/

## Laboratory of Molecular Biology of Bioresponse

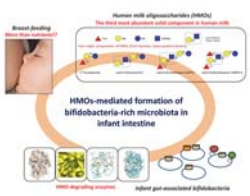
■ Professor **KATAYAMA, Takane**
■ Associate Professor **MASUDA, Seiji**

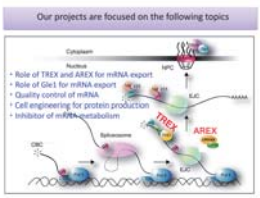
■ Main theme

The aim of our laboratory is to understand the fundamental life processes of microbes and human, and to develop food- and health-oriented application research. The research activities mainly include (1) elucidation of the molecular mechanism underlying symbiosis and co-evolution between gut microbes and host, and (2) elucidation of the mechanism of mRNA processing, export and quality control in the nucleus in human and its industrial applications.

(1) Recent studies have shown that the consortium of gut microbes exerts a considerable influence on host health. Most researchers approach this topic from "host" side using a mouse model, but we believe that approaches from "microbe" side are equally needed to understand the symbiosis between them. To this end, we are genetically and enzymatically analyzing unique metabolic pathways in gut microbes, which should uncover the cross-kingdom communications between bacteria and host in intestine.

(2) The main projects are (i) the role of TREX and AREX, which couple transcription and export of mRNA, (ii) the molecular mechanism of RNA quality control in the nucleus, (iii) cell engineering for the protein production using mRNA export mechanism in mammalian cells to apply to industrial applications and (iv) identifying the active compounds which inhibit the mRNA matabolism to apply to medical care.



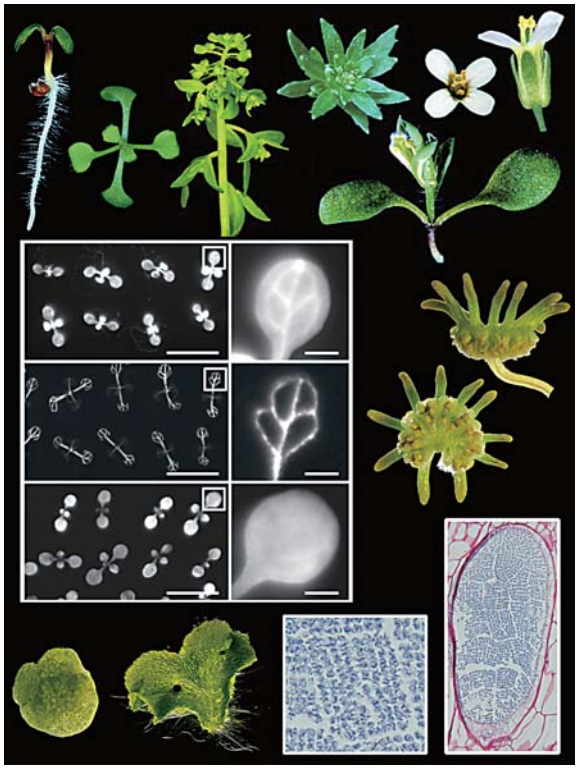

http://www.bunshioutou.lif.kyoto-u.ac.jp/

## Laboratory of Plant Developmental Biology

■ Professor **ARAKI, Takashi**
■ Associate Professor **ENDO, Motomu**
■ Assistant Professor **NIWA, Masaki**

■ Main theme

We are interested in molecular mechanisms underlying plant's responses to environment. Plants have evolved plastic developmental programs with both genetic and epigenetic basis to adapt their sessile mode of life to changing environment. Using an angiosperm, Arabidopsis thaliana and a liverwort, Marchantia polymorpha as model systems, we have been investigating (1) regulation of growth phase transition (especially, flowering) in response to environmental signals, (2) long-distance systemic signaling in the control of development, (3) tissue-specific roles of circadian clock for optimal environmental responses, (4) sexual reproduction processes, and (5) origin and evolution of regulatory systems for plastic development.



http://www.plantdevbio.lif.kyoto-u.ac.jp/

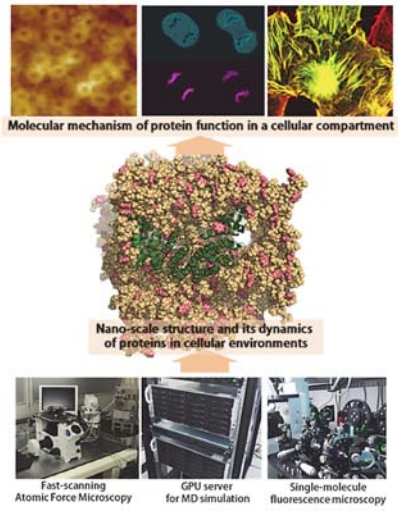
## Laboratory of Plasma Membrane and Nuclear Signaling

■ Associate Professor **YOSHIMURA, Shigehiro**
■ Assistant Professor **KUMETA, Masahiro**

■ Main theme

Our laboratory studies dynamic properties of proteins and large protein complexes in cellular environments by using a variety of techniques in biochemistry, molecular biology and cellular biology, in combination with nano-technology and computational simulation. Specific research topics include:

(1) Understanding molecular mechanism and biophysical background of mitotic chromosome condensation
(2) Single-molecule imaging of higher-order architectures of DNA, RNA and various nucleoprotein complexes
(3) Non-invasive imaging of membrane and cytoskeletal dynamics by fast-scanning atomic force microscopy
(4) Understanding physical and chemical mechanisms of subunit assembly and disassembly of nuclear pore complex
(5) Structural dynamics of flexible and repetitive proteins in intracellular environments and molecular crowding




http://www.chrom.lif.kyoto-u.ac.jp/english/index.html

# Division of Integrated Life Science

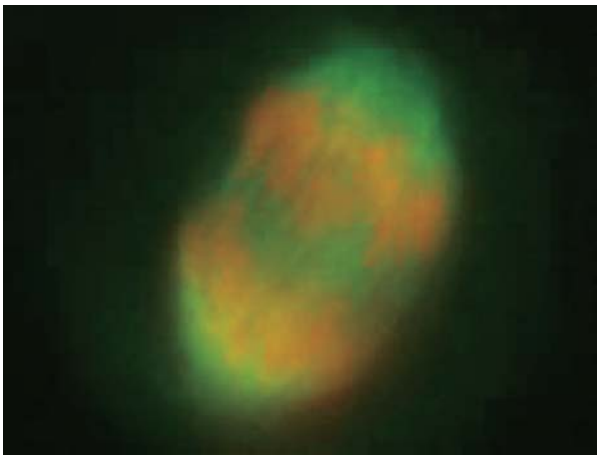
## Department of Molecular and Developmental Biology

### Laboratory of Genome Maintenance

■ Professor **MATSUMOTO, Tomohiro**

■ Main theme

The spindle checkpoint, our major research subject, is a surveillance mechanism to regulate cellular apparatus for compliance with this rule. It is a unique negative feedback that converts/amplifies a physical signal sensed by kinetochores (attachment of the spindle and/or tension) and regulates the timing of the sister chromatid separation. Mad2, a signal carrier of this feedback, plays a vital role in the spindle checkpoint. It is specifically localized at unattached kinetochores that are the origin of the checkpoint signal. Mad2 targets CDC20 and inhibits its activity to promote sister chromatid separation. We study Mad2, a central player of the spindle checkpoint, to reveal mechanisms, which regulate the activity of Mad2.



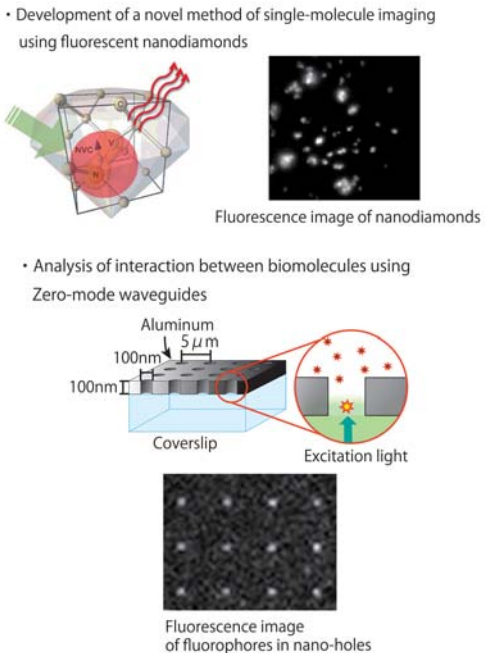
http://www.rbc.kyoto-u.ac.jp/radiation_system/m-index.htm

### Laboratory of Nanobiology

■ Professor **HARADA, Yoshie**

■ Main theme

We are developing novel single-molecule imaging techniques to investigate dynamic processes of intracellular substances and DNA-protein interactions related to genome DNA maintenance. To characterize dynamic processes of DNA-protein interactions, we are constructing Zero-mode waveguides. This method enables us to visualize single-molecule fluorescence at high concentration. Using Zero-mode waveguides, we focus on characterizations of proteins involved in homologous recombination or epigenetics such as RuvAB protein complex or nucleosome binding proteins. We are also developing a novel method for the selective imaging using nanodiamonds. Using this novel method, we study dynamic processes of intracellular substances of interest.



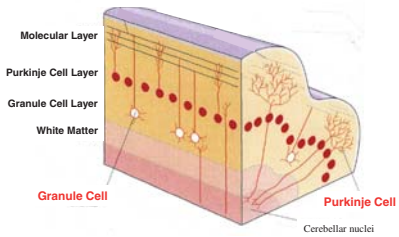

http://www.harada.icems.kyoto-u.ac.jp/en/

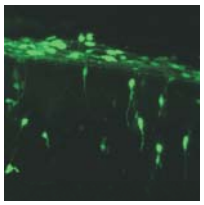
## Laboratory of Developmental Neurobiology

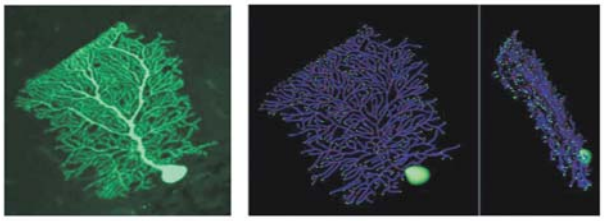
■ Professor **KENGAKU, Mineko**

■ Main theme

Neurons in the mammalian brain are orderly arranged in cortices and nuclei for integration into specific neural circuits. During development, neurons directionally migrate from the birthplace to their destination within the cortex, and then arborize well-patterned dendrites and axons to contact with their specific synaptic counterparts. The major goal of our research is to clarity the mechanisms of cortical lamination and functional wiring of neurons in the brain. We seek to identify the molecular signals regulating neuronal migration and dendrite patterning. We also aim to develop imaging techniques for real-time observation of molecular and cellular dynamics of neuronal migration and dendrite patterning to discover novel phenomena and rules in neuronal motility in the developing brain.





http://www.kengaku.icems.kyoto-u.ac.jp/

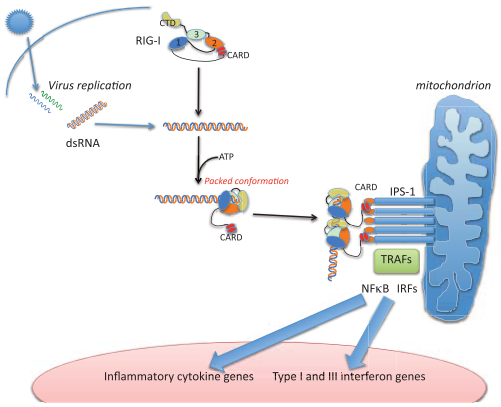
## Laboratory of Molecular Cellular Immunology

■ Professor **FUJITA, Takashi**

■ Associate Professor **KATO, Hiroki**

■ Main theme

Virus infections, such as influenza A epidemic and Chronic Hepatitis C virus infection are still important diseases and outbreaks of newly emerging viruses are serious problems for modern society. Higher animals, including humans, are genetically equipped with mechanisms, collectively known as innate immunity, to counteract viral infections. During the course of replication, many viruses generate double-stranded (ds) RNA, which is virtually absent in normal cells and likely serves as a "foreign molecule" in cells. An RNA helicase, RIG-I, functions as a sensor for viral dsRNA. RIG-I is composed of three domains : a Caspase recruitment domain (CARD), a DExD/H helicase domain, and a C-terminal domain (CTD) (Figure). CTD senses viral dsRNA produced in the cytoplasm, leading to a conformational change. This conformational change releases CARD, which signals to downstream, resulting in the activation of genes including those for type I interferon and other cytokines. The purpose of our project is to clarify the molecular mechanism underlying the antiviral innate immunity regulated by RIG-I, and to develop new diagnostic and therapeutic means for viral infections.




http://www.virus.kyoto-u.ac.jp/Lab/bunshiiden2012/English/index.html

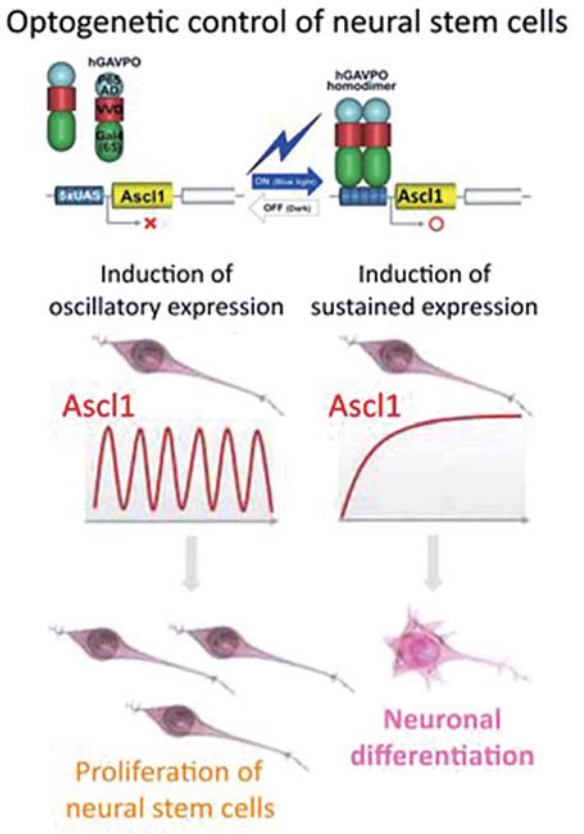
# Division of Integrated Life Science

## Laboratory of Developmental Dynamics

■ Professor **KAGEYAMA, Ryoichiro**
■ Associate Professor **OHTSUKA, Toshiyuki**
■ Assistant Professor **KOBAYASHI, Taeko**

■ Main theme

We analyze the molecular mechanism of embryonic development by using the most advanced methods such as imaging, optogenetics and transgenic mouse technologies. We evaluate mathematical modeling by using transgenic mice and seek to understand the principles of developmental dynamics.




**http://www.virus.kyoto-u.ac.jp/Lab/Kageyama/index_English.html**

# DIVISION OF SYSTEMIC LIFE SCIENCE

This division consists of 17 laboratories including 5 cooperative laboratories from Institute for Virus Research, Graduate School of Medicine, Institute for Frontier Medical Science and RIKEN Center for Development Biology. Thirty-five graduate students are accepted in the Master's Program annually, and 14 in the Doctoral Program. In this division, education and research are focused on the elucidation of the fundamentals of molecular and systemic biology, cell biology and immunology. Experimental approaches are taken with viruses, microorganisms, cultured cells and animals. We pursue education and research to elucidate the molecular aspects of Systemic Life Science.

# Division of Systemic Life Science

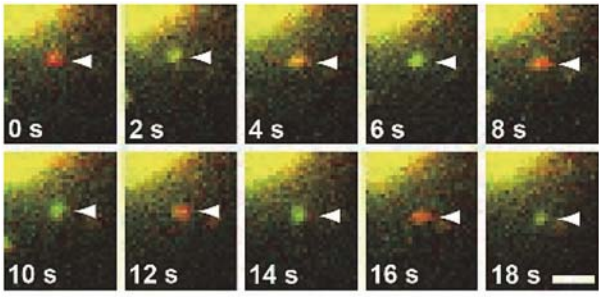
## Department of Molecular and System Biology

### Laboratory of Single-Molecule Cell Biology

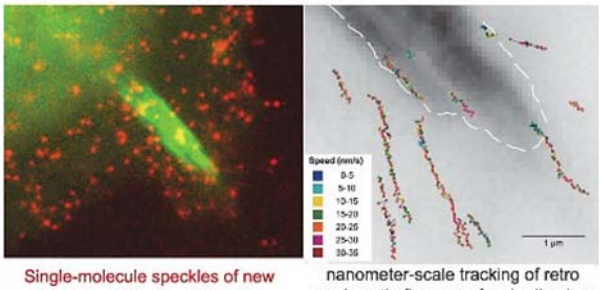
■ Professor **WATANABE, Naoki**
■ Assistant Professor **YAMASHIRO, Sawako**
■ Assistant Professor **MIZUNO, Hiroaki**

■ Main theme

Our laboratory aims at bridging the gap between molecular activities and cell physiology in life systems. We are trying to visualize signal transduction and cell structure remodeling processes directly in living cells by fluorescence single-molecule microscopy and related high-resolution imaging techniques.




Rotation of mDia1 along the actin helix during processive polymerization
Hiroaki Mizuno et al. Science **331**, 80-83, 2011



Single-molecule speckles of new DL-labeled photostable actin

nanometer-scale tracking of retro -grade actin flow near focal adhesions

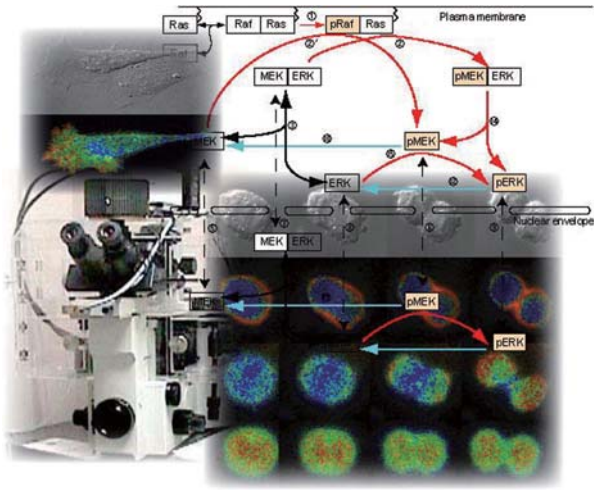
Sawako Yamashiro et al. MBoC 25: 1010-1024, 2014

### Laboratory of Bioimaging and Cell Signaling

■ Professor **MATSUDA, Michiyuki**
■ Assistant Professor **IMAJO, Masamichi**
■ Assistant Professor **KOMATSU, Naoki**

■ Main theme

We are visualizing the growth signal transduction cascades in living cells by using biosensors based on the principle of Foerster resonance energy transfer (FRET). These FRET videos are processed to extract parameters that characterize the property of each signaling molecule. We use these parameters obtained in living cells to build kinetic simulation models of growth signal transduction cascades.We are also developing transgenic mice expressing FRET biosensors to observe the signaling status in living mice with two-photon excitation microscopes.



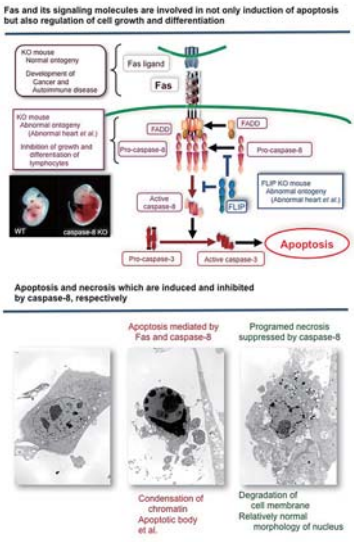

**http://www.fret.lif.kyoto-u.ac.jp/**

## Laboratory of Molecular and Cellular Biology


■ Professor **YONEHARA, Shin**
■ Associate Professor **SAKAMAKI, Kazuhiro**
■ Assistant Professor **LEE, Kyung-Kwon**


■ Main theme

Apoptosis, or programmed cell death, plays an important role in many biological processes, including embryogenesis, development of immune system, maintenance of tissue homeostasis, and elimination of virus-infected and tumor cells. We found cell surface Fas antigen (Fas), which can directly mediate apoptosis-inducing signals into cells by stimulation with agonistic anti-Fas mAbs or Fas ligand (Yonehara S, et al., 1989; Itoh N, et al., 1991). Our main research project is to understand the intracellular signal transduction mechanism of cell death including apoptosis and caspase-independent novel types of cell death, and the biological significance/physiological role of cell death and cell death-regulating molecules. In conjunction with these studies, we have been trying to identify other cell death-related molecules that play a key role in embryogenesis, tumorigenesis or immune system. Investigations of molecular mechanisms and physiological roles of cell death and its related molecules are important for a better understanding of mammalian embryogenesis, tumorigenesis and immune system.




http://www.fas.lif.kyoto-u.ac.jp/

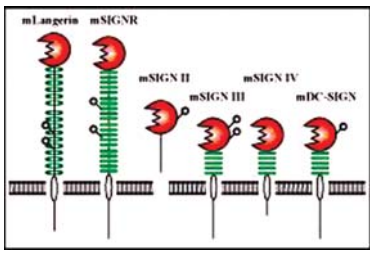
## Laboratory of Immunobiology

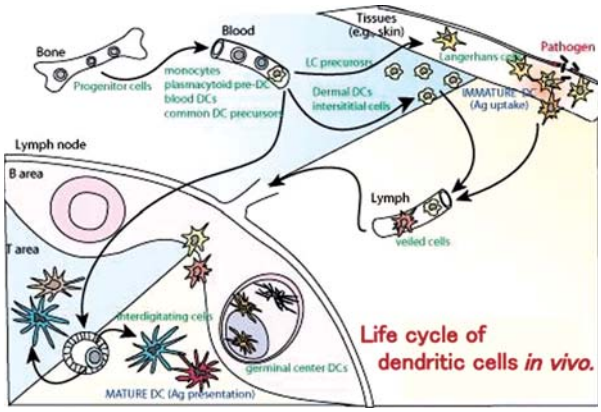

■ Professor **INABA, Kayo**
■ Lecturer **TAKAHARA, Kazuhiko**


■ Main theme

Our interest is the induction and control of immunity. We focus on dendritic cells (DCs), which are a primary antigen-presenting cell in the immune system. Our current major topics include the control of DC functions using several types of glycolipids, resulting in both immune activation and suppression. We are also interested in functions of lectin molecules expressed on DCs/macrophages that recognize polysaccharides on pathogenic agents. The study includes analyses of interaction between polysaccharides and lectins, and subsequent cellular and systemic responses in co-operation with TLR signaling. In this study, we found that certain lectin-polysaccharide interaction induced immune suppressive environment, ameliorating excessive and lethal inflammation. By these studies, we would like to develop new methods to control immune system.

Mouse lectins expressed on DCs/macrophages




http://zoo.zool.kyoto-u.ac.jp/imm/

# Division of Systemic Life Science

## Laboratory of Molecular Cell Biology and Development

(Matsuzaki Laboratory)

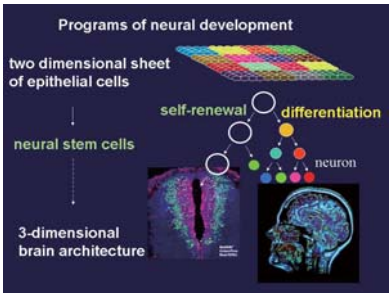
■ Visiting Professor **MATSUZAKI, Fumio**

■ Main theme

We seek to explore the molecular mechanisms underlying the organization of cells into highly ordered structures in the developing brain. The vertebrate brain comprises a considerably larger number of neurons arranged in a vastly complex functional network, which develops from a single layer of epithelial cells that function as neural stem cells. Those cells initially proliferate to expand the stem cell population. Subsequently neural stem cells undergo asymmetric cell divisions to generate self-renewing and differentiating daughter cells. Thus the transition from the proliferative phase to the neurogenic phase is critical for the determination of the brain size. Asymmetric cell division also appears to play an essential role in the neuronal production. However, little is known about mechanisms controlling those critical events in the brain development.

We use both an invertebrate (Drosophila) and vertebrate (mouse) model systems to understand principles for the brain organization such as:

1. How the timing of the proliferative to neurogenic transition is determined in the brain development.
2. How neural stem cells simultaneously generate self-renewing and differentiating cells.
3. How cell polarity contributes to control asymmetric cell division of neural stem cells.
4. How diverse neuronal types are generated from a single neural stem cell over time.
5. How the global brain architecture is dictated by the structure and activity of neural stem cells



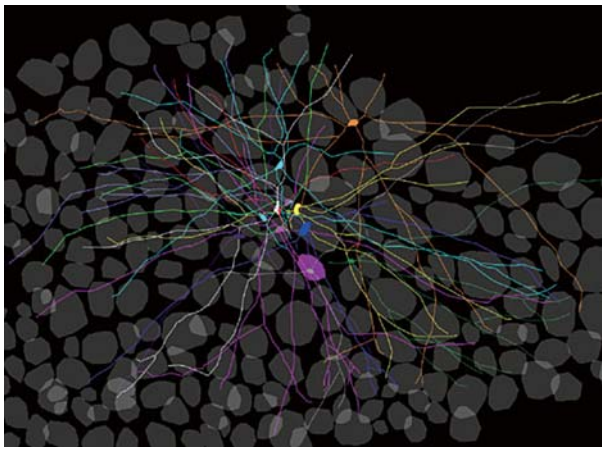

http://www.cdb.riken.jp/en/research/laboratory/matsuzaki.html

(Imai Laboratory)

■ Visiting Associate Professor **IMAI, Takeshi**

■ Main theme

The mammalian central nervous system is composed of enormous numbers of neurons. How do these neurons establish their identity and form functional neuronal circuitries? To address this question, we are studying the mouse olfactory system as a model system. In the mouse olfactory system, odorants are detected by ~1,000 types of olfactory sensory neurons, each expressing a single type of odorant receptor. The olfactory bulb, the primary olfactory area of the brain, receives inputs from olfactory sensory neurons through 1,000 sets of glomeruli. These inputs are then processed in the olfactory bulb circuits and are then sent out to the olfactory cortex. These complex neuronal circuits emerge in an autonomous fashion based on cell-cell interactions and neuronal activity after birth, rather than by strict genetic programs. Using the olfactory bulb as a model system, we are trying to understand simple rules behind the formation of complex neuronal circuitry.



Dendrite wiring of mitral cells in the mouse olfactory bulb.

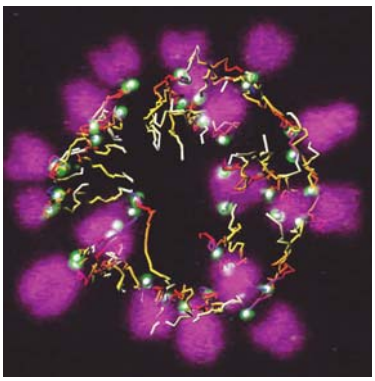
http://imai.uijin.com/english.html

## (Kitajima Laboratory)

■ Visiting Associate Professor **KITAJIMA, Tomoya**

■ Main theme

In order to maintain genetic information across generations, cells must segregate chromosomes equally to daughter cells during mitosis. Meiotic divisions of the mammalian oocyte, however, are known to exhibit a higher frequency of errors in chromosomal segregation than in other cell types. Moreover, oocyte chromosomes behave in ways distinct from those in other cells, and these unique dynamics may provide insights into novel mechanisms for chromosome segregation. Taking advantage of our established live imaging technologies, we seek to conduct detailed and comprehensive analyses of the chromosome dynamics and the molecular machinery that underlies chromosome segregation during mammalian oocyte meiosis. We also seek to identify the causes behind age-related increases in chromosome segregation errors during oocyte meiosis.



Prometaphase belt of chromosomes

**http://www.cdb.riken.jp/en/research/laboratory/kitajima.html**

## (Kuranaga Laboratory)

■ Visiting Associate Professor **KURANAGA, Erina**

■ Main theme

The development of multicellular organisms involves the collective effect of multiple events at the level of the individual cell, such as proliferation, differentiation, adhesion, and migration. Programmed cell death, for example, is a process by which cells are selected for death at set times in development, allowing for the sculpting of tissue, and is used in the adult organism to maintain homeostasis by eliminating cells that have developed abnormalities. Perturbations in cell death signaling can thus affect an organism's physiological stability, and result in developmental defects, tumorigenesis, or neurodegenerative disease. Cell death plays an important role in maintaining the cellular society not only by eliminating unneeded cells at given sites and stages, but in other functions, such as regulating the proliferation and migration of neighboring cells, as well. Such cellular behaviors give rise to cell networks capable of organizing into tissues, the study of which requires a experimental approach to spatiotemporal information in living systems, such as can be obtained through the real-time live imaging of biological phenomena.

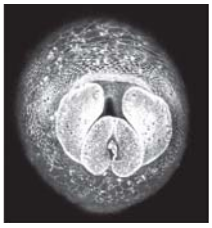
We have chosen the fruit fly Drosophila melanogaster as our primary research model, seeking to take advantage of its utility in developmental studies and wealth of genetic data in studying the coordination of morphogenesis through live-imaging and genetic screens. We especially focus on the morphogenetic processes that involve cellular migration and cell death, such as the looping morphogenesis of fly male terminalia and the abdominal epidermis rearrangement, to understand the principles for the morphogenetic dynamics as follows,

1) The physiological roles and regulating mechanisms of cell death during development

2) Non-autonomous mechanisms to induce cell death during regeneration

3) Mechanics and molecular mechanisms for unidirectional motion of collective cellular movement

Figure: Caudal view of developing fly male terminalia expressing DE-Cadherin:GFP



**http://www.cdb.riken.jp/en/research/laboratory/kuranaga.html**

# Division of Systemic Life Science

## Department of Signal Transductions

### Laboratory of Molecular Neurobiology

■ Professor **NEGISHI, Manabu**
■ Associate Professor **KATOH, Hironori**
■ Assistant Professor **OINUMA, Izumi**

■ Main theme

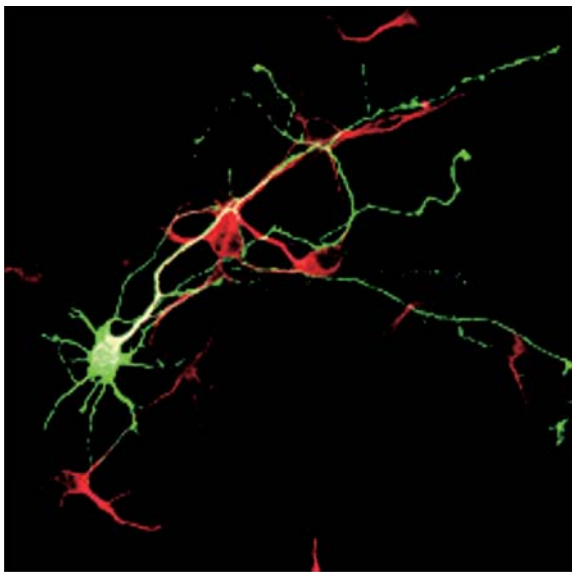
**Outline of Teaching Activities**

The laboratory provides seminars which review and discuss recent progress in molecular mechanisms of neuronal functions

**Outline of Research Activities**

The main themes of research in this laboratory are the molecular mechanisms underlying neuronal network formation and neuronal signal transductions.

1. Neuronal functions and signal transductions of GTP-binding proteins
2. Molecular mechanisms for axon guidance
3. Regulatory systems of synaptic transmission
4. Signal transduction of neuronal polarity formation



**http://www.negishi.lif.kyoto-u.ac.jp/e/Top.html**

### Laboratory of Genetics

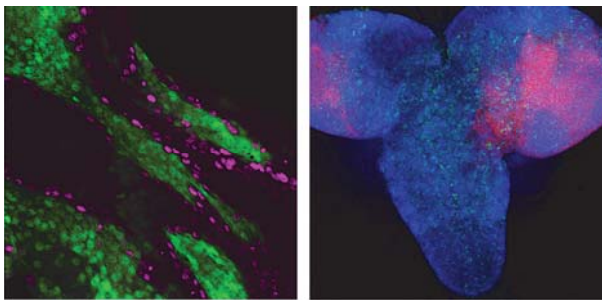
■ Professor **IGAKI, Tatsushi**
■ Lecturer **OHSAWA, Shizue**

■ Main theme

Our research focuses on the molecular basis of cell-cell communication that governs tissue growth, homeostasis, and cancer. We take advantage of the powerful genetics of Drosophila.

■ Research subjects:

1. Mechanism of cell competition
2. Genetic basis of tissue growth regulation
3. Molecular basis of tumor progression and metastasis



Left:Polarity-deficient cells (green; losers) are eliminated from epithelium by wild-type cells (magenta; winners) through cell competition.
Right:Malignant tumor cells (magenta) are invading and metastasizing from the eye disc to the brain (blue) in Drosophila larva.

**http://www.lif.kyoto-u.ac.jp/labs/genetics/**

## Laboratory of Functional Biology

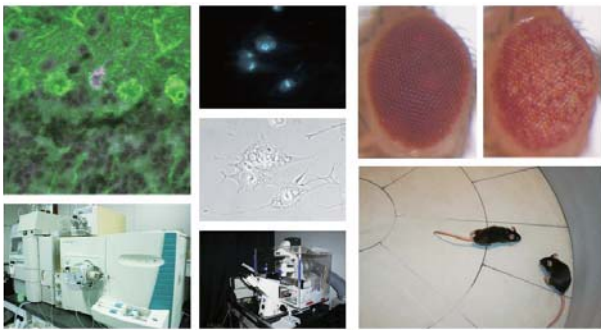
■ Professor **KAKIZUKA, Akira**
■ Associate Professor **IMAMURA, Hiromi**
■ Assistant Professor **SASAOKA, Norio**
■ Assistant Professor **ABE, Megumi**

■ Main theme

Using animal models of human diseases, such as neurodegenerations, cancers, and obesity-related diseases, and using metabolite imaging techniques, we aim to elucidate molecular bases of such diseases and develop new strategies to cure or prevent them.

One of the main features of life science research in the coming years will be that the results obtained from fundamental research should ideally be directly connected to the good of society. From this standpoint, in addition to handling topics with high scientific significance, we aim to contribute to the development of treatments for neurodegenerative diseases, cancers, and obesity-related diseases from our research results.

We hold the same view on scientific education, and through training individuals to communicate their ideas logically yet effectively, as well as by nurturing their creativity, in addition to strengthening their practical research skills, we aim to cultivate opinion leaders standing at the core of life science research in the 21st century.



**http://www.funcbiol.lif.kyoto-u.ac.jp/**



## Laboratory of Science Communication and Bioethics

■ Main theme

In our laboratory, we aim to identify essential issues in the interface between biostudies and the society, and to propose possible actions or solutions.

Currently, we are focusing on the following three areas.

1.Theoretical and practical analysis of science communication.

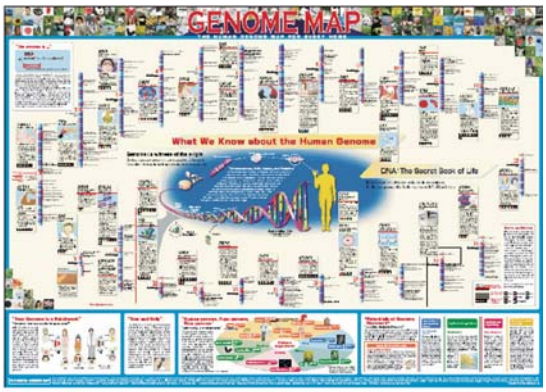
In addition to organizing practical activities such as "Genome Square", a public event (http://hiroba.genome.ad.jp/ in Japanese language only), we analyze the effects and significance of science communication. This includes the communication between scientists and the general public, and that among scientists and scientific communities.

2. Analysis of bioethical issues in biostudies.

We study ethical, legal and social implications of biostudies such as human genome research and human stem cell research.

3. Analysis of modern history of biostudies.

We analyze the development and changes of biostudies in the last 20 to 30 years through literature surveys and interviews with scientists.




The genome science poster: A human genome map for every home. (downloadable from: http://stw.mext.go.jp/20081025/)
We produce science communication tools such as this to convey scientific information to non-specialists, and we are also studying ethical, legal and social issues arising from bioscience research.

# Division of Systemic Life Science

## Laboratory of Science Communication

■ Professor **HEJNA James Alan**

■ Main theme

Our laboratory engages in the development and implementation of new approaches to the internationalization of science education and communication, based on principles of active learning. The particular challenges we are addressing often involve overcoming the differences in culture and pedagogical traditions between Japanese and Western societies, most potent obstacles that impede communication. Our efforts are chiefly in the educational arena, aimed at training the next generation of scientists to communicate their knowledge and expertise not only to the international scientific community but locally to the citizens who ultimately support basic research. Our activities entail the following:

1. Increasing the exposure of Japanese students to foreign peers. We are forging new partnerships with foreign universities to foster joint courses, using live Internet connections, with active student participation in English.
2. Establishing partnerships with foreign universities to encourage short-term reciprocal exchange of graduate students for collaborative research.
3. Expanding the opportunities for students to present their research in English to a broad audience.

## Laboratory of Bioeducation

■ Professor **CHISAKA,Osamu**

■ Main theme

Our laboratory has been trying to improve study materials on biology.

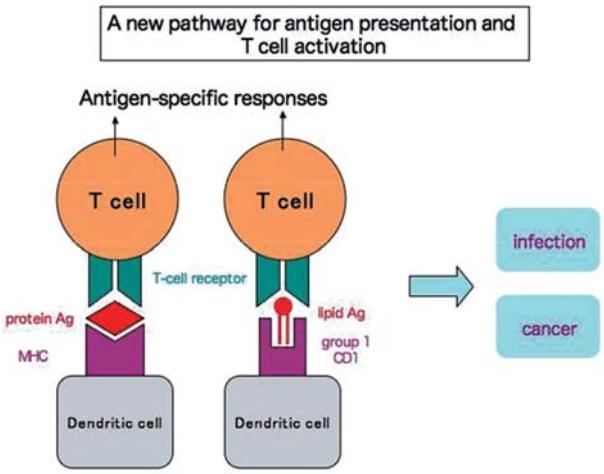
1. Introduction of modern topics into study materials on biology
2. Introduction of active learning methods into biology lectures in English
3. Exploitation of new biology lab course protocols and materials

## Laboratory of Cell Regulation and Molecular Network

■ Professor **SUGITA, Masahiko**
■ Assistant Professor **MORITA, Daisuke**

■ Main theme

Full attention of this laboratory has been directed to previously unappreciated aspects of the acquired immunity that we call "lipid immunity". Unlike conventional MHC molecules that present protein-derived peptide antigens, molecules of the human group 1 CD1 family (CD1a, CD1b, CD1c) mediate presentation of "lipid" antigens to specific T lymphocytes. In addition, we have recently identified a novel lineage of antigen-presenting molecules, termed LP1, capable of mediating presentation of "lipopeptide" antigens. By taking cell biological, immunological and lipid chemical approaches, this laboratory wishes to establish a molecular and cellular basis for lipid immunity and determine how CD1 and LP1 have been evolved to function critically in host defense. An important extension of this research is a challenge for developing a new type of lipid-based vaccines against cancer and microbial infection.



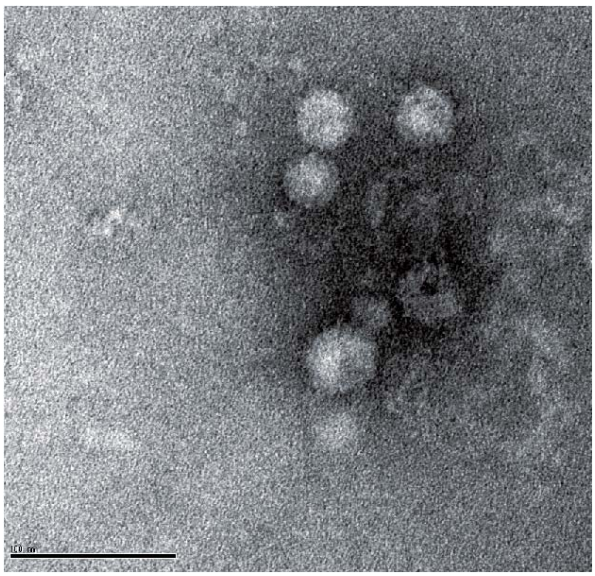

http://www.virus.kyoto-u.ac.jp/Lab/SugitaLab.html

## Laboratory of Viral Oncology

■ Professor **TOMONAGA, Keizo**
■ Associate Professor **HIJIKATA, Makoto**
■ Assistant Professor **HONDA, Tomoyuki**

■ Main theme

The researches carried out in our laboratory are focused on several RNA viruses, including bornavirus, influenza virus and hepatitis C virus. All our projects aim to understand the fundamental mechanisms of the replication and pathogenesis of these viruses. We are investigating the replication and persistent mechanism of the bornavirus in the cell nucleus. The understanding the biological significance of the endogenous element of bornaviruses in mammalian genomes is one of the main focuses of bornavirus researches. We also aim to develop a novel RNA virus vector using bornavirus, which can express stably functional small RNAs. In Influenza virus researches we examine the response of host cells to the virus infection. The understanding of the molecular mechanism of tumorgenesis caused by hepatitis C virus infection is also the main purpose of our laboratory.



http://www.virus.kyoto-u.ac.jp/virus/ganvirus.html

# Division of Systemic Life Science

## Laboratory of Cell Division and Differentiation

■ Professor **TOYOSHIMA, Fumiko**
■ Assistant Professor **MATSUMURA, Shigeru**
■ Assistant Professor **ODA, Yukako**

■ Main theme

Stem cells in adult tissues exist in a quiescent state. When they are needed in tissue homeostasis or repair, they exit quiescent state, undergo symmetric/asymmetric cell division, and give rise to differentiation-committed progenitor cells. Our group seeks to explore the molecular mechanisms underlying oriented cell division, stem cell quiescence, and cell fate determination. We want to know how stem cells response to the changes in the balance of body homeostasis during life events, including pregnancy.

Our research is focused on the following subjects:

1, Oriented cell division in culture cells and mouse tissues.
2, Quiescence VS Proliferation/differentiation of stem cells.
3, Proliferation and differentiation control of adult stem cells during pregnancy.

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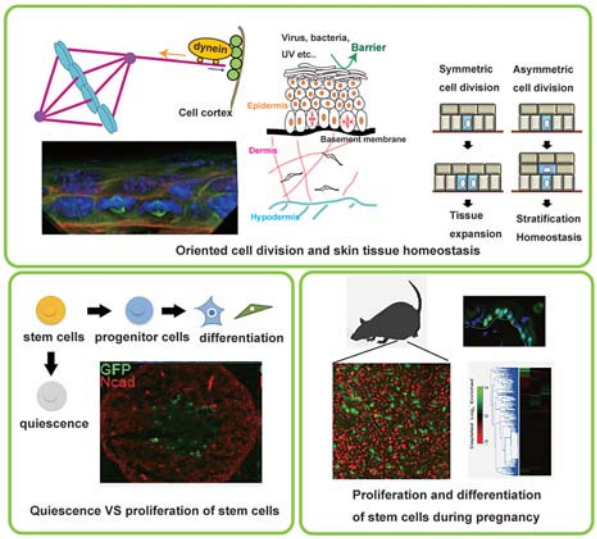



http://www.virus.kyoto-u.ac.jp/Lab/toyoshima.html

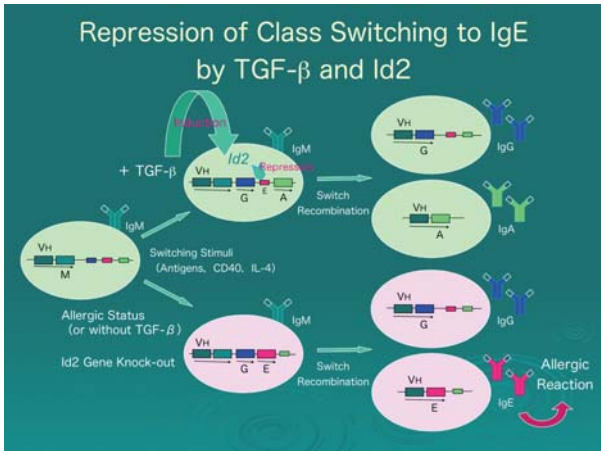
## Laboratory of Genetic Information

■ Professor **SHIMIZU, Akira**

■ Main theme

Major goal of research in this laboratory is to understand molecular and cellular mechanisms underlying highly systemic functions of living things, such as immune and neural systems. For this purpose, structure and regulation of genetic information responsible for such systemic functions are being analyzed using model animals, for example, transgenic or gene disrupted mice. Our research is focused on the following subjects:

1. Analysis of molecular mechanisms and regulation of chromatin modification, gene expression, gene rearrangements and RNA processing during lymphocyte differentiation.
2. Making and characterization of model mice of immunodeficiency or autoimmune by introduction of, or targeted disruption of interleukin, immunoglobulin or other genes.
3. Analysis of molecular and cellular mechanism for lymphocyte mobility and formation of immuno-microenvironment during development and immune reaction.



## Laboratory of Bio-functions Biomaterials

■ Professor **TABATA, Yasuhiko**
■ Associate Professor **YAMAMOTO, Masaya**
■ Assistant Professor **JO, Jun-ichiro**

■ Main theme

The main objective of our department is to proceed the research and development of methods, procedures, and technologies applicable to basic research of biology and medicine, and medicines (therapy, diagnosis, and prophylaxis) from the viewpoint of material sciences. The biomedical materials (biomaterials) to use in the body and to contact biological substances are being designed and created from biodegradable and non-biodegradable materials. Our goal is not only to carry out researches of tissue regenerative therapy (tissue engineering, cell transplantation, cell research, and drug discovery), drug delivery system (DDS), biomedical engineering, and stem cell technology, but also put the research results to clinical and practical uses.

■ Research contents

- Research and development of cell scaffolds and local release of bioactive drugs with biomaterials for regenerative medicine (regenerative therapy and research)
- Research and development of biomaterials for medical development
- Research and development of drug delivery system (DDS) for drug therapy, diagnosis, and prophylaxis
- Research and development of biomaterials for stem cells technology and drug discovery

**http://www.frontier.kyoto-u.ac.jp/te02/index_en.html**

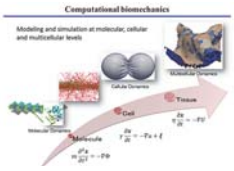
## Laboratory of Cellular and Molecular Biomechanics

■ Professor **ADACHI, Taiji**
■ Associate Professor **INOUE, Yasuhiro**
■ Assistant Professor **KAMEO, Yoshitaka**

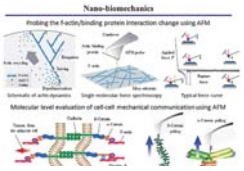
■ Main theme

Our research group aims to clarify the mechanisms by which cells sense mechanical stimuli and regulate their activities in tissue adaptation, regeneration and stem cell differentiation in morphogenesis. To better understand the mechano-regulation of these dynamical processes through the complex hierarchical structure-function relationships, bridging spatial and temporal scales from microscopic molecular/cellular activities to macroscopic tissue behaviors is very important. Based on multiscale biomechanics, our group is involved in the integrated biomechanics and mechanobiology researches of modeling and simulation combined with experiments, focusing on mechano-biochemical couplings in the system dynamics.

1. Biomechanics and mechanobiology studies on stem cell differentiation, morphogenesis, and remodeling in tissue development and regeneration.
2. Understanding mechanisms of tissue differentiation and regeneration emerged from multicellular dynamics.
3. Multiscale modeling and simulation of actin filament dynamics in cell migration.
4. Elucidation of mechano-biochemical coupling mechanisms in mechanosensory cells.
5. Nano- and microengineering of artificial systems combined with biomolecular and cellular systems.



Multiscale computational biomechanics on tissue morphogenesis



Nano-mechanical measurement of biomolecules

**http://www.frontier.kyoto-u.ac.jp/bf05/index-e.html**

# Organization (2015)

## DIVISION OF INTEGRATED LIFE SCIENCE

| Department | Laboratory | Professor | Associate Professor | Lecturer | Assistant Professor |
|---|---|---|---|---|---|
| Gene Mechanisms | Chromosome Transmission | TAKEYASU, Kunio | NAKASEKO, Yukinobu | | |
| | Gene Biodynamics | | SHIRAISHI, Hideaki | | |
| | Cell Cycle Regulation | ISHIKAWA, Fuyuki | | | SADAIE, Mahito |
| Cell and Developmental Biology | Cell Recognition and Pattern Formation | UEMURA, Tadashi | | | USUI, Tadao<br>HATTORI, Yukako |
| | Signal Transduction | NISHIDA, Eisuke | | | MIYATA, Yoshihiko<br>KUSAKABE, Morioh |
| Plant Gene and Totipotency | Plant Molecular Biology | KOHCHI, Takayuki | | NISHIHAMA, Ryuichi | YAMAOKA, Shohei<br>SUETSUGU, Noriyuki |
| | Molecular and Cellular Biology of Totipotency | SATO, Fumihiko | ENDO, Tsuyoshi | | IFUKU, Kentaro |
| Applied Molecular Biology | Biosignals and Response | NAGAO, Masaya | KAMBE, Taiho | | MIYAMAE, Yusaku |
| | Applied Molecular Microbiology | FUKUZAWA, Hideya | | | YAMANO, Takashi<br>KAJIKAWA, Masataka |
| | Molecular Biology of Bioresponse | KATAYAMA, Takane | MASUDA, Seiji | | |
| Responses to Environmental Signals and Stresses | Plant Developmental Biology | ARAKI, Takashi | ENDO, Motomu | | NIWA, Masaki |
| | Plasma Membrane and Nuclear Signaling | | YOSHIMURA, Shigehiro | | KUMETA, Masahiro |
| Molecular and Developmental Biology * | Genome Maintenance[1] | MATSUMOTO, Tomohiro | | | |
| | Nanobiology[2] | HARADA, Yoshie | | | |
| | Developmental Neurobiology[2] | KENGAKU, Mineko | | | |
| Molecular and Cellular Biology * | Molecular and Cellular Immunology[3] | FUJITA, Takashi | KATO, Hiroki | | |
| | Mammalian Molecular Biology[3] | | | | |
| | Developmental Dynamics[3] | KAGEYAMA, Ryoichiro | OHTSUKA, Toshiyuki | | KOBAYASHI, Taeko |

*Cooperation Course 1) Radiation Biology Center, 2) Institute for Integrated Cell-Material Sciences (iCeMS), 3) Institute for Virus Research

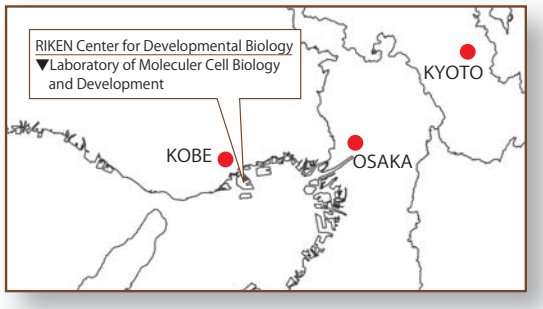
## DIVISION OF SYSTEMIC LIFE SCIENCE

| Department | Laboratory | Professor | Associate Professo | Lecturer | Assistant Professor |
|---|---|---|---|---|---|
| Molecular and System Biology | Single-Molecule Cell Biology | WATANABE, Naoki | | | YAMASHIRO, Sawako<br>MIZUNO, Hiroaki |
| | Bioimaging and Cell Signaling | MATSUDA, Michiyuki | | | IMAJO, Masamichi<br>KOMATSU, Naoki |
| Animal Development and Physiology | Molecular and Cellular Biology | YONEHARA, Shin | SAKAMAKI, Kazuhiro | | LEE, Kyung-Kwon |
| | Immunobiology | INABA, Kayo | | TAKAHARA, Kazuhiko | |
| | Molecular Cell Biology and Development ** | MATSUZAKI, Fumio[7] | IMAI, Takeshi[7]<br>KITAJIMA, Tomoya[7]<br>KURANAGA, Erina[7] | | |
| Signal Transductions | Molecular Neurobiology | NEGISHI, Manabu | KATO, Hironori | | OINUMA, Izumi |
| | Genetics | IGAKI, Tatsushi | | OHSAWA, Shizue | Enomoto, Masato |
| Functional Biology | Functional Biology | KAKIZUKA, Akira | IMAMURA, Hiromi | | SASAOKA, Norio<br>ABE, Megumi |
| Biostudies and Society | Science Communication and Bioethics | INABA, Kayo | | | |
| | Science Communication | HEJNA, James Alan | | | |
| | Bioeducation | CHISAKA, Osamu | | | |
| Mammalian Regulatory Network * | Cell Regulation and Molecular Network[4] | SUGITA, Masahiko | | | MORITA, Daisuke |
| | Viral Oncology[4] | TOMONAGA, Keizo | HIJIKATA, Makoto | | HONDA, Tomoyuki |
| | Cell Division and Differentiation[4] | TOYOSHIMA, Fumiko | | | MATSUMURA, Shigeru<br>ODA, Yukako |
| | Genetic Information[5] | SHIMIZU, Akira | | | |
| | Bio-functions Biomaterials[6] | TABATA, Yasuhiko | YAMAMOTO, Masaya | | JO, Jun-ichiro |
| | Cellular and Molecular Biomechanics[6] | ADACHI, Taiji | INOUE, Yasuhiro | | KAMEO, Yoshitaka |

*Cooperation Course 4) Institute for Virus Research, 5) Graduate School of Medicine, 6) Institute for Frontier Medical Sciences
**Collaboration Course 7) RIKEN Center for Development Biology

# Map & Access

## Getting to Kyoto University
URL: http://www.kyoto-u.ac.jp/en/access/




**Faculty of Medicine Bldg.F**
Laboratory of Bioimaging and Cell Signaling

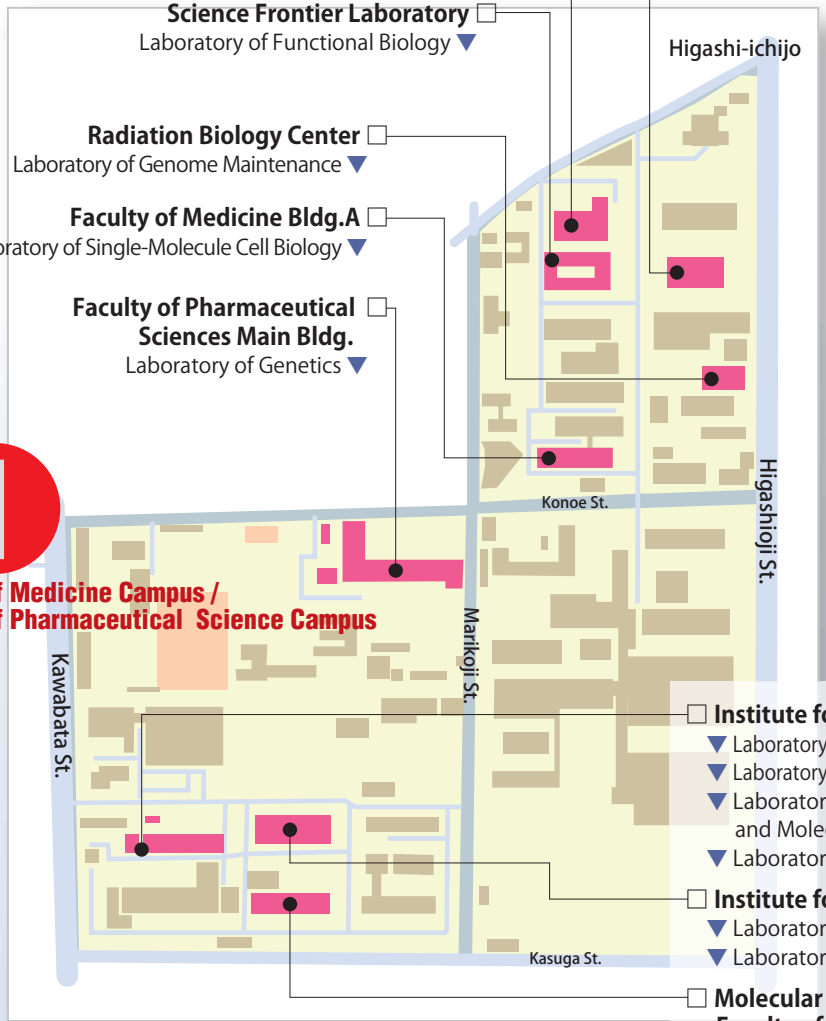
**South Campus Research Building for Integrated Life Sciences / Building G**
Laboratory of Chromosome Transmission
Laboratory of Cell Cycle Regulation
Laboratory of Cell Recognition and Pattern Formation
Laboratory of Plasma Membrane and Nuclear Signaling
Laboratory of Molecular and Cellular Biology
Laboratory of Immunobiology
Laboratory of Molecular Neurobiology
Laboratory of Science Communication
Laboratory of Bioeducation
Graduate School of Biostudies (Office)

**Science Frontier Laboratory**
Laboratory of Functional Biology

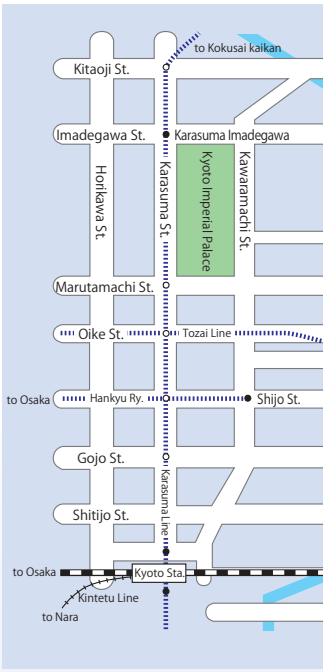
**Radiation Biology Center**
Laboratory of Genome Maintenance

**Faculty of Medicine Bldg.A**
Laboratory of Single-Molecule Cell Biology

**Faculty of Pharmaceutical Sciences Main Bldg.**
Laboratory of Genetics




**1 Faculty of Medicine Campus / Faculty of Pharmaceutical Science Campus**




**Institute for Virus Research Main Bldg.**
Laboratory of Molecular and Cellular Immunology
Laboratory of Developmental Dynamics
Laboratory of Cell Regulation and Molecular Network
Laboratory of Cell Division and Differentiation

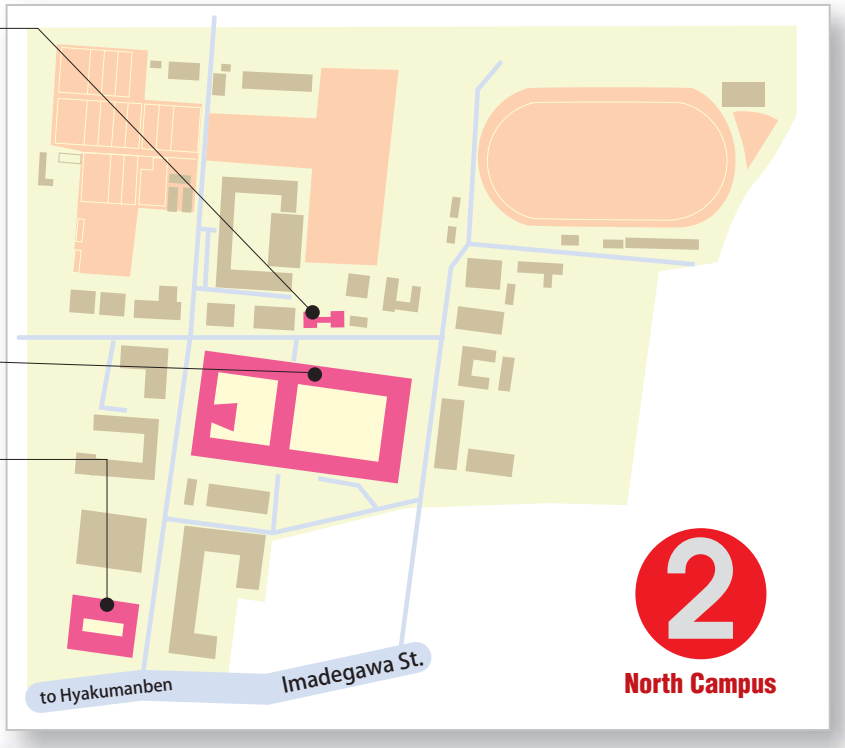
**Institute for Frontier Medical Sciences (East Bldg.)**
Laboratory of Bio-functions Biomaterials
Laboratory of Cellular and Molecular Biomechanics

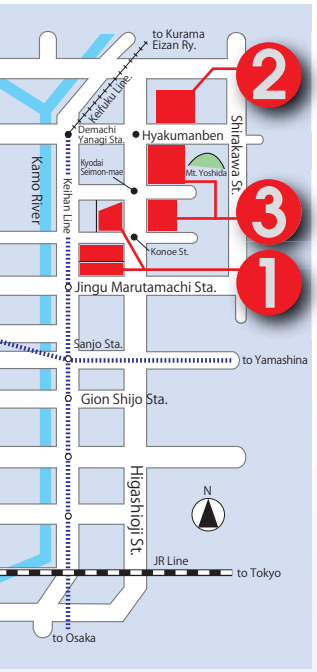
**Molecular Biology Research Bldg.**
**Faculty of Medicine Center for Genomic Medicine**
Laboratory of Mammalian Molecular Biology
Laboratory of Viral Oncology
Laboratory of Genetic Information

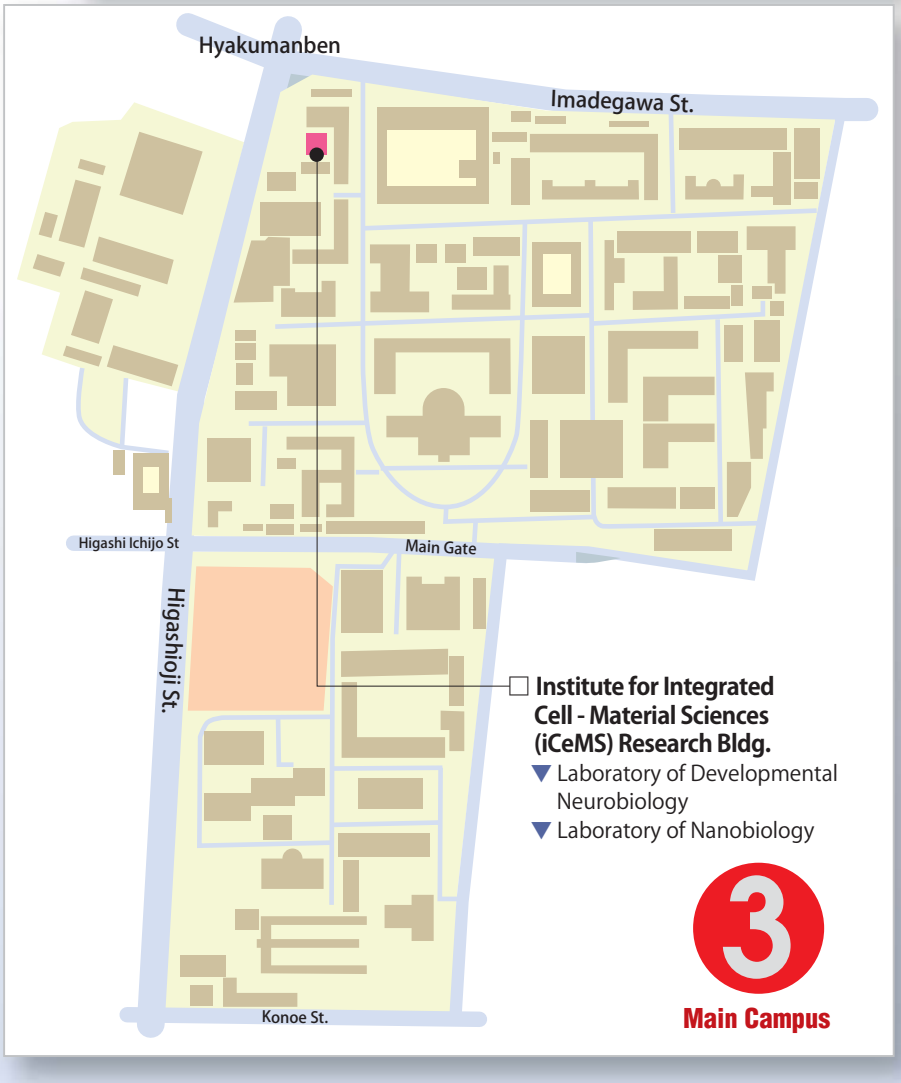
**North Campus Research Building for Integrated Life Sciences**
- Laboratory of Gene Biodynamics
- Laboratory of Plant Molecular Biology
- Laboratory of Biosignals and Response
- Laboratory of Applied Molecular Microbiology
- Laboratory of Molecular Biology of Bioresponse
- Laboratory of Plant Developmental Biology

**Faculty of Agriculture (Main Bldg.)**
- Laboratory of Molecular and Cellular Biology of Totipotency

**Faculty of Science (Bldg. No.2)**
- Laboratory of Signal Transduction




**Institute for Integrated Cell - Material Sciences (iCeMS) Research Bldg.**
- Laboratory of Developmental Neurobiology
- Laboratory of Nanobiology

# Contact

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## Other inquiries

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URL http://www.lif.kyoto-u.ac.jp/e/

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