GSB

Graduate School of BIOSTUDIES
Kyoto University

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BIOSTUDIES

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2021

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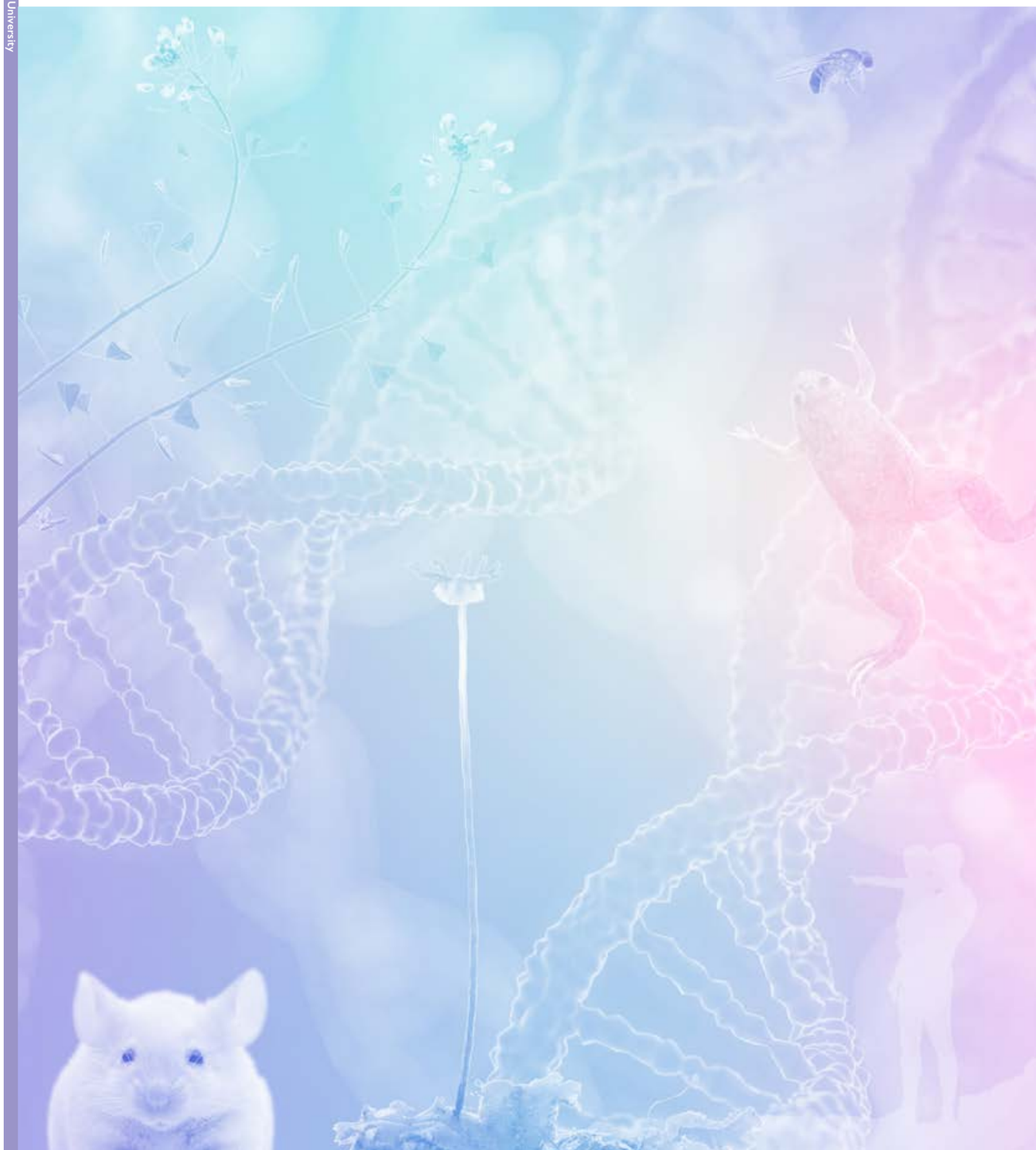


Graduate School of BIOSTUDIES,
Kyoto University

Expand your horizons!

In 1999, the Graduate School of Biostudies (GSB) was established as Japan's first independent graduate school by a group of faculty members who share a common language of molecular biology and whose research transcends the traditional framework of science, medicine, agriculture, and pharmacology. The GSB is organized into two multidisciplinary divisions: the Division of Integrated Life Science and the Division of Systemic Life Science. In order to broaden the research scope and educational area, the Radiation Biology Center and the Research Center for Dynamic Living Systems were added to the two Divisions in 2018. Further initiatives in the GSB include the Advanced Life Science Promotion Project for young faculty members, and industry-university joint laboratories in both divisions.

To develop creative individuals who can discover and solve problems on their own, the GSB emphasizes the participation of students in "free and original research" conducted by faculty members. In the laboratories where faculty members are exploring the frontiers of life science, students share their challenges and develop their scientific way of thinking, logic, and empirical skills. The fact that many research papers have been published with students as the first authors shows that students do not help faculty members with their research but play a leading role in science under the guidance of faculty members. To date, 1,599 master's degree graduates and 485 doctoral degree recipients have contributed not only to the field of academic research but also to the development of society at large. This has been the joy of all the faculty members who have been involved in research and education.

As scientists, we sometimes encounter phenomena that we have never seen before or that we cannot explain with our previous knowledge. We need to determine whether an observation is due to our own operational error, can be explained by known principles, or is a "seed" that will lead to a new discovery. By finding and nurturing these "seeds," we will be able to design new research projects. In turn, preliminary experiments may inform our conjectures about the principle behind them, leading to a formal hypothesis, and if we can prove the hypothesis through experiments, we can submit it as a paper. In order for a paper to be accepted by the scientific community, it needs to be recognized as "good" by several world-leading researchers. With this in mind, it is important to build an international network. Faculty members of the GSB have organized international conferences on world-standard model organisms established in our school, as well as technical workshops on fluorescence imaging and information processing using next-generation sequencers. These events have brought a stream of world-class investigators to our GSB students.

To encourage students to interact with scientists from around the world, the GSB provides remote lectures with overseas universities, a program for sending students abroad, an international student seminar program in which students invite overseas students and young researchers to participate, a program to support students from outside Japan, and a system for transferring credits and promoting joint research through inter-university agreements. We, the faculty and staff of the GSB, will do our utmost to support students as they gain scientific experience and establish a firm foundation for their future careers.

Dean, FUKUZAWA, Hideya

MISSIONS of our 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.

OPERATION POLICIES of our GRADUATE SCHOOL

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.

Admissions Policy

Master' s Program

As an advanced discipline that holds the key to the future of humankind, the life sciences today are undergoing a major evolutionary change. In response to this global trend, the Graduate School of Biostudies was founded in 1999 as Japan' s first independent graduate school focused on the life sciences with the objective of building a world-class center for research and developing individuals who can lead the life sciences field into the next generation. Our school has engineered a true fusion of cutting-edge areas in several existing fields. By harnessing the common language of “cells, molecules, and genes” that together form the fundamental principles of life, we have developed an integrated understanding of diverse life forms and the environments they help shape, and have launched innovative efforts in research and education that will produce a new set of values for the future and dignity of life.

To meet the diverse expectations of society for advances in the life sciences, which are becoming increasingly sophisticated and complex, our school seeks students from a broad spectrum of backgrounds who share these ideals of our school, who possess basic academic skills and research aptitudes in the life sciences, and who demonstrate a strong sense of ethics and responsibility in their academic research. We especially welcome students who possess a pioneering spirit to help propel the comprehensive and advanced branches of the life sciences, free from preconceptions, while fully appreciating the dignity of life. Accordingly, the Graduate School of Biostudies endeavors to cultivate individuals with the following attributes:

1. Researchers ready to discover, or to shed fresh light on, fundamental principles of life, who will pioneer new areas of the life sciences;
2. Researchers and engineers committed to global environmental conservation and gains in human health, welfare, and well-being, who are 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, who are ready to make social contributions through roles in education, industry, the news media, and government;
4. Researchers, educators, engineers, and working professionals who possess strong communication skills that enable them to hold discussions with researchers and others from Japan and around the world in life science–related fields.

The entrance exam will comprise achievement tests that include a written exam to evaluate the applicant' s ability to think logically in English, a skill that is required to read and analyze an article published in an international journal; a written exam to assess the applicant' s general knowledge of molecular biology, cell biology, biochemistry, and other life science fields; a written exam to assess the applicant' s fundamental knowledge as required to pursue his or her intended field of study; and an oral exam to assess the applicant' s judgement, thinking ability, communication skills, initiative, and ethical perspective. Admissions decisions will be made based on the applicant' s overall performance on these exams.

Doctoral Program

As an advanced discipline that holds the key to the future of humankind, the life sciences today are undergoing a major evolutionary change. In response to this global trend, the Graduate

School of Biostudies was founded in 1999 as Japan' s first independent graduate school focused on life sciences with the objective of building a world-class center for research and developing individuals who can lead the life sciences field into the next generation. Our school has engineered a true fusion of cutting-edge areas in several existing fields. By harnessing the

common language of “cells, molecules, and genes” that together form the fundamental principles of life, we have developed an integrated understanding of diverse life forms and the environments they help shape, and have launched innovative efforts in research and education that will produce a new set of values for the future and dignity of life.

To meet the diverse expectations of society for advances in the life sciences, which are becoming increasingly sophisticated and complex, our school seeks students from a broad spectrum of

backgrounds who share these ideals of our school, who possess broad academic knowledge and advanced expertise gained through their master' s education, who possess strong research ability,

and who demonstrate an even stronger sense of ethics and responsibility in their academic research. We especially welcome students who possess a pioneering spirit to help propel the

comprehensive and advanced branches of the life sciences, free from preconceptions, while fully appreciating the dignity of life. Accordingly, the Graduate School of Biostudies endeavors to

cultivate individuals with the following attributes:

1. Researchers ready to discover, or shed fresh light on, fundamental principles of life, who will produce world-class research results 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, who are ready to assume a leading role in public and private research institutions;
3. Educational leaders and high-level working professionals with a broad-based understanding of the varied phenomena of life, who are ready to assume a leading role in education, industry, the news media, and government;
4. Researchers, educational leaders, advanced engineers, and high-level working professionals equipped with strong logical explanation and communication skills, who can convey their ideas broadly to others in Japan and around the world and assume a leading role in a variety of fields.

The entrance exam will comprise achievement tests that include a written exam to evaluate the applicant' s ability to think logically in English, which is required for international communication; a presentation of the applicant' s research findings during their master' s program or elsewhere; and an oral exam to assess the applicant' s judgement, thinking ability, communication skills, initiative, and ethical perspective. Admissions decisions will be made based on the applicant' s overall performance on these exams.

Curriculum Policies of the Graduate School of Biostudies

Master' s Program

The Master' s Program offers courses that appropriately combine lectures, advanced studies, practical training, lab experiments, and seminars on specialized subjects in order to achieve the objectives set forth in the Diploma Policy. Courses conducted in English are also offered for international students. The curriculum is specifically designed in accordance with the following principles.

1. The curriculum is organized and delivered to cultivate broad scholarly knowledge spanning all domains of the life sciences, research capability in students' field of specialization, and specialized knowledge that will provide a foundation of competence for occupations that demand advanced expertise, based on the basic academic capabilities and specializations developed through education in the undergraduate program, as well as to enable the pursuit of cross-disciplinary study unencumbered by existing fields of specialization, which allows students to apply broad visions to put their own research into perspective and build systems of knowledge. Moreover, the curriculum includes practical training, lab experiments, workshops, and tutorials held in individual research labs that are designed to cultivate competence in research implementation, a capacity to explain research findings theoretically, communication skills, and firm ethical integrity and a sense of responsibility in academic research. Learning outcomes in each course are evaluated through written examinations, report examinations, and the outcomes of workshops, lab experiments, and practical training.
2. Emphasis is placed on students' proactive pursuit of a research theme that contributes academically or practically to the life sciences, mediated by research guidance and practical education, and leads to a master' s thesis with theoretical value. This thesis is assessed by a panel of three examiners in accordance with the Diploma Policy.

The curriculum created on the basis of the above policies is presented in curriculum maps, and the details of each individual course are clearly stated in the syllabus.

Doctoral Program

The Doctoral Program is comprised of lab-based research guidance and lectures designed to cultivate greater breadth of scholarly knowledge and advanced expertise in order to achieve the objectives set forth in the Diploma Policy. Courses conducted in English are also offered for international students. The curriculum is specifically designed in accordance with the following principles.

1. The curriculum is organized and delivered to further develop broad scholarly knowledge and advanced, specialized knowledge cultivated through education in the Master' s Program, and to enable students to acquire the basic capabilities required of an independent researcher who can perform well in an international setting. Moreover, research guidance is provided through special seminars and special workshops in individual research labs to cultivate advanced competence in research planning and implementation, a capacity to explain research findings theoretically, communication skills, and firm ethical integrity and a strong sense of responsibility in academic research. Learning outcomes in each course are evaluated through written examinations, report examinations, and the outcomes of workshops, lab experiments, and practical training.
2. Special emphasis is placed on students' proactive pursuit of a research topic that contributes to an academic or practical area of the life sciences, mediated by research guidance and practical education, and leads to a doctoral dissertation that contributes to the generation of new knowledge. This dissertation is assessed by a panel of three examiners and one or more expert examiner in accordance with the Diploma Policy.

The curriculum created on the basis of the above policies is presented in curriculum maps, and the details of each individual course are clearly stated in the syllabus.

Requirement for completing the Master' s program

- The Life-Science Experiments and Exercises (20 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.

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.

Diploma Policy of the Graduate School of Biostudies

Master' s Program

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 seeks to respond to this global change by building a world-class center for research and by training human resources to lead the life sciences field into the next generation. Our school has engineered a true 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 fundamental principles of life. Furthermore, it has developed an integrated understanding of diverse life forms and the environments they help shape, adding the perspective of mathematical science, 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 the life sciences, which are becoming increasingly sophisticated and complex, the Graduate School of Biostudies confers the degree of Master of Biostudies on students who maintain enrollment for the requisite period, complete curricular courses, earn the prescribed number or more of credits in accordance with the Curriculum Policy, and pass a review and examination of a master' s thesis prepared after undergoing the required research guidance. A further prerequisite for degree conferment is the attainment of the following:

1. Broader-based scholarly knowledge; research capability in their field of specialization; and advanced, specialized knowledge required for occupations that demand advanced expertise
2. Firm ethical integrity and a sense of responsibility in academic research in the life sciences field
3. Appropriate capabilities in research implementation in order to set topics and themes based on scholarly knowledge, techniques, and skills in the life sciences field, and to achieve solutions and development thereof
4. Appropriate skills in theoretical explanation and communication required to promote one' s research findings to researchers in one' s own specialization and fields related thereto, and to deepen mutual understanding
5. A master' s thesis, presented with theoretical rigor and clarity, with appropriate setting of research goals, planning, and execution of experimental work related thereto and discussion in regard to the findings thereof

Doctoral Program

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 seeks to respond to this global change by building a world-class center for research and training human resources to lead the life sciences field into the next generation. Our school has engineered a true 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 fundamental principles of life. Furthermore, it has developed an integrated understanding of diverse life forms and the environments they help shape, adding the perspective of mathematical science, 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 the life sciences, which are becoming increasingly sophisticated and complex, the Graduate School of Biostudies confers the degree of Doctor of Biostudies on students who maintain enrollment for the requisite period, complete curricular courses, earn the prescribed number or more of credits in accordance with the Curriculum Policy, and pass a review and examination of a doctoral dissertation prepared after undergoing the required research guidance. A further prerequisite for degree conferment is the attainment of the following:

1. Broad-based scholarly knowledge and advanced, specialized knowledge to engage as independent researchers or lead careers in advanced professional occupations
2. Firm ethical integrity and a strong sense of responsibility in academic research in the life sciences field
3. Advanced capabilities in research planning and execution in order to set unique topics and themes based on scholarly knowledge, techniques, and skills in the life sciences field, and to achieve solutions and development thereof through planning and implementation of joint research with other research institutions as necessary
4. Advanced skills in theoretical explanation and communication required to promote one' s research findings to researchers in one' s own specialization and fields related thereto, and to deepen mutual understanding
5. Doctoral dissertation that includes research findings demonstrating new discoveries or concepts that contribute academically or practically to the life sciences

Candidates considered to have made outstanding progress in their studies and research may be eligible for completion of the doctoral program in a reduced period of enrollment.

Composition of Departments

Research Laboratories in the Graduate School of Biostudies

Division of Integrated Life Science

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.

Dept. of Gene Mechanisms
Chromosome Transmission/Gene Biodynamics/Cell Cycle Regulation — 9

Major interest is the molecular mechanism of higher order phenomena (cell proliferation, morphogenesis, canceration, aging, etc.) and the cellular function (cell cycle, chromosome replication, segregation, maintenance and repair, etc.) in unicellular and multicellular organisms.

Dept. of Cell and Developmental Biology
Cell Recognition and Pattern Formation/Signal Transduction — 11

We are studying signal transduction mechanisms that control organogenesis and animal growth in response to nutrition and growth factors. We are also dissecting operating principles of neuronal circuits that evoke behaviors to sensory stimuli.

Dept. of Plant Gene and Totipotency
Plant Molecular Biology/Molecular and Cellular Biology for Totipotency — 13

The department pursues the basic research and application of molecular and cellular principles related to plant growth and development. We take approaches by cell biology, chemical biology, molecular and cellular biology, molecular genetics, and genomics.

Dept. of Applied Molecular Biology
Biosignals and Response/Applied Molecular Microbiology/ Molecular Biology of Bioresponse — 15

Signal response mechanisms have evolved in organisms through adaptations to fluctuations or changes in the natural environment. These mechanisms are being elucidated using various model organisms at different levels (individual, organ, tissue, cell, molecule and gene), and directing this knowledge toward applications with benefits to human welfare is a priority.

Dept. of Responses to Environmental Signals and Stresses
Plant Developmental Biology/ Plasma Membrane and Nuclear Signaling — 18

We aim at understanding fundamental systems underlying environmental responses by organisms through structural-functional study of information molecules involved in environmental responses and study of regulatory mechanisms of development in response to environmental signals.

Dept. of Molecular and Developmental Biology
Developmental Neurobiology/Biochemical Cell Dynamics/ Multidisciplinary Biology — 19

The development, function, and maintenance of tissues and organs are regulated by a coordinated interplay of cell-intrinsic programs and intercellular signals. We seek their mechanisms at cellular, organellar and molecular mechanisms using various model systems, including the brain and immune systems.

Dept. of Molecular and Cellular Biology
Molecular and Cellular Immunology/Developmental Dynamics/ Ultrastructural Virology — 21

We study on mammalian development, differentiation, aging and viral immunity. We utilize molecular biology and developmental engineering as tools of analyses to elucidate mechanisms at molecular, cellular and animal levels.

Dept. of Human-Residential Bifidobacteria (HRB) Research (Industry-Academia Collaboration Course)
Symbiotic and Coevolutionary Mechanisms — 23

The mission of this department is to elucidate the mechanisms underlying symbiosis between bifidobacteria and their human host, and to understand the molecular basis of the health-promoting effects of probiotic Bifidobacterium strains.

Attached Research Centers

Radiation Biology Center
Radiation System Biology/Mutagenesis/Late Effects Studies/Genome Repair Dynamics/ Chromosome Function and Inheritance/Stress Response — 43

Our center is trying to elucidate basic mechanisms behind biological responses to irradiation as well as chromosomal damages, and thereby pursue fundamental basis for evaluation of radiation exposure risks and for efficacious radiation therapy. To achieve the goals, our center is acting as a joint usage research center to promote collaborations among researchers in the community.

Research Center for Dynamic Living Systems
Cutting-edge Bioimaging/Multiscale Biomechanics/Physiological Network/Biological Function Manipulating/Spatio-temporally controlled biophotonics/Dynamic Genome Systems — 45

We aim at understanding the life as dynamic living systems. We observe the dynamic behavior of molecules and cells with cutting-edge technologies of microscopy, optogenetics, and mouse genomics. Based on the accumulated multidimensional data, we will uncover the working principles of life by the approaches of mathematics and informatics.

Division of Systemic Life Science

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.

Dept. of Molecular and System Biology
Single-Molecule Cell Biology — 24

We will challenge direct viewing of biomolecular dynamics using single-molecule imaging and multi-target super-resolution microscopy IRIS. By elucidating the molecular basis of morphogenesis and the action of drugs, we will pursue principles in biology and seeds for drug development.

Dept. of Animal Development and Physiology
Molecular and Cellular Biology/Immunobiology/ Molecular Cell Biology and Development — 25

The objectives of our studies are to clarify the mechanisms that regulate hierarchical structures composing cells, tissues, organs, at the molecular, cellular, and individual levels, especially about cell growth, differentiation, cell death, cell-cell interactions, and histogenesis.

Dept. of Signal Transductions
Molecular Neurobiology/Genetics — 27

Cancer, autoimmune diseases, and life-style related diseases can be caused by genetic abnormalities and aberrant response mechanisms. We aim to reveal dysfunctional biological mechanisms of cell proliferation, cancer, and immunological, genetic diseases.

Dept. of Functional Biology
Functional Biology — 29

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.

Dept. of Biology Education and Heredity
Science Communication/Bioeducation/ Chromosome Function and Inheritance — 30

Development of effective teaching materials for biological sciences.

Dept. of Systems Biology
Bioimaging and Cell Signaling/Theoretical Biology/Brain Development and Regeneration — 33

By the use of cutting-edge technologies of microscopy, optogenetics, and chemical biology, we will study the information that living organism perceive. Based on the accumulated information, mathematical models are built to understand systematically the mechanism of information processing of living organisms.

Dept. of Genome Biology
Genome Maintenance/Genome Damage Signaling/Cancer Cell Biology/ Chromatin Regulatory Network — 36

Genome and epigenome information are maintained by an intricate molecular system acting against exogenous and endogenous perturbations. We aim to study defects in these mechanisms that result in human disorders.

Dept. of Mammalian Regulatory Network
Cell Regulation and Molecular Network/RNA Viruses/ Cell Division and Differentiation/ Cellular and Molecular Biomechanics — 40

Laboratories consisting of this Department study multi-dimensional networks of life signals that contribute to the integrity of higher organisms. Studies also include those utilizing viruses, animal models, and biomaterials, serving to establish basic principles in life science.

Dept. of Advanced Imaging (Industry-Academia Collaboration Course)
Spatiotemporal Optical Control / Optical Neural and Molecular Physiology — 42

We will understand the principle of biological functions by measuring and manipulating dynamics of genes and molecules multidimensionally with cutting-edge imaging, optical control technologies, and optical probes.

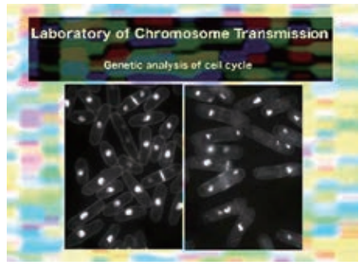
Laboratory of Chromosome Transmission

Assoc. Prof.
NAKASEKO, Yukinobu

Main theme

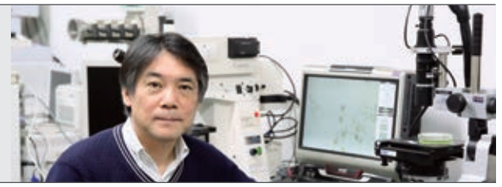
We are focusing on analyzing the genes involved in regulation of chromosome function. Especially, the genes essential for mitosis have been studied. Fission yeast Schizosaccharomyces pombe is used as a model system. This yeast has all basic features essential for eukaryotic cell division. Many genes 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.



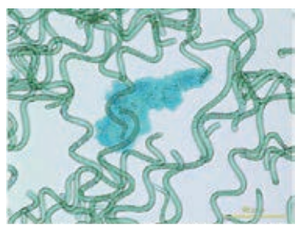
Laboratory of Gene Biodynamics

Assoc. Prof.
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 alkalophilic 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. We are currently focusing on developing tools for molecular genetic studies of this cyanobacterium.



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

Lab URL http://kuchem.kyoto-u.ac.jp/seika/

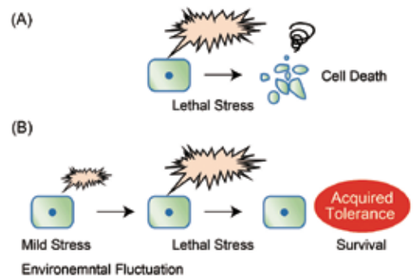
Laboratory of Cell Cycle Regulation

Professor
ISHIKAWA, Fuyuki

Main theme

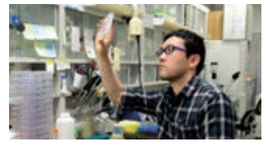
Stable maintenance of genetic information is essential for cell viability. Genetic instability, a condition in which the genome is not properly maintained, causes numerous pathologies including cancer and aging. Transposable elements (TEs) mobilize to other genomic loci and comprise ~45% of our genome. We are interested in how TEs destabilize genetic information and cause various diseases-associated phenotypes. Aging can be defined as the accumulation of damaged cells caused by various stresses. Stress is generally considered to be non-adaptive. However, low-dose stress can act in an adaptive role by fostering cell resistance to prospective lethal stresses. This process is termed acquired tolerance (or hormesis) and its molecular mechanisms remain largely unknown. We are trying to understand how acquired tolerance is induced molecularly. Arguably, cancer cells in vivo acquire stress resistance through experiencing ever-lasting environmental changes. As such, inhibiting the acquired tolerance in cancer cells may lead to fragility of cancers to various stresses, including iatrogenic ones.

- Functional roles of acquired tolerance in various physiological and pathological conditions.
- Development of therapeutic strategies for cancer by elucidating the mechanisms of cellular senescence.
- Mechanisms of retrotransposition and its impact on genomic instability in the mammalian genome.



In general, cells exposed to lethal stress undergo cell death (A). However, cells preconditioned with mild stress can become resistant to subsequent lethal stresses (B). This process is called acquired tolerance or hormesis: an adaptive behavior that is crucial for survival in an ever-changing environment. In vivo, cancer cells can experience environmental changes such as hypoxia and iatrogenic stress. This is in contrast to normal cells that live in a stable niche given by the tissue. It is possible that cancer cells are pre-conditioned by the environmental changes to prepare for the prospective lethal stress. Therefore, inhibition of this acquired tolerance may make cancer cells sensitive to anti-cancer therapeutics.

Assoc. Prof.
MIYOSHI, Tomoichiro



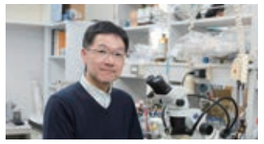
Assist. Prof.
NAKAOKA, Hidenori

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

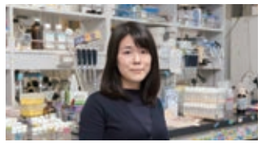
Laboratory of Cell Recognition and Pattern Formation

Professor
UEMURA, Tadashi

Senior Lecturer
USUI, Tadao



Assist. Prof.
HATTORI, Yukako

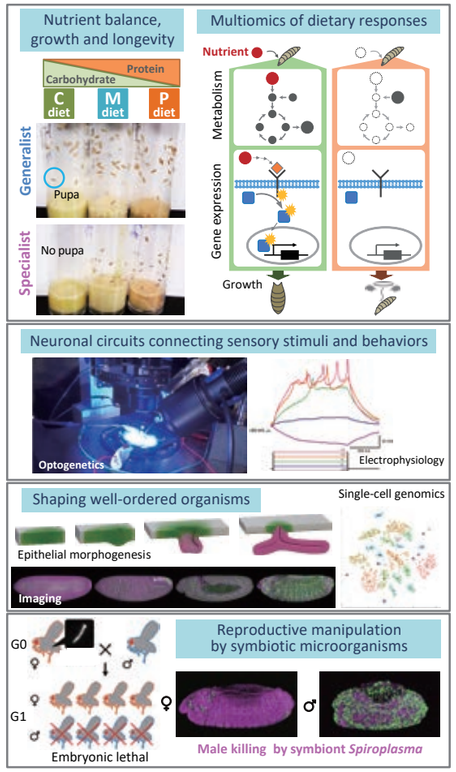


Program-Specific Assist. Prof.
KONDO, Takefumi

Main theme

We are interested in:

1. Contributions of nutrients and associated microbes to animal growth and aging
2. Neuronal circuits that evoke selective behaviors in response to sensory stimuli
3. Epithelial morphogenesis consisting of complex levels of hierachy
4. Reproductive manipulation (“male killing”) caused by insect symbionts



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

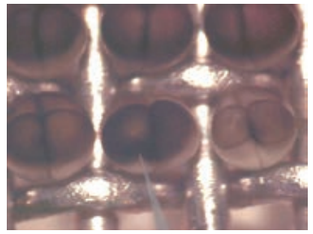
Laboratory of Signal Transduction

Senior Lecturer
KUSAKABE, Morioh

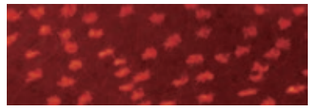
Assist. Prof.
MIYATA, Yoshihiko

Main theme

We are interested in identifying and elucidating molecular mechanisms that regulate cell proliferation, cell differentiation 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) roles of protein kinases in cell regulation, 4) signaling mechanisms in developmental processes.



Microinjection into *Xenopus laevis* embryos at the cleavage stage



Multiciliated cell differentiation in a salt-and-pepper pattern

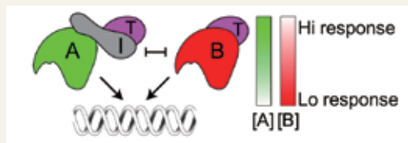
http://www.signal.lif.kyoto-u.ac.jp/ Lab URL

TOPICS

Design principles of a minimal auxin response system

This study was published in *Nature Plants* on 16th May, 2020.

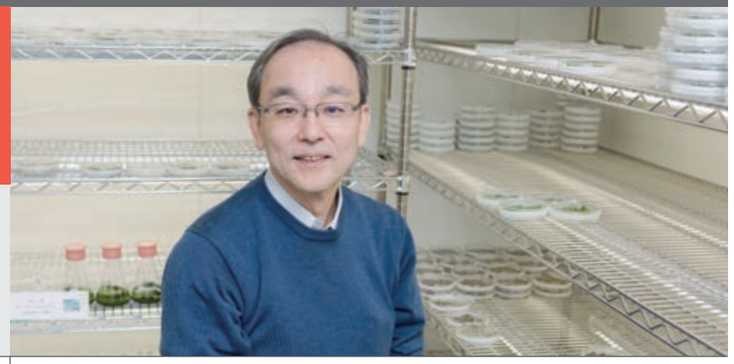
The research group of ex-graduate students Hirotaka Kato, Hidemasa Suzuki, and Emi Hainiwa, Assistant Professor Yoshihiro Yoshitake, ex-Associate Professor Ryuichi Nishihama and Professor Takayuki Kohchi, in collaboration with Professor Dolf Weijers’ s group in University of Wageningen elucidated design principles of a minimal auxin response system.
Comments from the research group:
We successfully derived an intuitive and simple model where a single auxin-dependent transcription factor activates gene expression. It is antagonized by an auxin-independent but structurally related transcription factor that represses common target genes. The expression patterns of both proteins define developmental zones where auxin response is permitted, quantitatively tuned or prevented. This fundamental design probably represents the ancestral system and formed the basis for inflated, complex systems. Simplicity is a big advantage of the studies using the liverwort *Marchantia polymorpha*, an emerging model plant established in Kyoto University.



Minimal auxin response model: Activator ARF (A) and repressor ARF (B) compete for binding to the same targets, where the stoichiometry of both determines the auxin responsiveness.

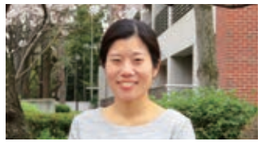
Kato, H., Mutte, S. K., Suzuki, H., Crespo, I., Das, S., Radoeva, T., Fontana, M., Yoshitake, Y., Hainiwa, E., Berg, W., Lindhoud, S., Ishizaki, K., Hohlbein, J., Borst, J. W., Boer, D. R., Nishihama, R., Kohchi, T. & Weijers, D. Design principles of a minimal auxin response system. ***Nature Plants*** vol. 6, issue 5, pp. 473-482, 2020.
DOI : https://www.nature.com/articles/s41477-020-0662-y

Laboratory of Plant Molecular Biology



Professor
KOHCHI, Takayuki

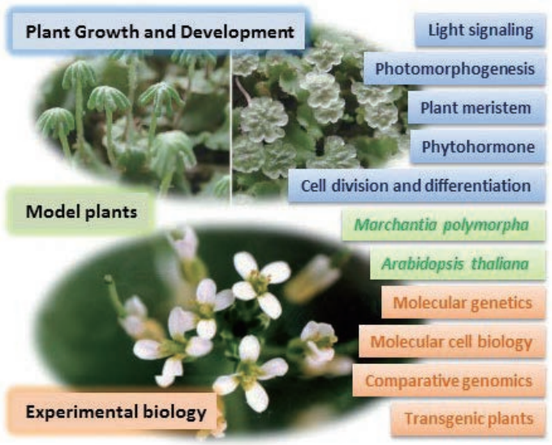
Assist. Prof.
YASUI, Yukiko



Assist. Prof.
YOSHITAKE, Yoshihiro

Main theme

Research in this laboratory focuses on the adaptive regulation of growth and development to environmental conditions and its evolution by using model photosynthetic organisms. Especially with the liverwort *Marchantia polymorpha*, which is a basal land plant ideal for comparative evolutionary studies and amenable to molecular genetic manipulation, we aim to elucidate principles and ancestral molecular mechanisms of photomorphogenesis, growth phase transition, phytohormone signaling, meristem function, sex determination, and sex differentiation in land plants.



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

Laboratory of Molecular and Cellular Biology for Totipotency

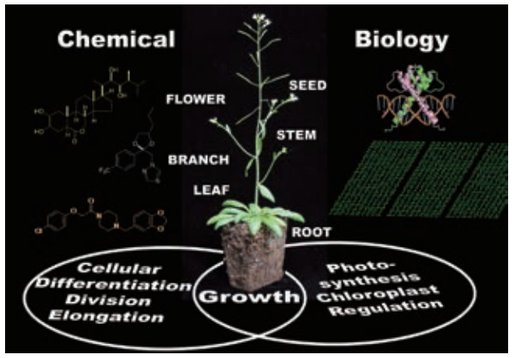
Professor
NAKANO, Takeshi

Main theme

Plant growth has been administrated by cooperative regulations between plant cell differentiation/division/elongation and photosynthesis. Based on these scientific aspects, our laboratory is trying to reveal the plant growth mechanisms by 'chemical biology' and 'molecular and cellular biology' .

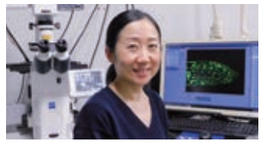
Major research topics are:

(1) Growth regulation by plant hormone signaling
(2) Chloroplast regulation by prassinosteroid
(3) Chemical functions to regulate plant growth and differentiation
(4) Plant biomass production regulated by chemicals and genes
(5) Evolution and diversity of steroid hormones



http://plantchembio.sun.bindcloud.jp/index.html Lab URL

Assist. Prof.
YAMAGAMI, Ayumi



Laboratory of Biosignals and Response

Professor
NAGAO, Masaya

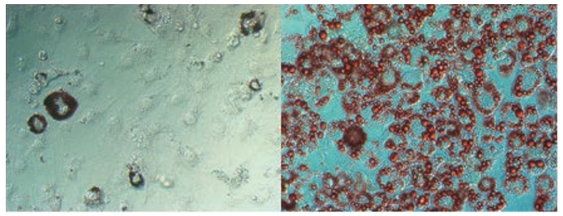
Assoc. Prof.
KAMBE, Taiho

Assist. Prof.
NISHINO, Katsutoshi

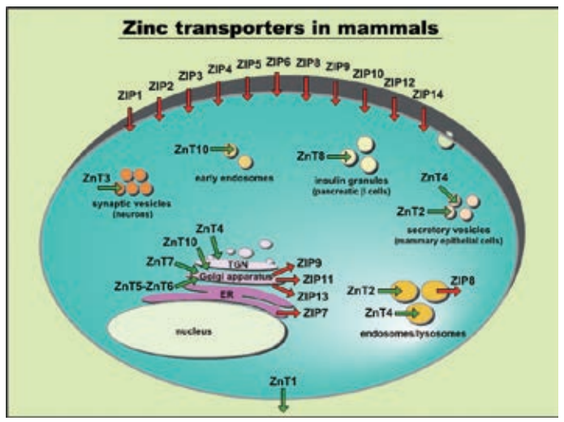
Main theme

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, compounds that are useful for treatment of lifestyle-related diseases and cancer 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



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

Laboratory of Applied Molecular Microbiology

Professor
FUKUZAWA, Hideya

Main theme

We are focusing on the molecular basis of biological functions of microalgae contributing to production of food, biofuel and industrial materials through photosynthesis. Especially, we employ a green alga, *Chlamydomonas reinhardtii*, as a model eukaryotic photosynthetic microorganism using genomic, proteomic, genetic, molecular and biochemical techniques.

The current projects are

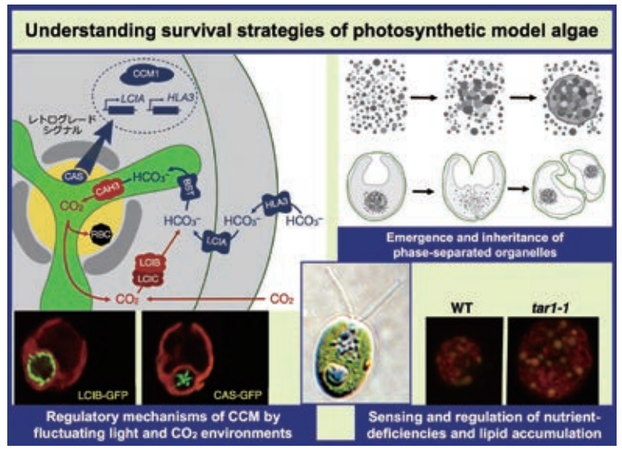
(1) Molecular characterization of the carbon-concentrating mechanism (CCM) supporting photosynthetic carbon fixation, biofuel production, and cell proliferation.

(2) Elucidation of regulatory systems controlling photosynthesis and carbon/nitrogen metabolisms by sensing environmental factors including changes of levels in CO_2 concentration, light and nutrients.

(3) Development and utilization of genome information and genome resources of the green alga Chlamydomonas reinhardtii.

(4) Molecular control and signaling of sexual reproduction and oil production by nutrient starvation.

(5) Identification of factors essential for intracellular signal transduction including calcium-dependent retrograde signal from chloroplast to nucleus and DYRK family of protein kinases supporting cell survival.



Assoc. Prof.
YAMANO, Takashi

Assist. Prof.
TSUJI, Yoshinori

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

Laboratory of Molecular Biology of Bioresponse

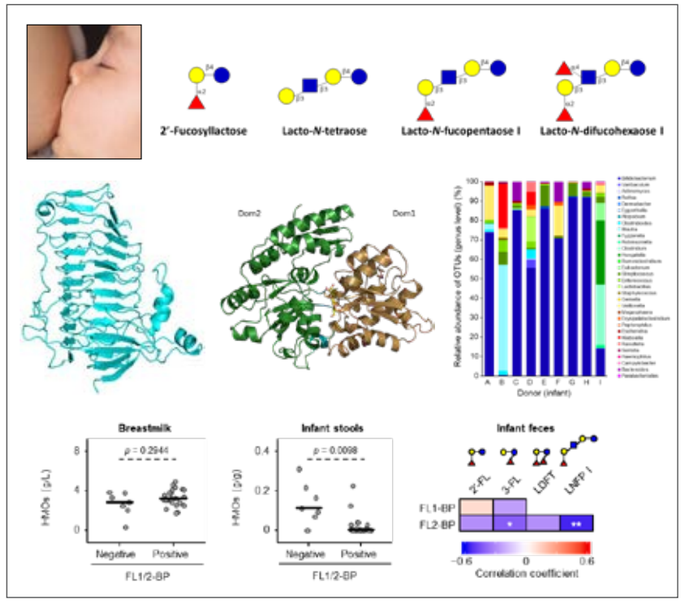
Professor
KATAYAMA, Takane

Assist. Prof.
KATOH, Toshihiko

Main theme

We are conducting research focusing on the symbiosis and co-evolution between gut microbes and the host. In particular, we are trying to understand the molecular basis of how gut microbes proliferate and persist in the host gut by assimilating milk oligosaccharides and mucin O-glycans produced by the host.

- Symbiosis between bifidobacteria and infants mediated through breastmilk
- Carbohydrate assimilation mechanism in gut microbes
- Aromatic amino acid metabolism in gut microbes
- Development of an apical aerobic co-cultivation system



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

Laboratory of Plant Developmental Biology

Professor
ARAKI, Takashi

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 reproductive transition) in response to environmental signals, (2) mechanism of day-length perception by photoreceptors and circadian clock, (3) long-distance systemic signaling (e.g. florigen) in the control of development, (4) sexual reproduction processes (especially, germline specification and gametogenesis), and (5) origin and evolution of regulatory systems for plastic development.

Assoc. Prof.
YAMAOKA, Shohei

Assist. Prof.
INOUE, Keisuke

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

Laboratory of Plasma Membrane and Nuclear Signaling

Assoc. Prof.
YOSHIMURA, Shigehiro

Assist. Prof.
KUMETA, Masahiro

Main theme

Our laboratory studies dynamic properties of cellular proteins and membrane in cellular environments by using a variety of techniques in biochemistry, cellular biology and biophysical approaches. We are also interested in how those dynamics of cellular architectures are related to diseases.
Specific research topics include:

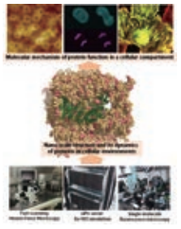
(1) Cytoskeletal dynamics in cell motility and metastasis: intracellular dynamics of actin cytoskeleton is elucidated by our live-cell nano-imaging technique.

(2) Molecular mechanism of signal transduction: how plasma membrane and membrane -bound proteins coordinates endocytic process.

(3) Virus vs host cell at cell surface: imaging viral particle at the host plasma membrane to elucidate the mechanism of viral infection and proliferation.

(4) Proteins in molecular crowding: dynamic assembly and disassembly of proteins and nucleic acids in cellular environments.

(5) How do cells feel force?: elucidating molecular mechanism of mechano-sensing and -responses by combining various biophysical approaches



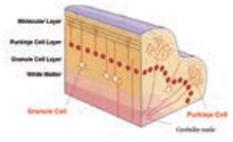
Lab URL http://www.chrom.lif.kyoto-u.ac.jp/

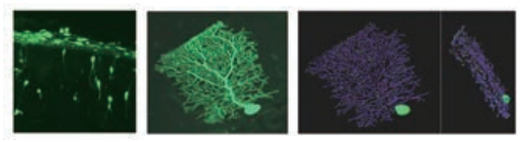
Laboratory of Developmental Neurobiology

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.





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

Laboratory of Biochemical Cell Dynamics

Professor
SUZUKI, Jun

Main theme

In principle, we identify specific genes regulating the biological phenomenon with our interests. The main approaches are as follows: Expression cloning using cDNA library, functional screening using sgRNA library in a CRISPR/Cas9 system, biochemical approach in combination with mass spectrometry. By establishing the robust experimental systems, we try to reveal the secrets of biological phenomenon. Currently, we are interested in the biological phenomenon called phospholipid scrambling that regulates blood coagulation, engulfment of dead cells, cell fusion, cancer progression, stress response, regulation of brain/bone/muscle functions and so on. In spite of its importance in various biological systems, much is unknown about how phospholipid scrambling is regulated. We are going to uncover the mechanisms.

Research Topic

- Identification of novel scramblases on plasma membranes
- Identification of novel scramblases on intracellular membranes
- Identification of regulators or subunits in scramblases
- Understanding physiological roles of scramblases
- Understanding how diseases occur by scramblase deficiency
- Understanding mechanisms of removal of unwanted cells
- Developing in vivo screening systems

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

Laboratory of Multidisciplinary Biology

Professor
TANIGUCHI, Yuichi

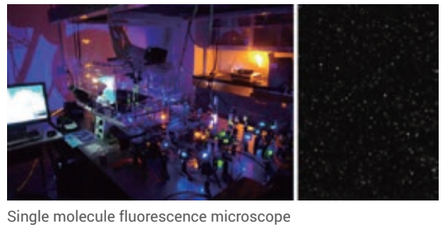
Main theme

We aim to understand the working principle of complex biological systems (e.g. the cell and genome) constituted with a wide variety of molecules. Based on knowledge of multiple academic fields including biology, physics, chemistry, computer science, engineering and informatics, we challenge development of new innovative technologies and creation of new life science fields.

Research Topic

- Elucidating the working principles of the genome based on molecular or atomic structures
- Understanding the constitutional principles of single cells
- New principles and methods in disease diagnosis and treatment

Nucleosome-resolved 3D genome structure



Single molecule fluorescence microscope

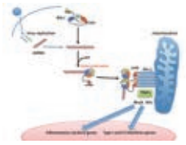
https://taniguchi.icems.kyoto-u.ac.jp/en Lab URL

Laboratory of Molecular and Cellular Immunology

Professor
NODA, Takeshi
(Concurrent post)

Main theme

Virus infections, such as influenza A epidemic, Ebola hemorrhagic fever, Middle East respiratory syndrom, Zika virus infection are 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.

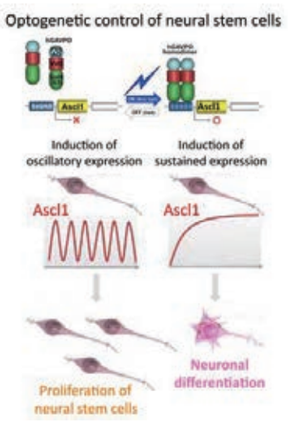


Laboratory of Developmental Dynamics

Assoc. Prof.
OHTSUKA, Toshiyuki

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. We found that oscillatory gene expression is important for many developmental processes such as brain morphogenesis and somite formation.



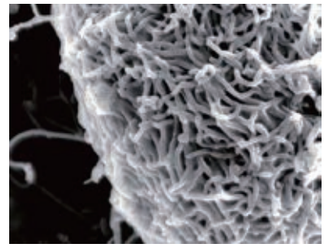
Lab URL http://www.infront.kyoto-u.ac.jp/research/lab28/

Professor
NODA, Takeshi

Laboratory of Ultrastructural Virology

Main theme

Virus infections are accompanied by numerous ultrastructural changes in viral and cellular components. Our laboratory has been investigating the replication mechanism of influenza and Ebola viruses from the ultrastructural point of view, by using different microscopic methods such as electron microscopy and high-speed atomic force microscopy. Visualization and characterization of the virus life cycle at the nano-mesoscopic level give us unique knowledge and novel paradigms, which will advance our understanding of molecular basis of the replication mechanism.



Scanning electron micrograph of Ebola viruses budding from cell surface.

Lab URL https://www.facebook.com/NodaLab/

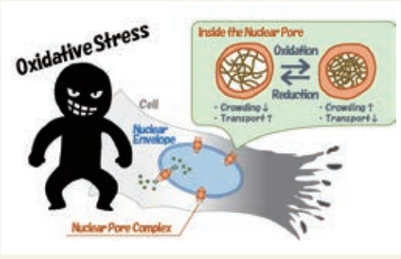
Assist. Prof.
NAKANO, Masahiro

Assist. Prof.
MURAMOTO, Yukiko

TOPICS

Control the Crowd - in the world of molecule -

The Yoshimura lab showed that the nature of the molecular crowding barrier within the nuclear pore complex is adaptively regulated in response to the different redox environment, leading to the proper control of molecular transport across the nuclear membrane.
The nuclear pore complex embedded in the nuclear membrane contains phase separated molecular crowding barrier within the pore that enables selective transport of macromolecules. In a study by Zhang W, Kumeta M, and Yoshimura SH in the laboratory of plasma membrane and nuclear signaling, adaptive regulation of the barrier under different redox environment has been investigated. They utilized a crowding-sensitive FRET (Förster Resonance Energy Transfer) probe to directly measure the crowding states in living cells and found drastic changes of crowding states in response to redox environmental condition, which was led by specific subunits of the nuclear pore. Single fluorescence observation of the nuclear transport further revealed the correlation between the crowding states and the nuclear transport activity. These findings uncovered a mechanism of adaptive regulation of nuclear transport system by modulating molecular crowding states in the pore.



These findings were published in *Cell Reports*, December 16, 2020.
For further information: **https://doi.org/10.1016/j.celrep.2020.108484**

Laboratory of Symbiotic and Coevolutionary Mechanisms

Project-Specific
Assoc. Prof.
SAKANAKA, Mikiyasu

Visiting Professor
XIAO, Jin-zhong

Visiting Assoc. Prof.
ODAMAKI, Toshitaka

Department Overview

The department of Human-Residential Bifidobacteria (HRB) Research was established in October 2020 as an industry-academia research collaboration between Morinaga Milk Co. Ltd., and the Graduate School of Biostudies, Kyoto University. The mission of this department is to elucidate the mechanisms underlying symbiosis between bifidobacteria and their human host, and to understand the molecular basis of the health-promoting effects of probiotic *Bifidobacterium* strains.

Research Theme

Probiotics are defined as "live microorganisms that, when administered in adequate amounts, confer a health benefit on the host," and bifidobacteria and lactobacilli are most commonly used as probiotics in food and medicine globally. Research suggests that bifidobacteria have co-evolved with hominids for over 15 million years, and we have collectively named the species that are characteristic of the human intestinal tract as "Human-Residential Bifidobacteria (HRB)". Accumulating evidence shows that HRB plays an extremely important role in human health. However, the mechanisms behind the probiotic effect of bifidobacteria remain unclear, because probiotics research has historically focused on the human (host) side (e.g., functional evaluation through clinical trials) and research from the bacterial side is limited. To address this research gap, our department will promote research from the probiotic side. Specifically, we will elucidate the molecular mechanisms underlying symbiosis and coevolution between HRB and humans.

Research Topics

- Elucidation of the symbiotic and co-evolutionary mechanisms between bifidobacteria, gut bacteria, and humans.
- Understanding the molecular basis of health-promoting effects of probiotics and development of technologies for social implementation.

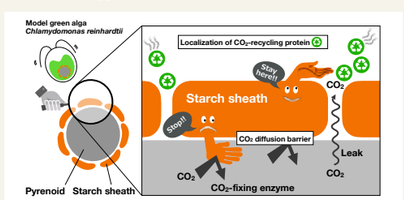
Distinctive differences in ecological distribution of bifidobacteria (HRB vs non-HRB).

TOPICS

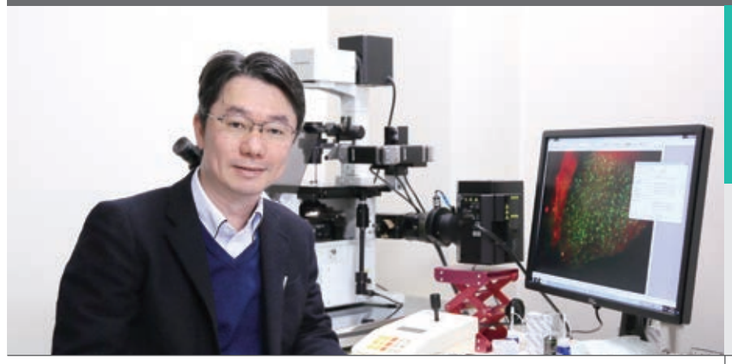
A New Function of the Pyrenoid Starch Sheath in Photosynthesis

In many algae, photosynthetic CO_2-fixing enzymes accumulate in a structure called a pyrenoid, which is further surrounded by starch to form a structure called a "starch sheath." The pyrenoid is necessary for algae to maintain photosynthesis in a CO_2-deficient environment, but the significance of starch accumulating around the pyrenoid has not been understood.
A research team led by Chihana Toyokawa, Takashi Yamano, and Hideya Fukuzawa, in the Lab. of Applied Mol. Microbiol., has discovered a new function of starch by using a mutant strain of the green alga *Chlamydomonas reinhardtii* that fails to form a starch sheath around the pyrenoid. They found that the starch sheath acts as a physical barrier to CO_2 leaking from the pyrenoid, serves as a correct location for proteins that recycle the leaked CO_2, and prevents reduction of the photosynthetic efficiency. This research has revealed a new role for starch, which has been described in textbooks as an energy storage substance, and is expected to be a cornerstone for applied research on the introduction of pyrenoids into land plants to improve crop productivity. This finding was also introduced in the News and View of Plant Physiology (https://doi.org/10.1104/pp.20.00267).

The findings were published in the following article.
Chihana Toyokawa, Takashi Yamano, Hideya Fukuzawa (2020). Pyrenoid Starch Sheath Is Required for LCIB Localization and the CO_2-Concentrating Mechanism in Green Algae.
Plant Physiology 182(4): 1883-1893.
doi: 10.1104/pp.19.01587.



For further information, please refer to the URL below.
https://www.kyoto-u.ac.jp/ja/research-news/2020-05-26-1
https://doi.org/10.1104/pp.19.01587

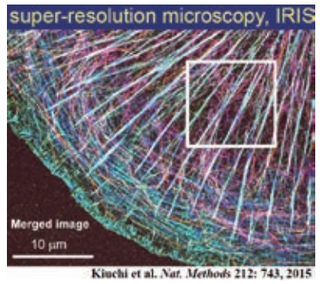


Laboratory of Single-Molecule Cell Biology

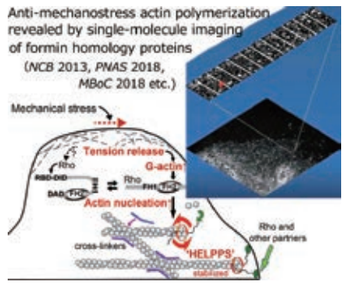
Professor
WATANABE, Naoki

Main theme

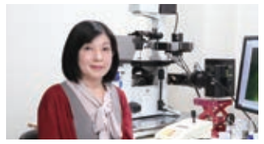
Our laboratory aims at bridging the gap between molecular activities and cell physiology by visualizing signal transduction and cell structure remodeling processes with live-cell fluorescence single-molecule (eSIMS) microscopy. We also invented super-resolution microscopy called IRIS, which achieves ultra-high density (= high-fidelity) labeling and unlimited multiplexed staining in a single specimen. By real-time and high-resolution monitoring of cell structures and adhesion/signaling molecules, our laboratory unveils real spatiotemporal dynamics of molecular mechanotransduction, pathophysiological cell signaling, body structure remodeling and actions of target-based drugs at unprecedented resolution.



Kiuchi et al. *Nat. Methods* 212: 743, 2015



Senior Lecturer
YAMASHIRO, Sawako



Assist. Prof.
MIYAMOTO, Akitoshi

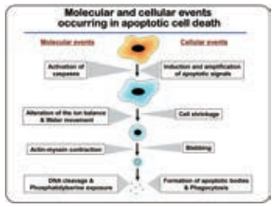
http://www.pharm2.med.kyoto-u.ac.jp/ **Lab URL**

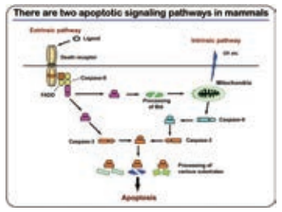
Laboratory of Molecular and Cellular Biology

Assoc. Prof.
SAKAMAKI, Kazuhiro

Main theme

Apoptosis, or programmed cell death, plays an important role in many biological processes, including embryogenesis, maintenance of tissue homeostasis, and elimination of improper cells such as unfunctional or harmful cells in both animals and plants. Our main research project is to understand the molecular and cellular mechanisms of apoptotic cell death in vitro and in vivo, using cultured cells, medaka and mouse as model systems. We also investigate to develop new methods and techniques for imaging and simulating of such a vital phenomenon. In conjunction with these studies, we have been challenging to pursue the biological significance of cell death.

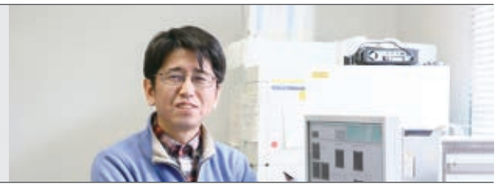




Lab URL http://www.MCB.lif.kyoto-u.ac.jp//

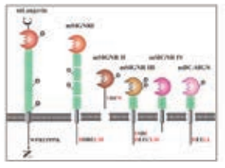
Laboratory of Immunobiology

Assoc. Prof.
TAKAHARA, Kazuhiko



Main theme

Our interest is the induction and control of immunity. We focus on dendritic cells (DC), which are a primary antigen-presenting cell in the immune system. We are especially interested in functions of lectin molecules expressed on DC and its relative, macrophage, 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

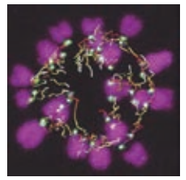
Lab URL http://zoo.zool.kyoto-u.ac.jp/imm/

GBS's Collaboration Course in the RIKEN KOBE BDR

Laboratory of Molecular Cell Biology and Development

Main theme

Meiosis in oocytes is prone to chromosome segregation errors and thus frequently produces aneuploid eggs. The aneuploidy of eggs is a leading cause of pregnancy loss and congenital diseases such as Down syndrome. We aim to understand the causes of chromosome segregation errors in oocytes. We will reveal molecular mechanisms of how unique features of oocytes and age-related effects predispose to chromosome segregation errors. The mechanisms in oocytes will be compared with those in eggs and zygotes, by which we will understand differentiation of intracellular mechanisms through development. By understanding how aging affects chromosome segregation in oocytes, we will provide insights into how events at cell, tissue and organ levels are interconnected at different life stages.



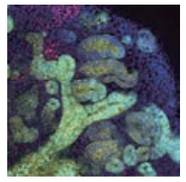
Prometaphase belt of chromosomes

http://chromosegr.riken.jp/index_en.html **Lab URL**

Visiting Professor
KITAJIMA, Tomoya

Main theme

In our previous study, we developed a protocol generating self-organizing kidney organoids from human iPS cells. While these kidney organoids comprise all anticipated renal tissues, they are still far from the real human kidney in terms of their size, tissue complexity, maturity and functionality. We study to achieve the ultimate goal of generating a functional and transplantable three-dimensional kidney. We appreciate knowledge from basic developmental biology that is essential for such regenerative studies; therefore, we are also highly interested in studies of human embryology. Particularly, we are focusing on uncovering the developmental mechanisms of the human mesoderm and kidney.



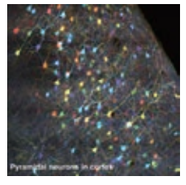
A kidney organoid generated from human pluripotent stem cells

https://www.bdr.riken.jp/jp/research/labs/takasato-m/index.html **Lab URL**

Visiting Assoc. Prof.
TAKASATO, Minoru

Main theme

"RNA" and "Brain" are the two keywords of our research. Using dynamic synapses and their association with intellectual ability, memory, and susceptibility to neurological disorders as the conceptual framework, we are studying a novel RNA neuroepigenetic mechanism in the central nervous system regarding to synapse function. The outcome of this quest will allow us to understand the regulatory mechanisms of gene networks for experience-based behavioral changes and diseases, over our lifespan. Our research is embraced by current revolution in quantitative and omics technology, fluorescence imaging, and genetic animal model systems.



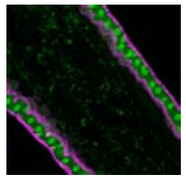
Building and maintaining neuronal networks and cognitive functions require mRNA localization and regulated protein synthesis.

https://www.bdr.riken.jp/en/research/labs/wang-do/index.html **Lab URL**

Visiting Assoc. Prof.
WANG, Dan Ohtan

Main theme

Nutrition and gut microbiota are vital players for organismal homeostasis and therefore influence our healthspan. Diet contributes to metabolic and physiological homeostasis by altering nutritional balance and gut microbiota, however our understanding of the molecular mechanism is far from complete. Our laboratory studies the functions of each nutrient and gut bacterial species using a model organism Drosophila melanogaster. We also aim to elucidate mechanistically how early-life diet alters life-long health. Our goal is to reveal evolutionally-conserved "dietological" mechanisms that govern organismal ageing and lifespan.



Drosophila intestine and gut microbiota

https://www.bdr.riken.jp/en/research/labs/obata-f/index.html **Lab URL**

Visiting Assoc. Prof.
OBATA, Fumiaki

Laboratory of Molecular Neurobiology

Professor
KIMURA, Ikuo

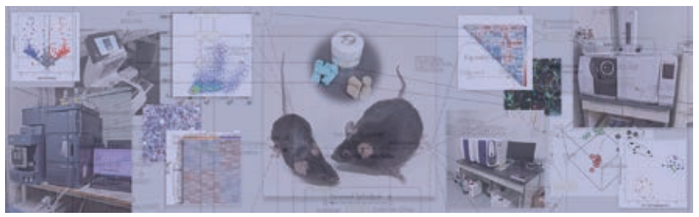
Assoc. Prof.
KATOH, Hironori

Assist. Prof.
OHUE, Ryuji

Main theme

Our research aims at understanding the molecular mechanism of homeostasis maintaining, especially focuses on dietary/nutritional function, endocrine metabolism, and cancer. Based on this research, we aim to provide valuable insight into the development of functional foods, supplements, and medicinal drugs.

1. Dietary signaling via nutrient-sensing receptors and metabolic syndrome
2. Non-genomic effects via sex steroid hormone receptors and neurological disorders
3. Metabolic regulation and signal transduction in cancer cells



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

Laboratory of Genetics

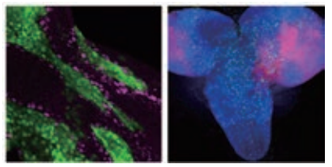
Professor
IGAKI, Tatsushi

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
4. Mechanism of aging



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.

Assoc. Prof.
KANDA, Hiroshi

Assist. Prof.
ENOMOTO, Masato

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

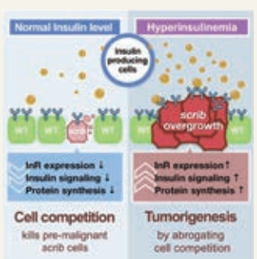
TOPICS

Hyperinsulinemia causes tumorigenesis by attenuating cell competition

This study was published in *Developmental Cell* on May 8, 2020

Abstract
The research group of Professor Tatsushi Igaki and a graduate student Yuya Sanaki found the mechanism by which high levels of circulating insulin in the body, called hyperinsulinemia, causes tumorigenesis by attenuating cell competition in fruit fly *Drosophila*.
Pre-malignant or oncogenic mutant cells emerged in normal epithelial tissue are eliminated by cell competition, a context-dependent cell elimination via cell-cell interaction. They found in *Drosophila* epithelia that pre-malignant mutant cells are not eliminated by cell competition when flies are undergoing hyperinsulinemia, leading to the formation of epithelial tumors. Mechanistically, under normal condition, pre-malignant cells have lower protein synthesis levels compared to neighboring normal cells and thus are eliminated by cell competition. However, under hyperinsulinemia, pre-malignant mutant cells acquire higher protein synthesis levels than wild-type neighbors, which makes pre-malignant cells resistant to cell competition and get tumorigenesis.

A diet-induced increase in insulin levels also triggers tumorigenesis, and pharmacological repression of protein synthesis prevents hyperinsulinemia-induced tumorigenesis. These findings provide an in vivo mechanistic link between metabolic disease and cancer risk via systemic regulation of cell competition.

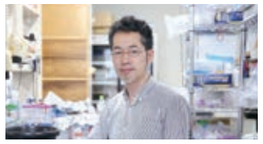


For further information, please refer to the URL below.
https://doi.org/10.1016/j.devcel.2020.04.008

Laboratory of Functional Biology

Professor
KAKIZUKA, Akira

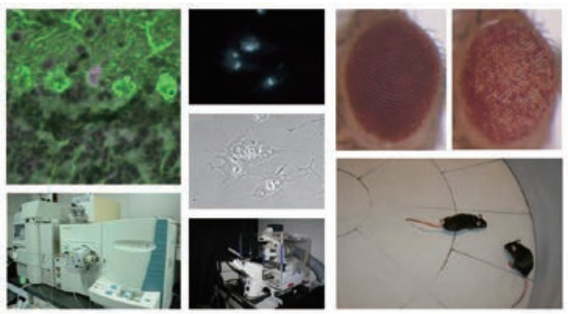
Assoc. Prof.
IMAMURA, Hiromi



Assist. Prof.
KOIKE, Masaaki

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.



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

Assoc. Prof.
GUY, Adam Tsuda

Laboratory of Science Communication

Specially Assigned 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. 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:

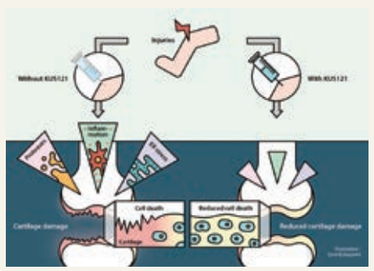
1. Increasing the exposure of Japanese students to foreign peers. We are forging new partnerships with foreign universities to foster joint courses, using live Internet connections, with active student participation in English.
2. Establishing partnerships with foreign universities to encourage short-term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

TOPICS

KUS121, developed from Gradduate School of Biostudies, supresses osteroarthritis

The results were published in Scientific Reports on November 27, 2020.

Osteoarthritis is a disorder in which the destruction of joint cartilage limits daily and social activities. There are more than 20 million sick people in Japan, and more than 8 million are suffering from pain. Professor Kakizuka's research group in our Graduate School has developed KUS121 (Kyoto University Substance 121) as a compound that specifically inhibits the ATPase activity of VCP, the major intracellular ATPase, and has shown that KUS 121 is effective in suppressing cell death and dramatically improving pathological conditions in model animals such as glaucoma, Parkinson's disease, and myocardial infarction. In a joint study with the orthopedic group of the Graduate School of Medicine, Kyoto University, KUS 121 was administered to knee osteoarthritis model rats. KUS was found to be effective in preventing cell death of articular cartilage and preventing knee osteoarthritis. In addition, by maintaining intracellular ATP levels in chondrocytes, we found that endoplasmic reticulum stress is suppressed and production of inflammatory cytokines and proteolytic enzymes from cartilage is also suppressed (Figure).



For further information, please refer to
https://www.nature.com/articles/s41598-020-77735-2
https://www.kyoto-u.ac.jp/ja/research-news/2020-12-17-1

Laboratory of Bioeducation

Professor
CHISAKA, Osamu

Main theme

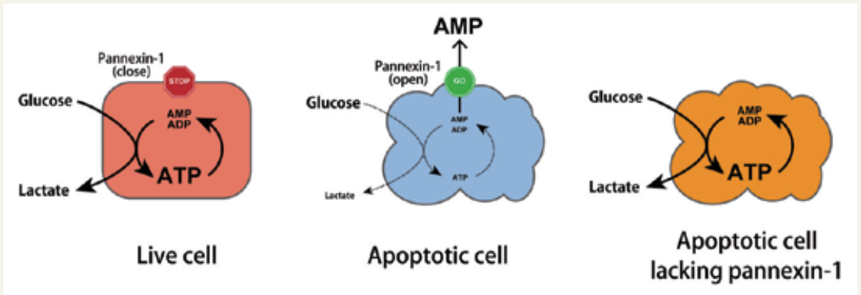
Our laboratory has been trying to improve study materials on biology.

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

TOPICS

How and why dead cells lose ATP.

ATP is a very important substance that acts as an energy carrier in cells. I has been known that little ATP remains in dead cells, but the mechanism and significance of the decrease in intracellular ATP concentration during cell death have not been fully understood.
A research group led by Dr. Hiromi Imamura of Department of Functional Biology has succeeded in the development of a method to accurately compare changes in ATP levels between individual dying cells in a process called apoptosis. As a result, it was found that the rapid decrease in intracellular ATP was accelerated by the opening of a cell membrane channel called pannexin-1. In addition, it was revealed that the cells lacking pannexin-1 did not stop the cycle of ATP hydrolysis and regeneration even when cell death progressed, and continued to consume glucose, a nutrient necessary for ATP regeneration, like living cells. This indicates that the loss of ATP from the apoptotic cell is necessary for the cell to “die a complete death” .



The study was published in eLife.
For further information, please refer to the URL below.
https://elifesciences.org/articles/61960

Assoc. Prof.
CARLTON, Peter

Laboratory of Chromosome Function and Inheritance

Main theme

To create haploid gamete cells (sperm or egg cells) from diploid precursors in meiosis, homologous chromosomes must pair, recombine, and then separate from each other, reducing the genome by half.
Recombination between homologous chromosomes is initiated in meiotic prophase by programmed DNA double-strand breaks; these breaks are then repaired through homologous recombination, giving rise to genetic crossovers that link homologous chromosomes until they divide.
Using the model organism Caenorhabditis elegans, we are working to determine the molecular mechanisms of recombination initiation and repair in the context of chromosome dynamics, combining molecular genetics, biochemistry and cytology with high-resolution microscopy and quantitative image analysis. Since errors during meiosis are common in humans and can lead to infertility and developmental defects, understanding these mechanisms is important for achieving improvements in human reproductive health.

Our current research focuses on the following areas:

- Understanding mechanisms of chromosome dynamics and regulation during meiosis
- Phosphoregulation of the synaptonemal complex
- Analysis of chromosome structures using super-resolution microscopy

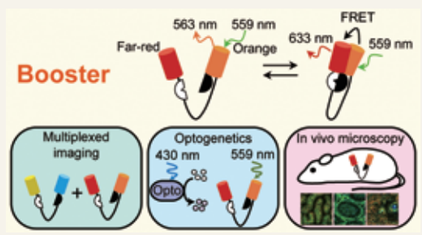
http://www.carltonlab.org **Lab URL**

TOPICS

Development of a red-shifted fluorescent proteins-based FRET biosensor “Booster”

Genetically encoded biosensors based on Förster resonance energy transfer (FRET) have been developed to visualize the activity of signaling molecules. Currently, most FRET biosensors comprise cyan and yellow fluorescent proteins (CFP and YFP), precluding the use of multiple FRET biosensors within a single cell. Moreover, the FRET biosensors based on CFP and YFP are incompatible with the optogenetic tools that operate at blue light. To overcome these problems, Professor Matsuda’ s research group has developed FRET biosensors with red-shifted excitation and emission wavelengths. By optimizing the order of fluorescent proteins and modulatory domains of the FRET biosensors, the researchers developed a FRET biosensor backbone named “Booster” .

Comments from the research group:
The performance of the protein kinase A (PKA) biosensor based on the Booster backbone (Booster-PKA) was comparable to that of AKAR3EV, a previously developed FRET biosensor comprising CFP and YFP. This novel biosensor enables the combination of a FRET biosensor with an optogenetic tool and simultaneous monitoring of activities of two protein kinases. Moreover, we confirmed the functional expression of Booster-PKA in transgenic mice. Collectively, Booster will accelerate our understanding of spatiotemporal cellular signaling in vitro and in vivo.



The findings were published in “ACS Sensors”
For further information, please refer to the URL below.
https://pubs.acs.org/doi/10.1021/acssensors.9b01941

Laboratory of Bioimaging and Cell Signaling

Professor
MATSUDA, Michiyuki

Assoc. Prof.
KOBAYASHI, Taeko

Assist. Prof.
YUKINAGA, Hiroko

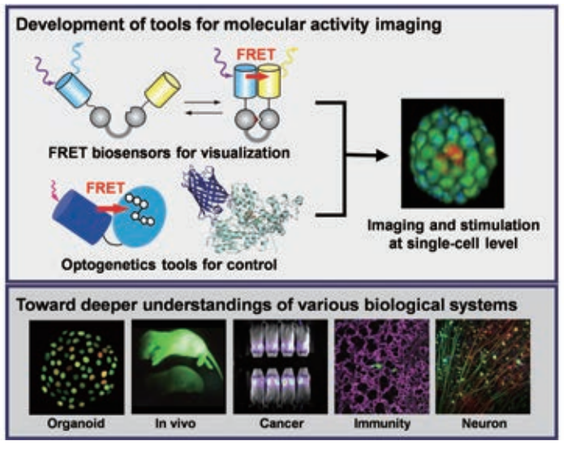
Program - Specific Assist. Prof.
HIRATSUKA, Toru

Main theme

Our research has been focused on the visualization of activities of various kinases and G proteins in living cells using biosensors based on the principle of the Förster resonance energy transfer (FRET). Our most recent study created FRET-based optogenetic tools which enables molecular activity control at single-cell resolution. These sensors and optogenetic tools will lead us to 'talk' with live cells under microscope to facilitate deeper understandings of the biological systems. Multiphoton microscopy of various tissues and organs of mice expressing our biosensor will reveal relationship between signal transduction and cellular behavior in physiological and pathological conditions.

Research objects

- Development of fluorescent and luminescent biosensors to visualize signal transduction in living cells.
- Intercellular/intracellular signaling in living cells and living mice.
- Live imaging of pancreatic cancer.
- Live imaging of glia.
- Analyses of proteostasis and lysosomal regulation to maintain neural stem cells in the adult brain.



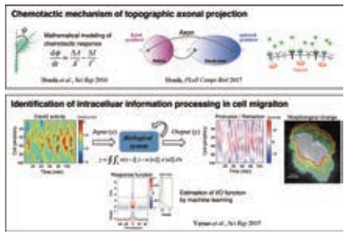
Lab URL http://www.fret.lif.kyoto-u.ac.jp/mi.htm

Laboratory of Theoretical Biology

Professor
MATSUDA, Michiyuki
(Concurrent post)

Main theme

Our laboratory aims to elucidate theoretical logic of dynamic living systems. By developing and simulating mathematical models, we are trying to understand mechanisms underlying phenomena in a bottom-up manner. We are also utilizing machine learning to extract hidden rules of dynamic, complicated phenomena from experimental quantitative data in a top-down manner. By means of these theoretical approaches, we are studying neuronal wiring in the brain, emotional neural dynamics, noise-resistant embryonic development, mechano-chemical mechanism of collective cell migration, cytoskeleton-based cellular morphogenesis, identification of intracellular information processing and animal behavioral strategy.



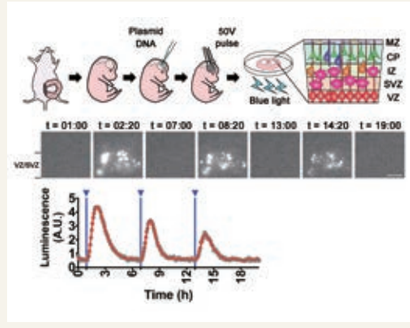
https://sites.google.com/view/theoretical-biology/ Lab URL

Specially Assigned Professor
HONDA, Naoki

TOPICS

Optimization of Light-Inducible Gal4/UAS Gene Expression System in Mammalian Cells

The laboratory of Itaru Imayoshi and Mayumi Yamada characterized a novel light-control system of cellular gene expressions. The Gal4/UAS system is a binary gene expression system primarily used in Drosophila, although it has also been applied to zebrafish and mammalian model organisms. The researchers designed the Gal4/UAS system and photo-activatable (PA) protein switch to bind together in the presence of blue light, resulting in PA-Gal4/UAS system. This new tool was shown to increase transcription activity depending on the light dose, and even short pulses of light could control cellular gene expressions.
Lead researcher Itaru Imayoshi concludes, "Our lab's main focus is neural development and regeneration of the brain. Neural stem cells show dynamic changes in gene expression in a precise and timed manner. This PA-Gal4/UAS system will help not only our field of research but the wider study of genetics and cell biology."



The blue-light induced gene expression in the neural stem cells of mouse brain.

The findings were published in the Journal of "iScience" .
For further information, please refer to the URL below.
URL: https://www.sciencedirect.com/science/article/pii/S2589004220306982?via%3Dihub

Laboratory of Brain Development and Regeneration

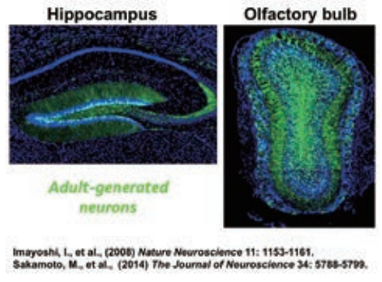
Professor
IMAYOSHI, Itaru

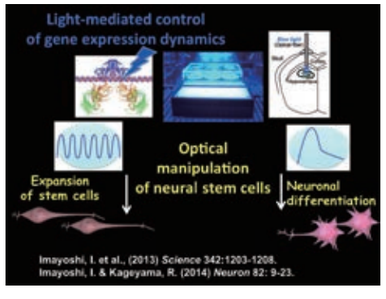
Assist. Prof.
SUZUKI, Yusuke

Program - Specific Assist. Prof.
YAMADA, Mayumi

Main theme

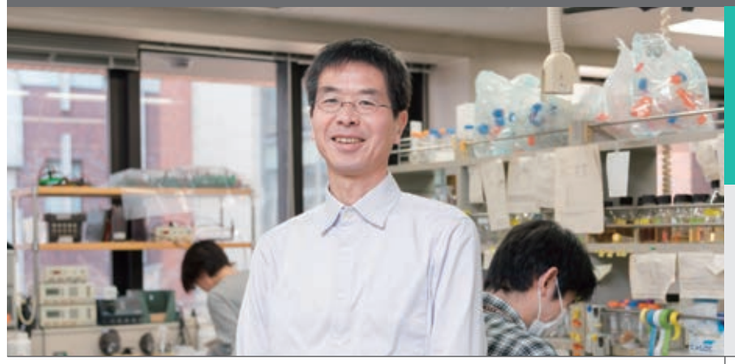
Our laboratory aims at understanding the mechanisms of development and regeneration processes in the mammalian brain, and their functional outcomes on neural circuits, higher brain functions, and animal behaviors. We are focusing on the regulatory mechanism of cell growth, differentiation, and quiescence of neural stem cells. We are also focusing on the functional contribution of newly-generated neurons to neural circuits and animal behaviors. Our laboratory is also developing novel optogenetic tools that can manipulate gene expression of cells by light.





Lab URL http://brainnetworks.jimdofree.com

Laboratory of Genome Maintenance

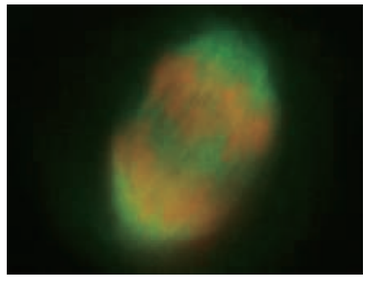


Professor
MATSUMOTO, Tomohiro

Senior Lecturer
FURUYA, Kanji

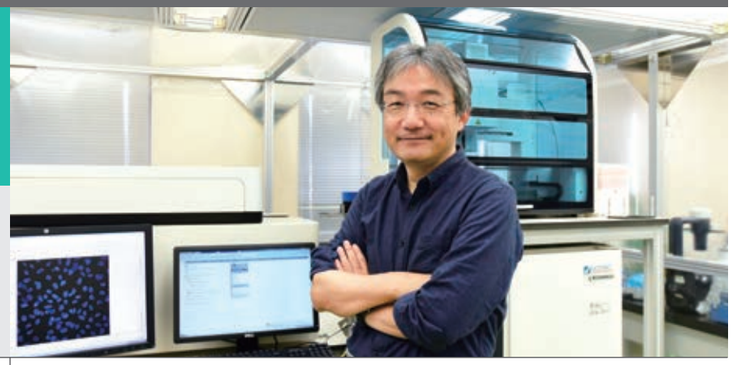
Main theme

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/ Lab URL

Laboratory of Genome Damage Signaling

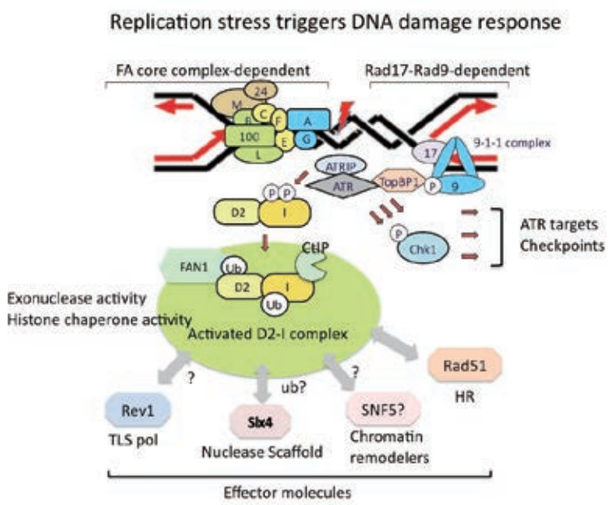


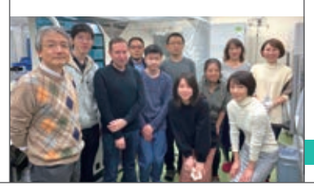
Professor
TAKATA, Minoru

Program - Specific Lecturer
KATSUKI, Yoko

Main theme

DNA damage response (DDR) is the fundamental mechanism that stabilizes our genome. Genome stability underlies all biological processes. We try to identify molecules involved in genome stability/ replication stress/DDR by methods such as screening mutations in human patients, and further analyze their function using genome engineering in various cell lines, iPS cells, and model organisms.





Lab URL http://house.rbc.kyoto-u.ac.jp/late-effect

Laboratory of Cancer Cell Biology

Professor
HARADA, Hiroshi

Assoc. Prof.
NAM, Jin-Min

Main theme

Cells maintain their function and morphology by exploiting a suitable adaptive response system to diverse and complex tissue microenvironments. Several lines of evidence have suggested that hypoxic, acidic and nutrients-depleted microenvironments exist in solid tumors and induce malignant phenotypes and chemo/radioresistance of cancer cells (Figure 1). We aim to elucidate molecular mechanisms responsible for cellular adaptive responses to the tumor-specific microenvironments and malignant progression of cancer cells (Figure 2).

- Cellular adaptive responses to tumor microenvironments, e.g. hypoxia
- Molecular mechanisms underlying malignant progression and chemo/ radioresistance of cancer cells
- Regulatory mechanisms of carbohydrate metabolic pathway

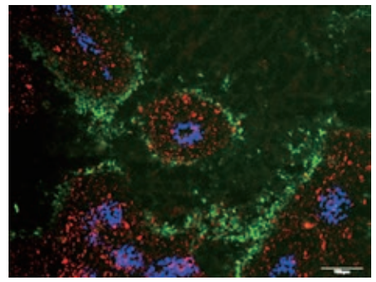


Figure 1: Hypoxic tumor cells (green) distant from blood vessels (blue) are resistant to radiation-induced DNA damage (red).

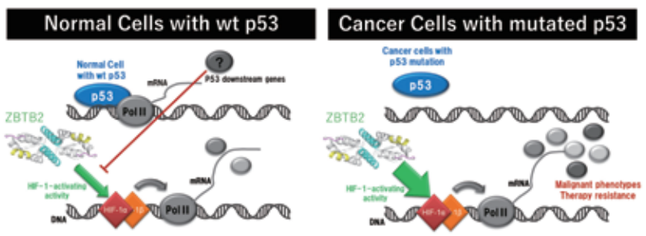
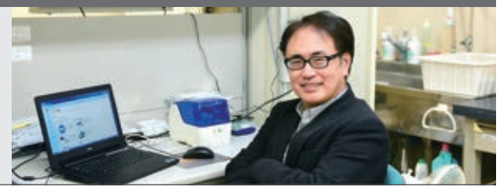


Figure 2: HIF-1-mediated gene networks responsible for both adaptive responses to hypoxia and malignant progression of cancer cells.

http://www.rbc.kyoto-u.ac.jp/cancer_biology/ Lab URL

Laboratory of Chromatin Regulatory Network



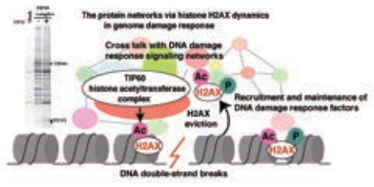
Assoc. Prof.
IKURA, Tsuyoshi

Main theme

The purpose of our research is to clarify the role of chromatin dynamics, which is required for the DNA metabolisms such as transcription, DNA replication, and DNA repair. In particular, we focus on the molecular mechanisms by which histone modifier complexes regulate the histone eviction as chromatin remodeling machinery upon DNA damage induced by ionizing radiation. Our goal is to understand how histone eviction activates DNA damage signaling pathways and functions as an anti-cancer signaling.

Main research topics

- Memory of genomic damage
- Cellular robustness in genomic stress response
- Solution of energy metabolism mechanism in specific cancer cell

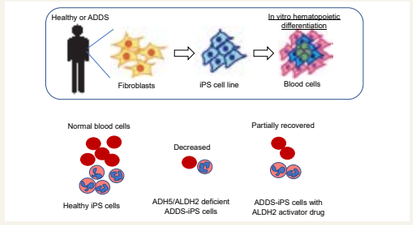


Lab URL http://house.rbc.kyoto-u.ac.jp/mutagenesis2/index1

TOPICS

A novel Inherited Bone Marrow Failure Syndrome (IBMFS) was discovered (Mol Cell online, Nov 3, 2020) and the pathophysiology was elucidated (Blood online, Jan 12, 2021).

IBMFS is a severe childhood hematological disorder that often leads to leukemia or a solid tumor. It has been an important focus of biomedical research efforts. The group led by Professor Minoru Takata (Radiation Biology Center, Graduate School of Biostudies, Kyoto University) identified a hitherto unrecognized IBMFS caused by combined mutations in ADH5 and ALDH2 genes. The enzyme encoded by ALDH2 is known to degrade acetaldehyde, which is generated after alcohol drinking. Its mutation is common among Japanese and causes alcohol flushing., whereas the ADH5 enzyme degrades formaldehyde. They found that ALDH2 can act as a backup in degradation of endogenous formaldehyde, and the combined deficiency leads to extreme sensitivity to formaldehyde toxicity. They confirmed the combined defects in ADH5/ALDH2 inhibit cellular expansion with increased levels of DNA damage during in vitro hematological differentiation using disease model iPS cells reprogramed from patients. Thus, hematopoietic differentiation process itself is the origin of formaldehyde generation. They also showed that the addition of a novel ALDH2 activator drug can partially ameliorate the hematopoietic differentiation defects. Now they propose to call this novel disorder “Aldehyde Degradation Deficiency (ADD) Syndrome” .



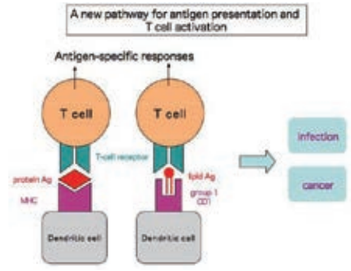
To analyze the pathophysiology of this disorder, the research group generated model iPS cell lines from fibroblasts obtained from the patients with ADD syndrome. The cells showed decreased hematopoietic differentiation capacity *in vitro*, which was partially recovered by the addition of a novel ALDH2 activating compound.

Laboratory of Cell Regulation and Molecular Network

Professor
SUGITA, Masahiko

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 **Lab URL**

Assist. Prof.
MORITA, Daisuke

Assist. Prof.
MIZUTANI, Tatsuaki

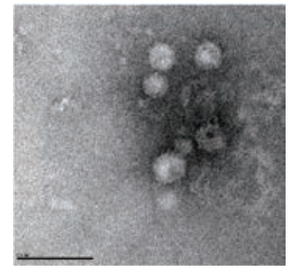
Laboratory of RNA Viruses

Professor
TOMONAGA, Keizo

Main theme

The researches carried out in our laboratory are focused on several RNA viruses, including bornavirus, 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.

The understanding of the molecular mechanism of tumorigenesis caused by hepatitis viruses is also the main purpose of our laboratory.



https://t.rnavirus.virus.kyoto-u.ac.jp/ **Lab URL**

Assoc. Prof.
HIJIKATA, Makoto

Assist. Prof.
MAKINO, Akiko

Laboratory of Cell Division and Differentiation

Professor
TOYOSHIMA, Fumiko

Assist. Prof.
ODA, Yukako

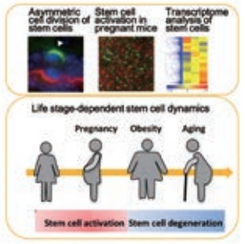
Assist. Prof.
ISHIBASHI, Riki

Main theme

How adult tissue stem cells adapt to physiological changes is a fundamental question in stem cell biology. Balance between self-renewal and differentiation of stem cells via symmetric/asymmetric cell division is essential for steady state homeostasis. Biased stem cell self-renewal or differentiation leads to changes in tissue organization and in organ size. Our group focuses on the mechanisms of symmetric/asymmetric stem cell division, stem cell differentiation, and cell lineage-commitment in tissues metabolism and regeneration. We further research on the stem cell regulation in response to the physiological changes of the body, including pregnancy, obesity and aging.

Research subjects

1. Symmetric and asymmetric stem cell division in tissue homeostasis
2. Maternal tissue stem cell dynamics during pregnancy
3. Obesity- and age-related stem cell degeneration



Lab URL https://www2.infront.kyoto-u.ac.jp/Toyoshima-HP/index-En.html

Laboratory of Cellular and Molecular Biomechanics

Professor
ADACHI, Taiji

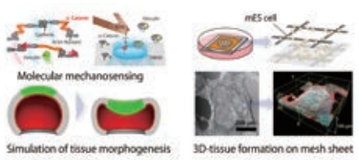
Senior Lecturer
OKEYO, Kennedy

Assist. Prof.
KAMEO, Yoshitaka

Main theme

Our group aims to clarify the mechanisms by which cells sense mechanical stimuli and regulate their activities in stem cell differentiation, tissue/organ morphogenesis, and functional adaptation. To better understand how these dynamical processes are mechano-regulated through complex hierarchical structure-function relationships, we are bridging spatial and temporal scales ranging from microscopic (molecular and cellular level) phenomena to macroscopic (tissue level) behaviors. Based on multiscale biomechanics integrating biomechanics and mechanobiology researches, we combine modeling and simulation with experiments to elucidate mechano-biochemical couplings in living system dynamics.

1. Biomechanics and mechanobiology studies of stem cell differentiation, morphogenesis, and remodeling in tissue development and growth.
2. Understanding the mechanisms of tissue development and growth emerging from multicellular dynamics.
3. Clarifying the mechanisms of tissue functional adaptation in a mechanical environment by remodeling.
4. Elucidation of mechano-biochemical coupling mechanisms in mechanosensory cells.
5. Engineering nano/micro artificial systems integrating biomolecular and cellular systems for biomedical applications.

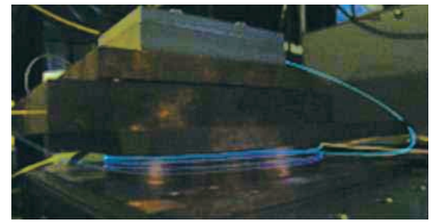


Lab URL https://www2.infront.kyoto-u.ac.jp/bf05/index-e.html

Laboratory of Spatiotemporal Optical Control / Laboratory of Optical Neural and Molecular Physiology

Main theme

This department was launched in January 2020 as an academic-industrial cooperation with Hamamatsu Photonics. In this department, scientists at Graduate School of biostudies and research groups at Hamamatsu Photonics will maximize their respective expertise to develop next-generation technologies for microscope. By integrating the knowledge and experience of academia and companies, we aim to achieve innovative optical technology development through industry-academia collaboration and apply it to the elucidation of life phenomena. In this department, two laboratories (“Laboratory of Spatiotemporal Optical Control” and “Laboratory of Optical Neural and Molecular Physiology”) were founded and they will develop cutting-edge imaging, optical control technologies, and probes. By measuring and manipulating dynamics of genes and molecules multidimensionally, they will understand the principle of biological functions.



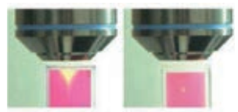
Laboratory of Spatiotemporal Optical Control

Program-Specific Professor
ISOBE, Keisuke

Main theme

Two-photon fluorescence microscopy has become a powerful tool for deep imaging of biological tissues. However, many biological phenomena in which intercellular interaction and communication networks play a crucial role are invisible because of insufficient imaging performance of commercial two-photon fluorescence microscopes. We aim to make the invisible visible by creating novel optical techniques. Our current research focuses on the following subjects;

1. Development of femtosecond lasers for ultra-deep imaging and their applications
2. Development of wide-field deep imaging techniques using spatiotemporal control of laser pulses and their applications
3. Development of 4-dimensional optical control techniques using multiphoton patterned illumination their applications



Laboratory of Optical Neural and Molecular Physiology

Program-Specific Assoc. Prof.
SAKAMOTO, Masayuki

Main theme

Probing functional neural circuits at high spatial-temporal resolution is crucial to understand how neuronal populations work together to achieve higher brain functions such as learning and memory. We aim to understand these circuit mechanisms with cutting-edge multiphoton imaging and optical control technology. Our current research focuses on the following subjects;

1. Dendritic voltage integration of synaptic potentials.
2. Circuit mechanisms underlying odor-induced behaviors.
3. Development of fluorescent probes for monitoring neural activity.

In vivo two-photon imaging from head-fixed mouse during learning

Radiation Biology Center (RBC)

Radiation Biology Center, Kyoto University

Message from Director of the Center

Hiroshi Harada

The Radiation Biology Center (RBC) was founded in 1976 to promote basic research on biological effects of radiation. As a Joint Usage Research Center, the RBC has been fulfilling its responsibilities as a hub for scientists in radiation biology and its related research fields. The center was integrated with Graduate School of Biostudies in 2018 to commence novel and deeper research activities from this privileged position as a part of "Biostudies" looking into the vast areas of life sciences.

Overview

The research in the RBC is in large part strongly linked with users of Joint Usage Research Center, but at the same time, each member of RBC pursues science with their own research direction.

Departments

Dept. of Radiation System Biology

We are pursuing mechanistic understanding of genetic and epigenetic inheritance by analyzing regulation of centromere structure, various cell cycle check points, and stress responses.

[Staff] MATSUMOTO, Tomohiro (Prof.)
FURUYA, Kanji (Senior Lecturer)

Dept. of Late Effects Studies, Lab of DNA Damage Signaling

We are studying (1) cellular and molecular mechanisms in response to endogenous DNA damage and replication stress, and (2) disorders caused by the defects in these mechanisms such as Fanconi anemia and hereditary breast and ovarian cancer. We employ technologies *in vitro* recapitulation of pathologies with iPS cell lines derived from patients, genome editing, and analysis of human materials.

[Staff] TAKATA, Minoru (Prof.)
KATSUKI, Yoko (Program-Specific Lecturer)

Dept. of Chromosome Function and Inheritance

Using the model organism *Caenorhabditis elegans*, we are working to determine the molecular mechanisms of recombination initiation and repair in the context of chromosome dynamics. Understanding these mechanisms is important for achieving improvements in human reproductive health problems such as infertility and developmental defects.

[Staff] CARLTON, Peter (Assoc. Prof.)

Dept. of Mutagenesis, Lab of Chromatin Regulatory Network

How does the cell maintain its integrity in response to various stress such as radiation or UV? What kind of strategy is employed? To solve these questions and to elucidate mechanisms of cancer or lifestyle-related disorders, we focus on chromatin that is the characteristic of eukaryote's genome using proteomics analysis of chromatin regulator protein complexes, bioimaging, and mathematical and statistic approaches.

[Staff] IKURA, Tsuyoshi (Assoc. Prof.)

Dept. of Genome Repair Dynamics, Lab of Cancer Cell Biology

We are conducting studies on endogenous and exogenous factors that affect cellular radiation sensitivity/resistance such as genetics deficiencies and tissue microenvironments and on the effect of low dose and low dose rate radiation on our body. Our focus is ranging from molecules to individual mice.

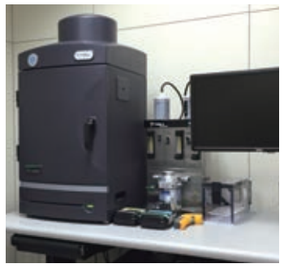
[Staff] HARADA, Hiroshi (Prof.)
NAM, Jin-Min (Assoc. Prof.)
KOBAYASHI, Minoru (Program-Specific Assist. Prof.)

Dept. of Stress Response

We will elucidate what kind of molecular reactions cells would display upon low dose irradiation in terms of stress response. Our main research targets are regulatory mechanisms of chromatin dynamics, translational regulation on ribosomes, acquired resistance mechanisms to low dose irradiation.

[Staff] ISHIKAWA, Fuyuki (Prof.)
MIYOSHI, Tomoichiro (Assoc. Prof.)
NAKAOKA, Hidenori (Assist. Prof.)

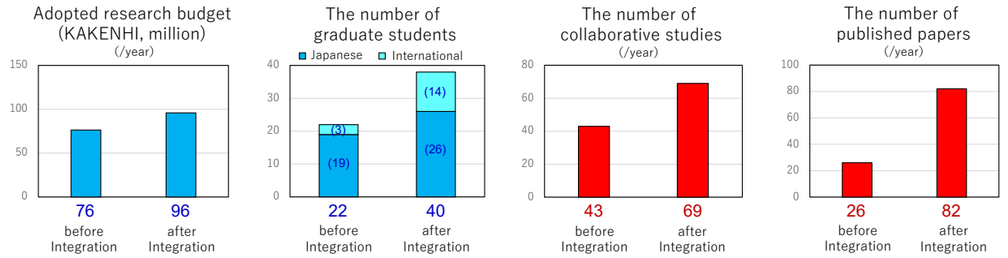
Low Dose and Low Dose-rate Irradiation System



Optical In Vivo Imaging System

The 2nd RBC-CEA Joint Workshop

Effect of the Integration of RBC and GSB



Research Center for Dynamic Living Systems

Message from Director of the Center　Matsuda Michiyuki

Recent advent of biology largely depends on the reductionist' s approach that has been deciphering the function of molecules of interest. New functions of molecules are still being discovered, leading to the discovery of new biological phenomena. Meanwhile, it will be also quite important to integrate the huge knowledge accumulated so far and to deduce common principles of biological phenomena. Theoretical biology, mathematical biology, or systems biology are the school of such research area, but their advancement depends on technological break-through of imaging and omics that fuels these theoretical research field with the ground-truth data and tools for validation. With this background, a MEXT-supported project named 'a research and education platform for innovative research on dynamic living systems' were launched by Graduate Schools of Medicine, Biostudies, and Informatics, and by Virus Research Institute and Institute for Frontier Medical Sciences. Here, to further promote this interdisciplinary approach, Research Center for Dynamic Living Systems has launched in 2018. Setting the cutting-edge microscopy as the core of technology, we attempt to understand the biological systems by the collaboration of theoretical researchers and experimental biologists.

Overview

- Course meeting of developmental biology, cell biology and systems biology: Monthly seminars are given by foreign or domestic top runners and by young researchers. Annual retreat will provide the graduate students with the opportunity to talk and discuss on their data.
- MACS education program: In collaboration with department of mathematics, graduate school of science, a series of lectures will be provided under the title of "Fusion of imaging technology and mathematics" .
- Introduction to mathematics, statics, and computational biology: For the graduate students who belongs to the wet laboratories, the basics of mathematics and statistics and the use of mathematical software will be lectured.
- Kyoto University Live Imaging Center: Cutting-edge microscopes including multiphoton microscopes are available for researchers both in and out of Kyoto University. Technicians maintain the microscopes in good condition and help researchers for the operation.

Laboratories

Cutting-edge Bioimaging Team (Matsuda Lab)

By using fluorescence biosensors, we will visualize molecular activity and cellular function in the tissue culture cells and the living mice, and thereby decipher the principle of intercellular communication.

[Staff] MATSUDA, Michiyuki (Prof.)
KOBAYASHI, Taeko (Assoc. Prof.)

Physiological Network Team (Uemura Lab)

By taking multi-omics and genetic/optogenetic approaches, we will unravel operating principles of physiological mechanisms that control animal life-history traits and neuronal circuits that evoke selective behaviors, in response to nutrient balances or sensory stimuli.

[Staff] UEMURA, Tadashi (Prof.)

Spatio-temporally controlled biophotonics Team (Isobe Lab)

By combining spatio-temporal pattern control of excitation light pulses with optogenetic technique, we will visualize and manipulate multiceller interactions within highly scattering tissue.

[Staff] ISOBE, Keisuke (Prof.)

Multiscale Biomechanics Team (Adachi Lab)

Roles of force in hierarchical living systems from molecular/cellular levels to tissue/organ levels will be clarified by multiscale biomechanics approach through integration of in-vitro and in-silico experiments.

[Staff] ADACHI, Taiji (Prof.)
KAMEO, Yoshitaka (Assist. Prof.)

Biological Function Manipulating Team (Imayoshi Lab)

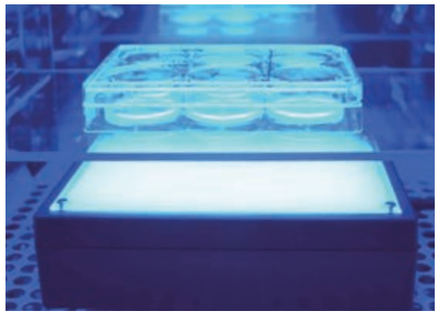
We will develop genetic and virus vector methods for expressing fluorescent proteins and functional molecules in specific cell types of the model organisms, especially mice. We will also develop novel optical methods to manipulate cellular and biological functions. By integrating these cutting-edge technologies, we will unveil the regulatory mechanisms underlying brain development, plasticity, and regeneration.

[Staff] IMAYOSHI, Itaru (Prof.)

Dynamic Genome Systems Team (Taniguchi Lab)

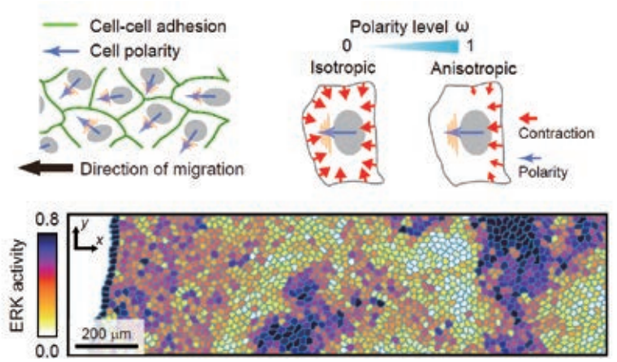
We aim at revealing the general principle of how the genome dynamically controls expressions of a huge number of genes to reproduce complex biological functions. Towards this goal, we utilize genome-wide or exhaustive measurements based on high-throughput imaging and next-generation sequencing coupled with large-scale computational analyses.

[Staff] TANIGUCHI, Yuichi (Prof.)



Blue light illumination to cultured cells expressing the light-induced gene expression system.

A transgenic mouse expression FRET biosensor (right).



Physical model and simulation of collective cell migration.

Data

As of April, 2021

Number of Students

*Students who pass Interim Exam will recieve master's degree.

(=10) total 272

1st year	2nd year	3rd year	4th year	5th year
74	82	32	37	47

Number of International Students

(=10) total 71

Government-sponsored	Personally funded
13	58

Non-degree Students

(=2) total 5

Japanese Students	International Students
1	4

International Students Numbers

total 71

Asia		Africa		Middle East		North America	
China	35	South Africa	1	Palestine	1	Canada	2
Hong Kong	1	Kenya	1			Mexico	1
India	2	Sudan	1			USA	1
Korea	8	Nigeria	1				
Malaysia	3	Egypt	1				
Philippines	2						
Sri Lanka	1						
Taiwan	4						
Thailand	1						
Viet Nam	1						
Mongolia	1						

Europe	
Germany	1
Hungary	1

Male-female ratio of students

(As of April 1 , 2021)

	female	male
master	47%(74)	53%(82)
doctorate	40%(46)	60%(70)

Number of Staff

*( )The numbers in parentheses indicate number of visiting academic staff.
*〈 〉The numbers in brackets indicate affiliate academic staff, in addition to the regular staff.

(=5) total 65

Academic Staff

Professor	Associate Professor	Senior Lecturer	Assistant Professor
18 (3) 〈8〉	16 (6) 〈2〉	4 〈1〉	14 〈9〉

Administration Office

Administrative Staff	Technical Staff
12	1

Activity of Students following graduation

Master's degree holder

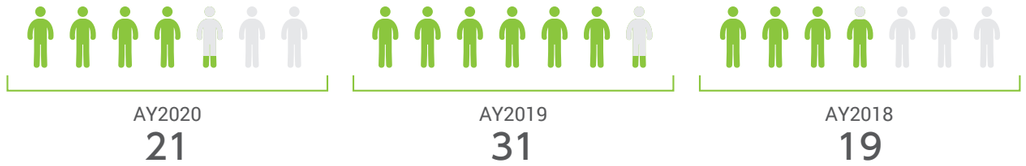
	Employment	Promotion	Others
AY2020	46%	36%	18%
AY2019	63%	34%	3%
AY2018	61%	27%	12%

Employment of Doctoral degree holder

	Academia	Industry
AY2020	17%	83%
AY2019	35%	65%
AY2018	55%	45%

Number of Doctoral degree holder

(=5)



AY2020	AY2019	AY2018
21	31	19

Places of Employment

Business

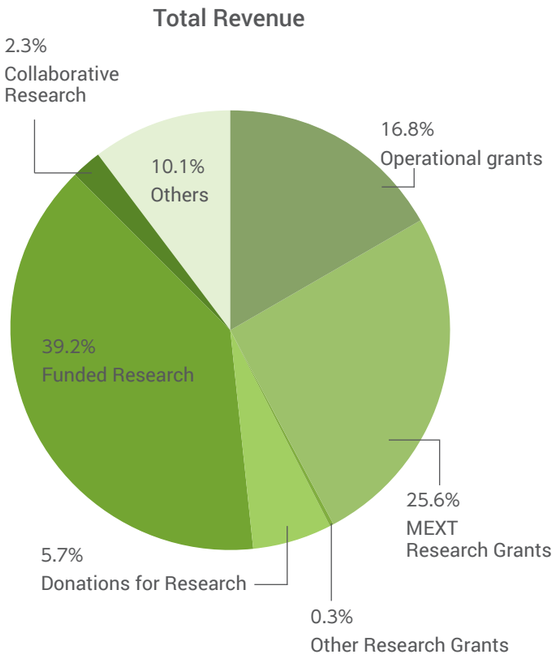
DENKA SEIKEN Co., Ltd. / KAWASUMI LABORATORIES. INC. / KOSÉ Corporation / Shionogi & Co., Ltd. / Astellas Pharma Inc. / Waqoo, Inc / choseido Pharmaceutical Co., Ltd. / TAKII & CO., LTD / Panasonic Corporation / Sumitomo Mitsui Card Co., Ltd. / KYORIN CO., LTD / SEIWA KASEI Co, Ltd. / Kyowa Kirin Co., Ltd. / JAPAN POST Co., Ltd. / Gakken Holdings Company, Limited / CMIC HOLDINGS Co., Ltd. / Mandom Corporation / DENTSU INC. / Toho Co., Ltd. / OSAKA GAS CO., LTD / Lion Corporation. / Maruho Co., Ltd. / Sysmex Corporation / NICHIREI CORPORATION / NISSIN FOODS HOLDINGS CO., LTD / Mediscience Planning Inc. / Linical.Co., Ltd / NBC Meshtec Inc. / NEXCO EAST Corporate /AIREX INC. / Works Applications Co., Ltd. / Sumitomo Dainippon Pharma Co., Ltd. / CHUGAI PHARMACEUTICAL CO., LTD /FUJIREBIO Inc. / fixpoint, Inc. / Daiichi Sankyo Healthcare Company, Limited / Taiyo Kagaku Co., Ltd. / Shiseido Company, Limited / KYOKUTO PHARMACEUTICAL INDUSTRIAL CO., LTD / SDS Biotech K.K. / AOHATA Corporation / JCR Pharmaceuticals Co., Ltd. / MORINAGA MILK INDUSTRY CO., LTD. / EUGLENA CO, LTD / ASAHI BREWERIES, LTD / ARKRAY, Inc. / SANYO FOODS.Co., Ltd. / Kobayashi Pharmaceutical Co., Ltd. / GLICO NUTRITION CO., LTD. / CHUGOKU ELECTRIC POWER CO., INC. / Sunstar Inc. / NIDEC CORPORATION / Takara Bio Inc. / Toyota Motor Corporation. / Idemitsu Kosan Co., Ltd. / Oriental Yeast Co., ltd. / ROHTO Pharmaceutical Co., Ltd. / MANDA FERMENTATION CO., LTD. / Otsuka Pharmaceutical Co., Ltd. / P&G. / TOYO SHINYAKU Co., Ltd. / Santen Pharmaceutical Co., Ltd. / TSUMURA & CO. / AJINOMOTO CO., INC. / House Foods Corp. / Mizkan Holdings Co., Ltd. / Nissan Motor Corporation / The Nisshin OilliO Group, Ltd. / Sapporo Breweries Limited / Eurofins Analytical Science Laboratories, Inc. / Bank of Japan / AOYAMA & PARTNERS / Yakult Honsha Co., Ltd. / KEYENCE SOFTWARE CORPORATION / KYOWA HAKKO BIO CO., LTD. / Nomura Securities Co.,Ltd. / Genex Partners / DAIKIN INDUSTRIES, LTD. / H.U. Group Holdings, Inc.

Others

Hokkaido University / University of Tokyo / Kyoto University / Shiga University of Medical Science / Wakayama Medical University / Kumamoto University / Okinawa Institute of Science and Technology Graduate University / RIKEN / JICA / City of Kobe / Ministry of Education, Culture, Sports, Science and Technology / Ministry of Agriculture, Forestry and Fisheries / KYUSHU INTERNATIONAL UNIVERSITY HIGH SCHOOL

Total Revenue in Fiscal 2020

Category	Total (yen)
Operational grants	232,986,256
MEXT Research Grants	354,418,019
Other Research Grants	3,860,000
Donations for Research	79,047,150
Funded Research	542,712,011
Collaborative Research	31,593,643
Others	139,941,858
Total	1,384,558,937



Professors Emeriti As of April 1, 2021

Name	Laboratory	Enrollment period	
		from	to
SASAKI, Ryuzo	Biosignals and Response	April 1, 1999	March 31, 2001
TAKEICHI, Masatoshi	Cell Recognition and Pattern Formation	April 1, 1999	March 31, 2002
OHYAMA, Kanji	Plant Molecular Biology	April 1, 1999	March 31, 2003
KUMAGAI, Hidehiko	Applied Molecular Microbiology	April 1, 1999	March 31, 2004
YANAGIDA, Mitsuhiro	Chromosome Transmission	April 1, 1999	March 31, 2005
IZUI, Katsura	Plant Physiology	April 1, 1999	March 31, 2005
NAKANISHI, Shigetada	Neuroscience	April 1, 1999	March 31, 2005
YAMAMOTO, Kenji	Applied Molecular Microbiology	April 1, 1999	March 31, 2010
KOZUTSUMI, Yasunori	Membrane Biochemistry and Biophysics	April 1, 1999	March 31, 2012
TAKEYASU, Kunio	Plasma Membrane and Nuclear Signaling	April 1, 1999	April 30, 2014
INOUE, Tan	Gene Biodynamics	April 1, 1999	March 31, 2015
INABA, Kayo	Immunobiology	April 1, 1999	March 31, 2016
YONEHARA, Shin	Molecular and Cellular Biology	August 1, 2001	March 31, 2018
SATO, Fumihiko	Molecular and Cellular Biology of Totipotency	April 1, 1999	March 31, 2018
NISHIDA, Eisuke	Signal Transduction	April 1, 1999	March 31, 2018
NEGISHI, Manabu	Molecular Neurobiology	April 1, 1999	March 31, 2019
HEJNA, James Alan	Science Communication	November 1, 2010	March 31, 2020

Campus MAP

Graduate School of Agriculture
Graduate School of Biostudies

South Campus Research Bldg (Bldg. G)
Science Frontier Laboratory

Faculty of Medicine Bldg F

Graduate School of Biostudies, Radiation Biology Center

Access