Campus MAP

Graduate School of Agriculture
Graduate School of Biostudies

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

Graduate School of Biostudies,
Radiation Biology Center

Access

Kyobashi Station	Keihan Limited Exp. 47min	Demachiyanagi Station	20min Walk				Yoshida Campus
Osaka Umeda Station	Hankyu Limited Exp. 41min	Kyoto Kawaramachi Station	Shijo Kawaramachi Station	Kyoto city bus (201, 31) 20min			
Osaka Station	JR Special Rapid Service 29min	Kyoto Station	Kyoto city subway For Kokusaikaikan 10min	Imadegawa Station / Karasuma Imadegawa	Kyoto city bus (201) 15min		
Osaka International Airport (Itami)	Airport Limousine Bus 60min						
Kansai International Airport	JR Airport Express "Haruka" 75min		In front of a Kyoto station	Kyoto city bus (206) 30min			

Contact

Graduate School of Biostudies Kyoto Univ.
Yoshida-Konoe-cho, Sakyo-ku, Kyoto 606-8501

【Inquiries concerning entrance examinationand "Global Frontier in Life Science"】
Student Affairs Section
Email kyomu@adm.lif.kyoto-u.ac.jp

【Other Inquiries】
General Affairs Section
Phone 075-753-9221 FAX 075-753-9247
Email soumu@adm.lif.kyoto-u.ac.jp

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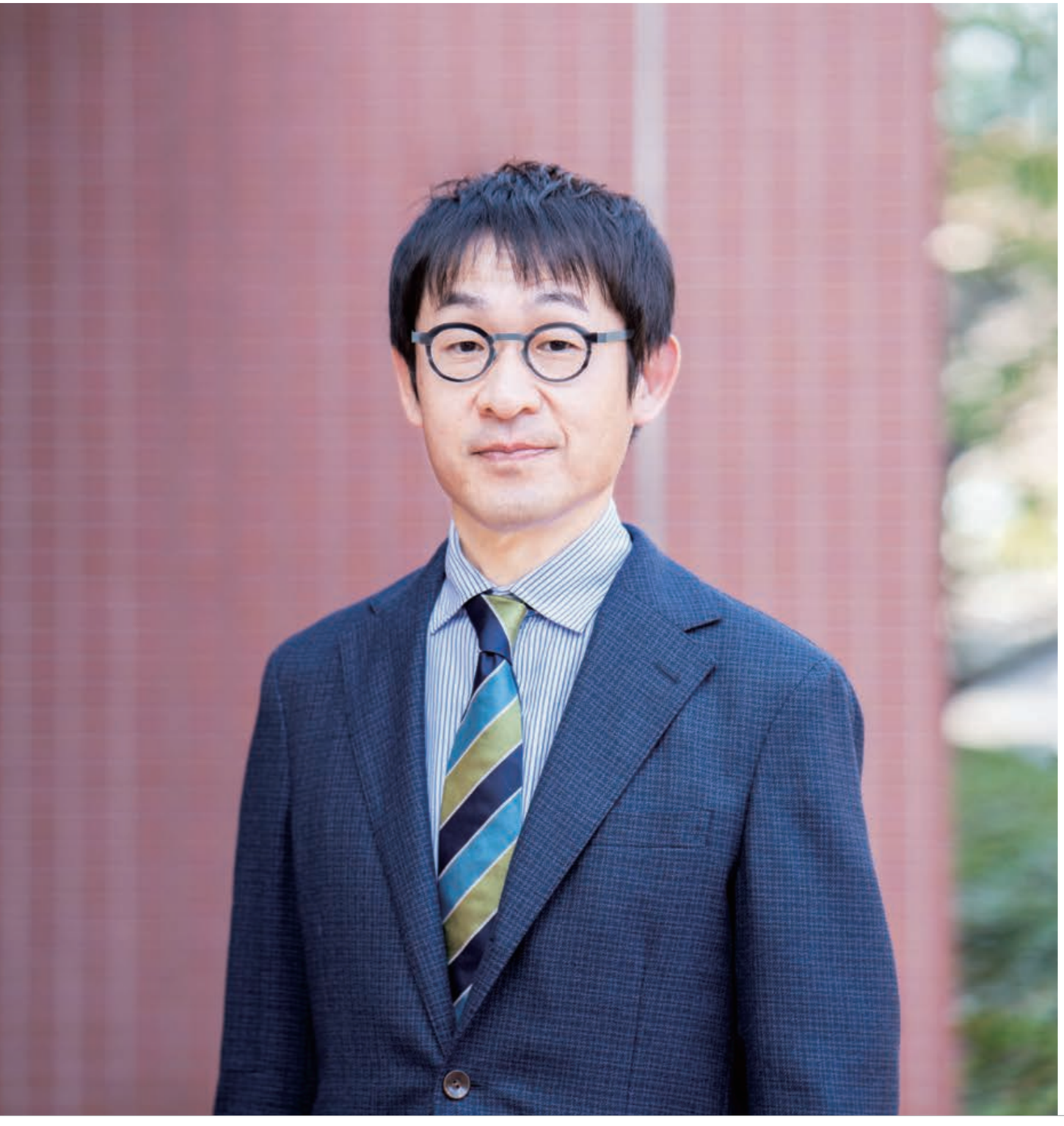
BIOSTUDIES

Graduate School of BIOSTUDIES Kyoto University

Graduate School of BIOSTUDIES Kyoto University

Shaping the future
by exploring the nature of life

2025
BIOSTUDIES



Graduate School of BIOSTUDIES,
Kyoto University

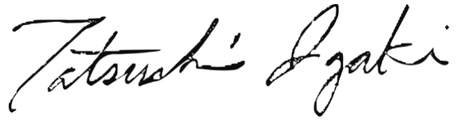
Challenge the mysteries of life!

Life science is the study that tries to understand “the mechanism of life” . The mechanism of life can be described as the rules of all life phenomena that have been created over the 4.6 billion years since the birth of the earth. The rules of life phenomena are unbelievably amazing. For instance, the genomic DNA in a cell is automatically and accurately duplicated in S phase, and then divides into two cells on its own. When the sperm and egg are fertilized, the fertilized egg begins cell division automatically, causing differentiation, proliferation, migration, and cell death precisely in a spatio-temporal manner and automatically creates the exact individual animal. It is as if life is defying even the second law of thermodynamics, a major principle of the universe. In fact, there is much we do not understand about how such a mysterious phenomenon occurs. Yes, there are many life phenomena that we take for granted in textbooks, but the details of their rules are surprisingly unknown. Moreover, important life phenomena that were previously unknown or overlooked are being discovered every year. Thus, life science is truly a treasure trove of research. On top of that, a single big discovery in life science can change the world instantly. In fact, we have just witnessed one such example with the development of an mRNA vaccine against COVID-19, which was resulted from the latest basic research. Of course, life science is not only for curing human diseases. The discovery of new mechanisms of life opens up the possibility of significant contributions to the welfare and happiness of humankind, and even the earth itself, through its application. Above all, the pleasure and excitement of discovering a new mechanism of life is incomparable to anything else. You may be moved by the precision of life, bow down in awe at its mystery, and think of the evolutionary history of living systems. If you publish it in a paper to the world, your discovery will be recorded forever as the knowledge of humankind. I believe that life science is so interesting and exciting that we do not even need to consider about the major principles of the universe!

The Graduate School of Biostudies (GSB) was established in April 1999 as Japan’ s first independent graduate school for life sciences with the aim of promoting world-leading life science researches and fostering human resources beyond the traditional framework of Science, Agriculture, Pharmaceutical Sciences, and Medicine. Since then, for the past 25 years, leading researchers in various fields of life sciences have led their laboratories and achieved world-leading discoveries together with students and staffs. In 2018, to further expand our research scope and educational area, the Radiation Biology Center and the Research Center for Dynamic Living Systems were established. We also established industry-university joint laboratories to promote social implementation of research results. In April 2023, we launched the Center for Living Systems Information Science (CeLiSIS), which is a developmental reorganization of the Research Center for Dynamic Living Systems. CeLiSIS will promote new researches that will lead data-driven life science, as well as create a university-wide hub for fostering “two-way players” who can simultaneously acquire big data through experimental science and perform information analysis, thereby playing a leading role in the digital transformation in life sciences.

In addition, the GSB offers various programs to support students’ research and education globally, such as remote lectures with overseas universities, a program for sending students abroad, international student seminars organized by students, a program to support international students, and a system for transferring credits and promoting joint researches through inter-university agreements. We invite you to join us and challenge the mysteries of life at the GSB. Beyond that, an exciting life far beyond your expectation may await you!

Dean, IGAKI, Tatsushi



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.

5 Promotion of gender equality

To promote gender equality, we draw up the action plan.
Also we enhance the research environment and support for child-rearing and caregiving.

Admissions 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 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 an assessment of 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; an assessment of the applicant's general knowledge of molecular biology, cell biology, biochemistry, and other life science fields; an assessment of the applicant's fundamental knowledge as required to pursue his or her intended field of study; an assessment of 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 an assessment of 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

- Experimental Course and Seminar (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

- Advanced Experiments (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 Life sciences 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 Philosophy in Life sciences 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
Gene Biodynamics/Biomolecular Dynamics at Nanoscale/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/Plant Chemical Biology — 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/Ecosystems and Coevolution/ Plasma Membrane and Nuclear Signaling — 17

We aim at understanding fundamental systems underlying environmental responses by organisms through structural-functional study of information molecules involved in environmental responses, study of regulatory mechanisms of development in response to environmental signals, and ecosystem-level study of multi-species (multi-genome) systems.

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
Ultrastructural Virology/Aging and Infection Control — 21

We are studying aging, host responses to viral infections, and immune regulation at the molecular, cellular, and individual levels using molecular/genetic/cell biological and morphological/structural approaches.

Dept. of Human-Residential Bifidobacteria (HRB) Research (Industry-Academia Collaboration Course)
Symbiotic and Coevolutionary Mechanisms — 22

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 — 41

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 development of innovative cancer radiation therapy. To achieve the goals, our center promotes collaborations in the intranational and international research communities.

Center for Living Systems Information Science (CeLiSIS)
Strategic Education Program/Computational and Systems Biology/ Computational Genomics/Advanced Big Data Analysis — 43

Our center consolidates and systematizes informatics-based educational and research resources in life science throughout Kyoto University, and develops new programs in order to generate expert "two-way" researchers who lead data-driven life science.

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
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 — 29

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 — 31

Cell–cell adhesion is essential for the establishment of multicellular organisms. We purse the systemic regulation mechanisms of cell–cell adhesion and signal transduction. We aim to elucidate the mechanisms of tissue formation and the pathogenesis of various diseases caused by disruption of cell–cell adhesion. We also aim to establish the basis for drug discovery and development, and to establish new therapeutic strategies.

Dept. of Biology Education and Heredity
Science Communication/Chromosome Function and Inheritance — 32

The Department of Biology Education and Heredity is composed of the Laboratory of Science Communication, and the Laboratory of Chromosome Function and Inheritance. The Laboratory of Chromosome Function and Inheritance studies the mechanisms of meiosis using cell biological and genetic approaches. The department as a whole focuses on training internationally-minded scientists, developing English-based science education and communication at the highest levels.

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

We aim to understand the principles and functions of life, from the cellular level to the individual animal level, as a multicellular system with the advanced technologies in molecular genetics, biomolecular visualization sensors, optogenetics, bio-imaging, structural biology, and mathematical modeling.

Dept. of Genome Biology
Genome Maintenance/Genome Stress Response/ Cancer Cell Biology/Chromatin Regulatory Network — 35

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.

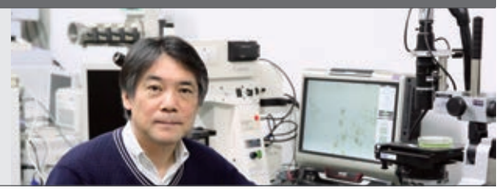
Dept. of Mammalian Regulatory Network
RNA Viruses/Cellular and Molecular Biomechanics/ Mechanosensory Physiology — 39

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 — 40

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.

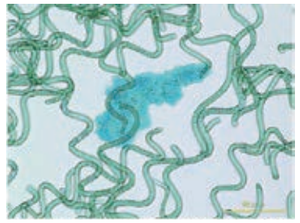
Laboratory of Gene Biodynamics



Assoc. Prof.
SHIRAISHI, Hideaki

Main theme

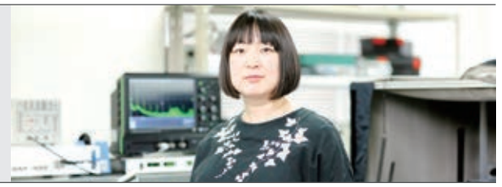
We are interested in the mechanism of growth, development and evolution of photosynthetic microorganisms and currently focusing on the study of the edible cyanobacterium *Arthrospira (Spirulina) platensis*. *A. platensis* is a filamentous alkalophilic cyanobacterium that has been traditionally consumed 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/shiraishi/index_e.html

Laboratory of Biomolecular Dynamics at Nanoscale



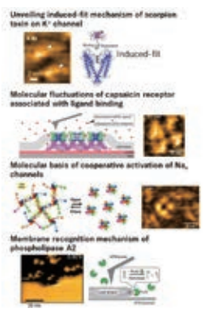
Assoc. Prof.
SUMINO, Ayumi

Main theme

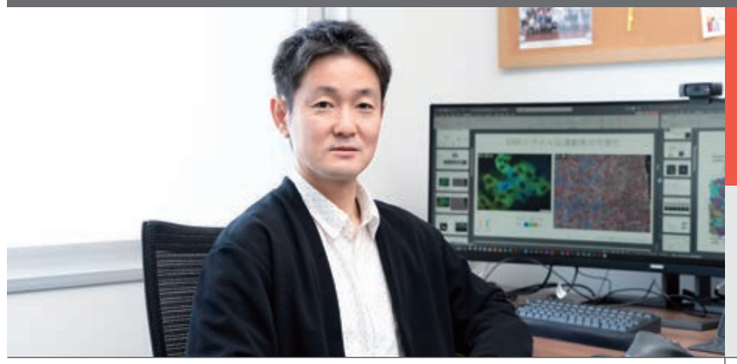
In living organisms, the "structure and motion" of biomolecules change every moment. These molecules dynamically associate and dissociate through interactions with one another, enabling them to perform complex functions as molecular assemblies. Our research focuses on elucidating the functional mechanisms of biomolecules by analyzing their structural dynamics. We use high-speed atomic force microscopy (HS-AFM) to observe the nanoscale structures and sub-second dynamics of biomolecules. Additionally, we utilize computer simulations to predict structural dynamics across multiple spatiotemporal scales. By combining these approaches, we aim to uncover the molecular mechanisms of various biomolecules from a molecular science perspective.

Research subjects

- Development of Temperature-Jump HS-AFM
- Structural Dynamics in Temperature Activation of Thermosensitive Ion Channels
- Structural Dynamics of the Temperature-Dependent Contraction of the Elastic Fiber Elastin
- Structural Changes in Voltage-Gated Sodium Channels
- Membrane Recognition Mechanism of Phospholipase A2
- Intermolecular Interactions between Ion Channels that form nanocluster and Function Cooperatively in Cells



Examples of our recent studies



Laboratory of Cell Cycle Regulation

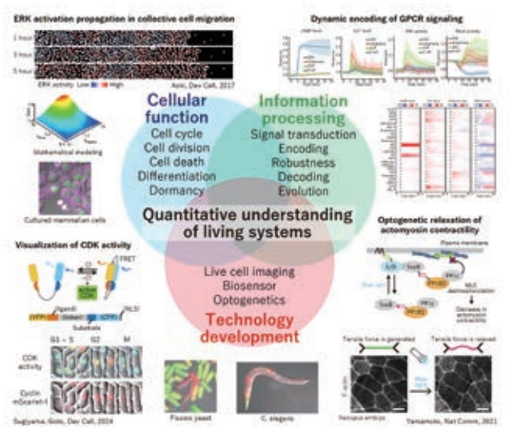
Professor
AOKI, Kazuhiro

Main theme

A cell is a vessel stuffed with proteins, nucleic acids, lipids, and small compounds. Within the cell, an immense number of physicochemical reactions are constantly taking place. Cells maintain homeostasis at various levels, from the cellular to the organismic, by perceiving external substances, processing this information within intricate intracellular networks, and manifesting adaptive phenotypes. Our research focuses on elucidating the mechanisms underlying the cellular information processing (encoding) and cell fate decision making (decoding). In addition to the development of quantitative measurement and perturbation techniques, we aspire to address the fundamental question of "what is life?" through approaches such as reconstructing a cell on a computer.

Research subjects

- Visualization and manipulation of molecules involved in cell cycle progression
- Understanding and manipulation of biological functions that emerge in cell populations
- Elucidation of intracellular mechanical properties and their physiological significance
- Implementation of whole cell modeling
- Development and application of novel biosensors and optogenetic tools

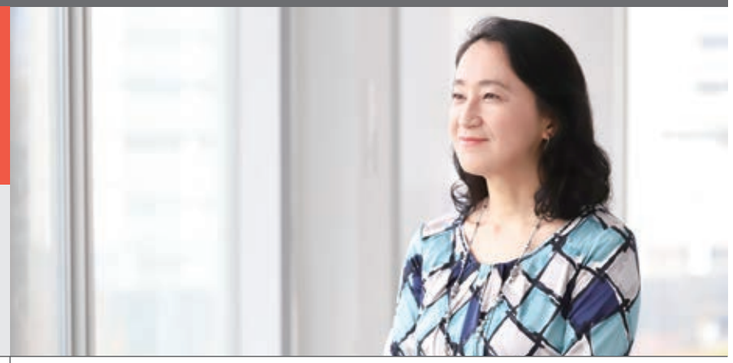


https://sites.google.com/kyoto-u.ac.jp/cellcycle/ Lab URL

Assoc. Prof.
GOTO, Yuhei

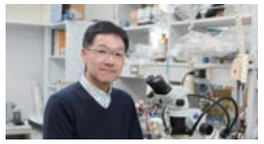
Assist. Prof.
HIRANO, Sayuki

Laboratory of Cell Recognition and Pattern Formation



Professor
KAI, Toshie

Junior Assoc. Prof.
USUI, Tadao



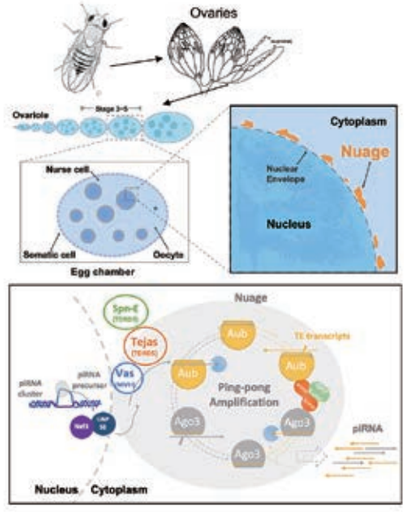
Main theme

Higher animals are mortal as individuals, but species survive through sexual reproduction. In this view, individuals are transient carriers of genetic information, while germline cells are essential for species continuity. Using *Drosophila melanogaster* as a model, we study how germline stem cells (GSCs) are maintained in niches within ovaries and testes, and how they differentiate into eggs or sperm. In addition, we also focus on piRNAs, small non-coding RNAs expressed in the germline. piRNAs suppress transposable elements and protect genome integrity. They are produced in a non-membranous organelle called *nuage*, which serves as a platform for piRNA biogenesis.

Disruption of nuage impairs piRNA production, leading to genome instability, defective gametes, and infertility. We use genetics, cell biology, bioinformatics, and AlphaFold-based protein structure prediction to investigate the formation and function of nuage and piRNAs, and their role in germline development.

Research subjects

- Mechanisms of germline stem cell maintenance and differentiation into eggs and sperm
- Biogenesis of piRNAs and their function in transposon silencing in the germline
- Structural and functional analysis of nuage and its role in piRNA production



Lab URL https://www.fbs.osaka-u.ac.jp/labs/kai/en/

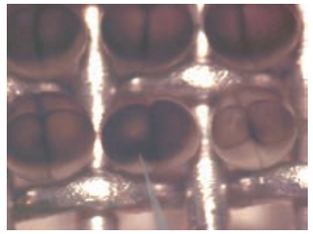
Laboratory of Signal Transduction

Junior Assoc. Prof.
KUSAKABE, Morioh

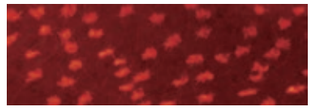
Assist. Prof.
MIYATA, Yoshihiko

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

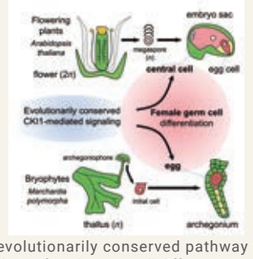
https://www.signal.lif.kyoto-u.ac.jp/ Lab URL

TOPICS

Identification of a gene for egg progenitor cell differentiation in bryophytes: molecular mechanism of germ cell differentiation and its evolution in land plants

This study was published in Current Biology on March 25, 2024.

Land plants have evolved from a common algal ancestor, although their germ cell differentiation processes vary across their lineages. In flowering plants, the egg and central cell, an endosperm progenitor cell, are produced within the embryo sac in the pistils, while sperm cells are produced within the pollen in the stamens. In bryophytes, the egg and flagellated sperm are produced in reproductive organs termed archegonia and antheridia, respectively. However, the molecular mechanisms underlying these reproductive processes remain largely uncharacterized.
A research group led by Assistant Professor Yoshihiro Yoshitake and Professor Takayuki Kohchi from Laboratory of Plant Molecular Biology, along with Associate Professor Shohei Yamaoka from Laboratory of Plant Developmental Biology, showed that the model bryophyte *Marchantia polymorpha* utilizes a gene homologous to CKI1 to regulate the differentiation of egg progenitor cells during archegonium development. CKI1 is known to be involved in the central cell differentiation in flowering plants. Their studies suggest that CKI1 was invented in the common ancestor of land plants and has played a crucial role in the differentiation of female reproductive cells in both flowering plants and bryophytes since their divergence 470 million years ago.



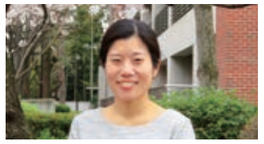
An evolutionarily conserved pathway for regulating female germ cell differentiation

For further information, please refer to the URL below.
https://www.lif.kyoto-u.ac.jp/j/research/research_results/cat6/2024-02-22/
https://doi.org/10.1016/j.cub.2024.01.013

Laboratory of Plant Molecular Biology

Professor
KOHCHI, Takayuki

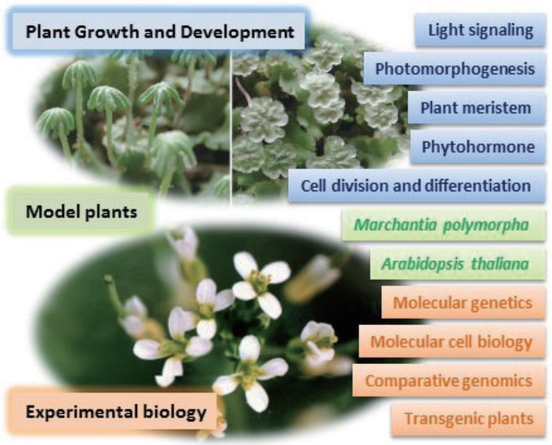
Assoc. Prof.
YASUI, Yukiko



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 molecular mechanisms of photomorphogenesis, growth phase transition, phytohormone signaling, meristem function, sex determination, and sex differentiation in land plants.



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

Laboratory of Plant Chemical Biology

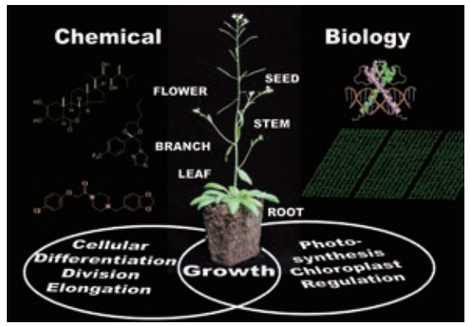
Professor
NAKANO, Takeshi

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:

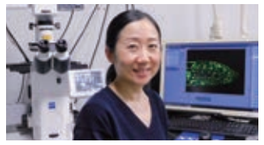
(1) Growth regulation by plant hormone signaling
(2) Chloroplast regulation by prassinosteroid
(3) Chemical functions to regulate plant growth and differentiation
(4) Plant biomass production regulated by chemicals and genes
(5) Protein functions to regulate plant growth mechanism by structure biology



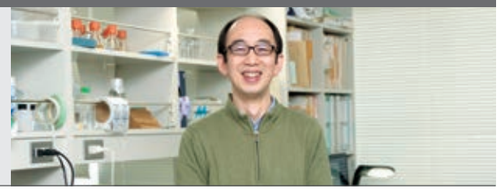
https://plantchembio.lif.kyoto-u.ac.jp/ Lab URL

Assoc. Prof.
MIYAKAWA,Takuya

Assist. Prof.
YAMAGAMI, Ayumi



Laboratory of Biosignals and Response



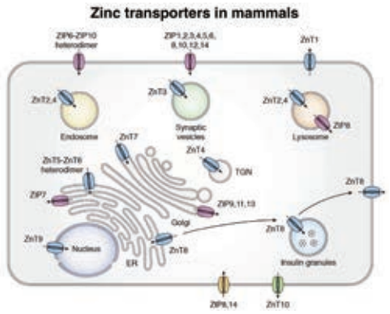
Assoc. Prof.
KAMBE, Taiho

Main theme

Our research aims to elucidate the strategies by which living organisms utilize essential trace minerals and explore their applications in health promotion.

Current projects

- Molecular mechanisms underlying metal selection and coordination in metalloenzymes
- Elucidation of regulatory mechanisms of zinc absorption and identification of dietary factors that enhance it
- Investigation of the mechanisms of disease onset resulting from disruptions in metal homeostasis



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

Laboratory of Applied Molecular Microbiology

Assoc. Prof.
YAMANO, Takashi

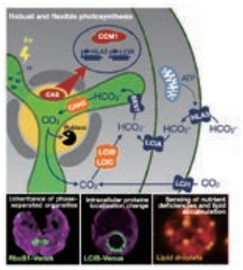
Main theme

Using the model green alga *Chlamydomonas reinhardtii*, also known as "green yeast," we will elucidate survival strategies of microalgae in response to various environmental stresses at the genomic and molecular levels and expand our research into applications such as modification of photosynthesis, CO_2 reduction, bioenergy, and valuable material production.

Current projects

Molecular mechanisms of

- photosynthetic regulatory network by sensing environmental signals
- photosynthetic CO_2-concentrating mechanism
- formation, disappearance, and inheritance of phase-separated organelles
- signal transduction, energy storage, and induction of sexual reproduction during nutrient starvation
- protein localization changes in response to environmental stimuli and their physiological significance



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

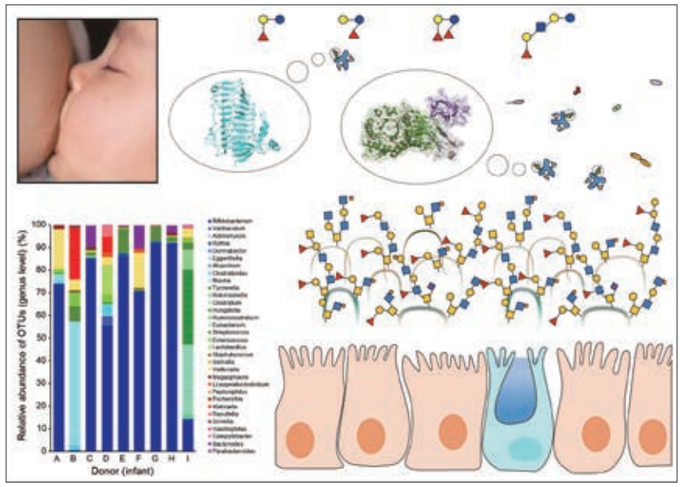
Laboratory of Molecular Biology of Bioresponse

Professor
KATAYAMA, Takane

Main theme

We are conducting research focusing on the symbiosis and co-evolution between gut microbes and the host. In particular, we aim to understand the molecular basis of how gut microbes proliferate and persist in the host gut by assimilating host-derived glycans, such as milk oligosaccharides and mucin *O*-glycans, and plant-derived glycans from the diet.

- 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 device



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

Assoc. Prof.
KATOH, Toshihiko

Assist. Prof.
SASAKI, Yuki

Laboratory of Plant Developmental Biology

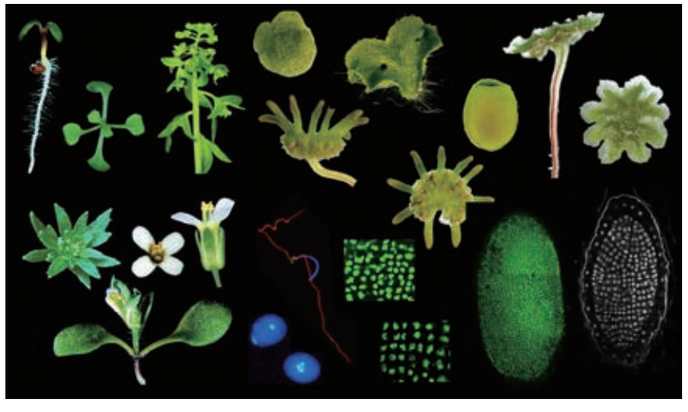
Professor
ARAKI, Takashi

Assoc. Prof.
YAMAOKA, Shohei

Assist. Prof.
INOUE, Keisuke

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.



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

Laboratory of Ecosystems and Coevolution

Professor
TOJU, Hirokazu

Assist. Prof.
FUJITA, Hiroaki

Main theme

Throughout its four-billion-year evolution, life has expanded into diverse environments. In the history of life, symbiosis has brought about innovations, resulting in explosive evolution and species diversification in new environments. We aim to understand how interactions between species have organized ecosystems on the Earth. Combining fieldwork in natural ecosystems with genomics and information science, we will decipher the driving principles of life systems at the population, community, and ecosystem levels from phenomena at the molecular and cellular levels.

Research subjects

- Roles of microbiomes in environmental adaptations of plants
- Coevolutionary history of land plants and mycorrhizal/endophytic symbionts
- Effects of aquatic/gut microbiomes on fish' s physiology and ecology
- Coevolution of invertebrates and their symbionts/parasites
- Multistability and temporal dynamics of ecosystems

Exploring the diversity of life

Exploring the principles of ecosystem-level phenomena

https://sites.google.com/view/tojulab Lab URL

Laboratory of Plasma Membrane and Nuclear Signaling

Professor
AOKI, Kazuhiro
(Concurrent post)

Program-Specific Professor
YOSHIMURA, Shigehiro

Assist. Prof.
KUMETA, Masahiro

Main theme

Our laboratory studies structural and functional dynamics of cellular proteins and organelles from micro- and macro-scopic viewpoints. We try to understand how the cell cycle and intracellular signaling are regulated and how their collapses cause diseases.

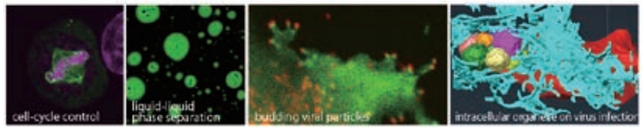
Research topics

(1) How post-translation modification such as phosphorylation regulates liquid-liquid phase separation

(2) How mitotic phosphorylation/dephosphorylation cycle regulates the cell cycle and cell proliferation

(3) How cell division is regulated during tissue morphogenesis and development.

(4) How intracellular membrane-less organelles play roles in anti-viral function of host factors



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

Laboratory of Developmental Neurobiology

Professor
KENGAKU, Mineko
AFFILIATION :
Institute for Advanced Study

Main theme

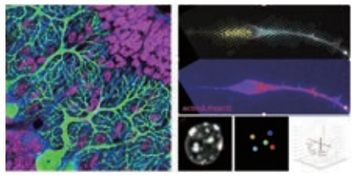
During brain development, neurons directionally migrate from the birthplace to their destination within the cortex, and then arborize well-patterned dendrites and axons to contact with their specific synaptic counterparts. Failures in these processes lead to neurodevelopmental and neuropsychiatry diseases. The major goal of our research is to clarity the mechanisms that govern the formation and maintenance of the mammalian brain.

Research topics

Live imaging and molecular analyses of dynamics and kinetics of neuronal motilities (cell migration, process arborization, organelle transport, etc).

Elucidating the mechanism of external stimuli-dependent neuronal differentiation and circuit organization.

Developing live imaging techniques for real-time observation of molecular and cellular dynamics of brain development.



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

Professor
SUZUKI, Jun
AFFILIATION :
Institute for Advanced Study

Laboratory of Biochemical Cell Dynamics

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 topics

- 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

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

Professor
TANIGUCHI, Yuichi
AFFILIATION :
Institute for Advanced Study

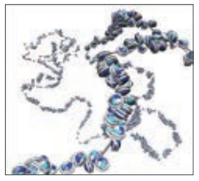
Laboratory of Multidisciplinary Biology

Main theme

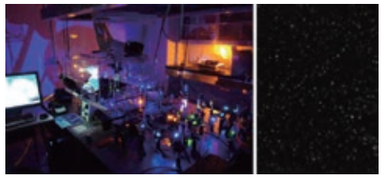
We aim to understand the working principle of complex biological systems (e.g. the cell and genome) constituted with a wide variety of molecules. Based on knowledge of multiple academic fields including biology, physics, chemistry, computer science, engineering and informatics, we challenge development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

Research topics

- 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 Ultrastructural Virology

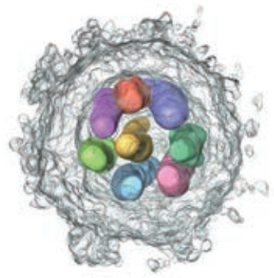
Professor
NODA, Takeshi
AFFILIATION :
Institute for Life and Medical Sciences

Assoc. Prof.
SUGITA, Yukihiko

Assist. Prof.
MURAMOTO, Yukiko

Main theme

Our laboratory aims to elucidate the replication mechanisms of human pathogenic viruses, such as influenza virus, Ebola virus, and SARS-CoV-2, for the prevention and treatment of viral infectious diseases. To this end, we use several cutting-edge techniques such as cryo-electron microscopy, electron tomography, and high-speed atomic force microscopy to visualize virus entry, replication, assembly, and virus formation. In addition, we use human respiratory organoids to understand virus replication and the host responses in human respiratory organs. We also develop novel therapeutics for deadly viruses such as Ebola virus.



3D structure of influenza virus particle reconstructed by electron tomography

Lab URL https://www.infront.kyoto-u.ac.jp/en/laboratory/labo04/

Laboratory of Aging and Infection Control

Professor
KAGE-NAKADAI, Eriko
AFFILIATION :
Institute for Life and Medical Sciences

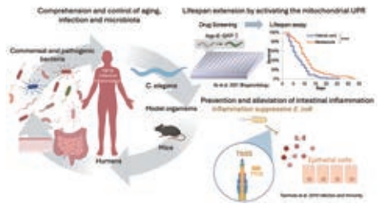
Assist. Prof.
TANIMOTO, Yoshihiko

Main theme

We are studying the mechanisms of aging and infection, and how to control them via food and microbiota. The microbiota that are endemic in the gut and skin are deeply involved in aging and infection of the host. We have elucidated the mechanisms of the interaction between the microbiota and the host using *C. elegans* and mice as model organisms. The gut microbiota is also attractive as a tool to potentially control inflammation. In recent years, inflammatory bowel disease has been on the rise, and we have found that some strains of *Escherichia coli*, which are often highlighted for their diarrheagenic properties, show inhibitory activity in the induction of inflammatory cytokines. We are also focusing on mitochondria, which are closely related to aging. We are challenging the development of methods for imaging mitochondrial activity and developing methods to extend lifespan by targeting mitochondria.

Research subjects

- Methods to control aging and elucidation of its mechanisms
- Imaging technology focusing on mitochondria and metabolism
- Anti-infective effects and improvement of host resistance against bacterial infection
- Host inflammation suppression by gut microbiota
- Interaction between host and microbiota



Lab URL https://www.kagenakadailab.com/English.html

Laboratory of Symbiotic and Coevolutionary Mechanisms

Visiting Professor
ODAMAKI, Toshitaka

Department Overview and Research Theme

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.
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. 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 understand the molecular basis of the health-promoting effects of probiotic HRB strains, and elucidate the molecular mechanisms underlying symbiosis 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.

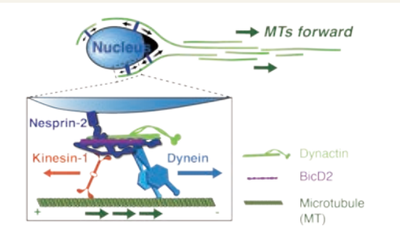
Distinctive differences in ecological distribution of bifidobacteria (HRB vs non-HRB).

TOPICS

Microtubule-dependent nuclear transport during brain cortex formation

This study was published in Journal of Cell Biology on Aug 8, 2024.

Microtubules (MTs) serve as railways for the intracellular logistics system. MTs have polarity, with + and – ends, and two types of motor proteins move in opposite directions to transport molecules, organelles, and other cargoes of various sizes. During brain cortex formation, MTs are used to transport neurons, with the cell nucleus serving as the cargo. It was unclear how the two types of motor proteins, moving in opposite directions, work together to ensure that the neuronal nucleus reaches its precise position in the cortex.
Professor Kengaku' s group elucidated the mechanism of nuclear transport regulated by a nuclear adaptor protein Nesprin-2. Nesprin-2 binds to two opposing motors and mediates their synergistic interplay, ensuring long-lasting, bidirectional movement of the cargo. In this scenario, however, the nucleus repeats moving back and forth and fails to reach its destination, as Nesprin-2 does not determine the direction of transport. The group further discovered that the MTs themselves, which were thought to be fixed as rails in neurons, move forward with the nucleus on them. These findings will contribute to understanding the pathology of neurodevelopmental diseases caused by dysregulated neuronal migration.



For further information, please refer to the URL below.
https://www.icems.kyoto-u.ac.jp/news/10113/
https://doi.org/10.1083/jcb.202405032

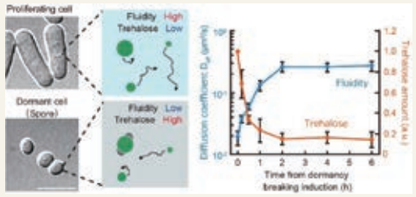
TOPICS

Unraveling the Mystery of Dormancy Breaking through Cytoplasmic Fluidization

This study was published in Proceedings of the National Academy of Sciences on June 18, 2024.

Cells possess various mechanisms to endure environmental stress, including a reversible state known as "dormancy," in which cells temporarily halt their growth and proliferation. When stress conditions are alleviated and the environment becomes favorable, cells resume their growth and proliferation, a process referred to as "dormancy breaking." This phenomenon has been observed across diverse organisms. While many researchers have sought to understand the processes of dormancy and awakening, the cellular mechanisms underlying dormancy breaking have remained largely elusive. The research group, led by Associate Professor Yuhei Goto and Professor Kazuhiro Aoki, focused on the cytoplasmic fluidity within dormant yeast cells. We found that while dormant cells exhibit low cytoplasmic fluidity, this rapidly increases during dormancy breaking. Furthermore, we elucidated the molecular pathways controlling cytoplasmic fluidization. During the course of our investigation into the mechanisms, we also identified trehalose, a disaccharide, as a crucial regulator of cytoplasmic fluidity.

Dormancy is also known to be associated with cancer cell behavior, and the spontaneous dormancy breaking of dormant cancer cells is considered one of the factors making cancer treatment challenging. The insights from this study are expected to contribute to our understanding of dormancy and dormancy-breaking mechanisms in cancer cells, potentially leading to applications in medicine.



Trehalose regulates cytoplasmic fluidity and dormancy breaking.

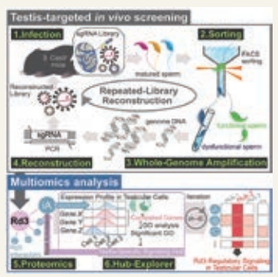
For further information, please refer to the URL below.
https://www.lif.kyoto-u.ac.jp/j/research/research_results/cat3/2024-07-02/
https://www.pnas.org/doi/10.1073/pnas.2405553121

TOPICS

In vivo CRISPR screening directly targeting testicular cells

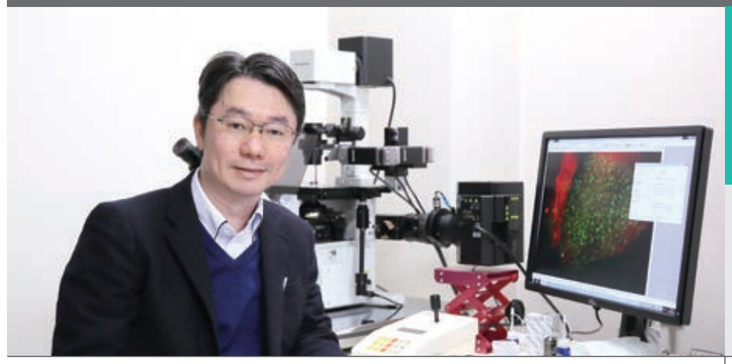
This study was published in Cell Genomics on March 5, 2024.

Unbiased screening methods are crucial for identifying regulatory factors in cellular phenomena. While traditionally developed in model organisms like Drosophila, their application to mammalian cells has been challenging. The advent of CRISPR sgRNA library-based screening has enabled high-throughput studies in mammalian cells, but its application to non-proliferative or dying cells remains difficult. To overcome this limitation, we developed Revival Screening (Molecular Cell, 2021), a method that introduces an sgRNA library into cells, isolates target cells using flow cytometry, and reconstructs the sgRNA library for repetitive screening. Applying this technique to mouse testicular germ cells, we identified critical factors for germ cell development. A key challenge was the limited number of cells obtainable from mouse organs, which we addressed by integrating whole-genome amplification into the screening workflow. Additionally, we developed an informatics tool to refine and prioritize relevant signaling pathways. This approach has broad applications across tissues and organ systems, enabling the study of cellular phenomena that were previously difficult to investigate using standard cell lines. *In vivo* Revival Screening provides a powerful tool for uncovering novel regulatory mechanisms in diverse biological contexts.



Flowchart of *in vivo* CRISPR screening
（refer to Noguchi et al., 2024 Cell Genomics）

For further information, please refer to the URL below.
https://www.icems.kyoto-u.ac.jp/news/9559/
DOI: 10.1016/j.xgen.2024.100510

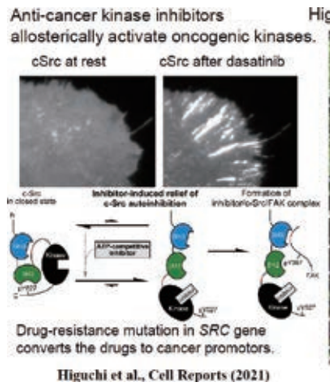


Laboratory of Single-Molecule Cell Biology

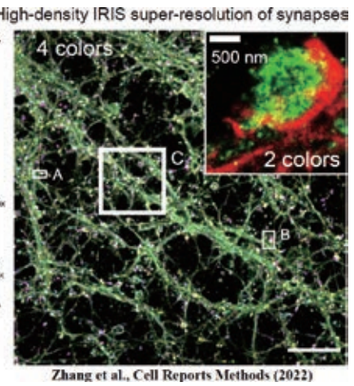
Professor
WATANABE, Naoki

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 new super-resolution microscopy called IRIS, which achieves unprecedented ultra-high density (= high-fidelity) labeling of multiple targets in a single specimen. Furthermore, real-time imaging revealed an unexpected allosteric effect of anti-cancer kinase inhibitors, which may potentially convert inactive oncogenic kinases into an activated state. By real-time and high-resolution monitoring of cell structure and adhesion molecules using these advanced optical techniques, our laboratory unveils mechanisms and dynamics of pathophysiological cell signaling, drug actions and body structure remodeling.

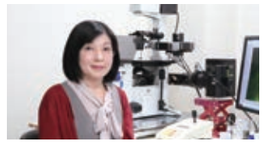


Higuchi et al., Cell Reports (2021)



Zhang et al., Cell Reports Methods (2022)

Assoc. Prof.
YAMASHIRO, Sawako

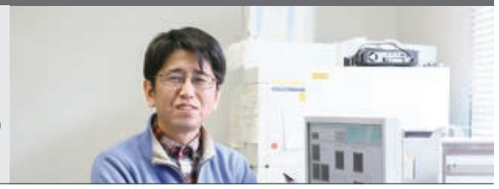


Assist. Prof.
MIYAMOTO, Akitoshi

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

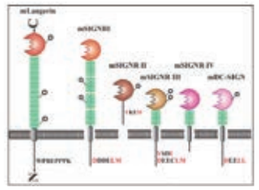
Laboratory of Immunobiology

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

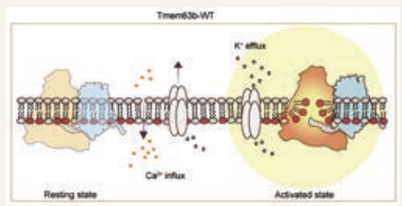
Lab URL https://zoo.zool.kyoto-u.ac.jp/imm/

TOPICS

Phospholipid scrambling induced by an ion channel/metabolite transporter complex

The study was published in Nature Communications on August 31, 2024.

The lipid bilayer of the cell membrane is asymmetrically organized, with phosphatidylserine concentrated on the inner leaflet and phosphatidylcholine on the outer leaflet. This asymmetry is crucial for various cellular functions but must be dynamically altered in response to environmental changes through lipid scrambling. This process is regulated by lipid scramblases that we identified, including TMEM16F (2010, Nature) and Xkr8 (2013, Science), promoting lipid scrambling by forming homodimers. Interestingly, lipid scrambling can still occur following calcium stimulation, even in the absence of these proteins, suggesting the presence of other scramblases. To explore this, we used a revival screening technique developed in our laboratory (Mol Cell, 2021; Cell Genom, 2024) and identified TMEM63B as a component of the scramblase. We further discovered that TMEM63B forms a heterodimer with the vitamin B1 transporter SLC19A2, which is essential for its lipid scrambling activity. Mutations in TMEM63B result in constitutive activation, leading to developmental epileptic encephalopathy. Understanding how heterodimer formation between membrane proteins with distinct roles influences lipid scrambling and transporter activity is a significant challenge. Advancing this knowledge could provide critical insights into membrane biology and pave the way for novel therapeutic strategies targeting lipid dysregulation in disease.



A model for phospholipid scrambling
(Refer to Niu et al., 2024 Nat Commun)

For further information, please refer to the URL below.
https://www.icems.kyoto-u.ac.jp/news/10008/
https://doi.org/10.1038/s41467-024-51939-w

GBS's Collaboration Course in the RIKEN CBS

Laboratory of Molecular Cell Biology and Development

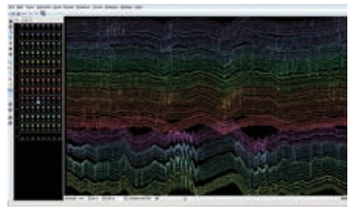
Visiting Professor
FUJISAWA, Shigeyoshi

Main theme

Our goal is to elucidate the neuronal circuit mechanisms of cognitive functions such as episodic memory and spatial navigation by observing neuronal activity in the brains of animals performing cognitive behaviors using the large-scale recording techniques with multi-channel silicon probes.

Research subjects

- To elucidate the mechanism of spatial navigation in the hippocampus and entorhinal cortex.
- To clarify the role of oscillations in the information processing of neuronal circuits.
- Development of technology for manipulating neuronal activity by combining optogenetics and electrophysiology.



Large-scale extracellular recording of neural activity using silicon probes

https://fujisawalab.riken.jp/ Lab URL

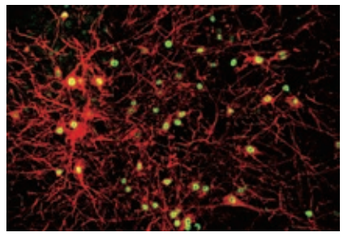
Visiting Assoc. Prof.
TAKEOKA, Aya

Main theme

Movement is the ultimate expression of neural computation, integrating sensory perception and motor control to interact with the world.
Our research focuses on how animals learn to generate and refine movement, emphasizing the role of sensory feedback in shaping motor learning. From basic motor functions to skilled movements honed through repetitive training, understanding these processes can inform interventions for motor recovery after spinal cord injury, aiding rehabilitation and functional restoration.

Research subjects

- Spinal learning and memory
- Sensory integration for motor adaptation
- Sensorimotor circuit connectivity and function



Spinal neurons known as Renshaw cells (green nucleus with red cell body) responsible for recalling learned motor behavior independent of the brain input.

https://takeokalab.riken.jp/ Lab URL

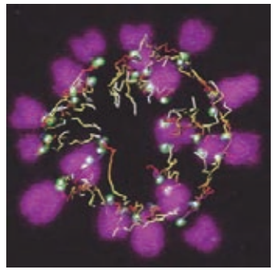
Laboratory of Molecular Cell Biology and Development

GBS' s Collaboration Course in the RIKEN KOBE BDR

Visiting Professor
KITAJIMA, Tomoya

Main theme

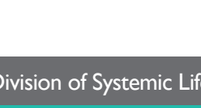
Meiosis in oocytes is prone to chromosome segregation errors and thus frequently produces aneuploid eggs. The aneuploidy of eggs is a leading cause of pregnancy loss and congenital diseases such as Down syndrome. We aim to understand the causes of chromosome segregation errors in oocytes. We will reveal 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

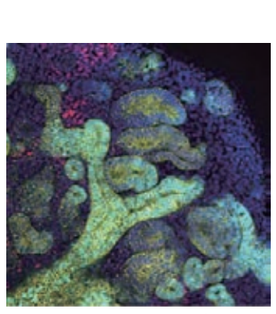
Lab URL https://chromosegr.riken.jp/index_en.html

Visiting Assoc. Prof.
TAKASATO, Minoru



Main theme

We have developed a protocol generating self-organizing kidney organoids from human iPS cells. While these organoids comprise all anticipated renal tissues, they are still far from the real human kidney in size, tissue complexity, maturity and functionality. We study to achieve the ultimate goal of generating functional and transplantable three-dimensional urinary organoids, including kidney and bladder. 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 urinary tract.



A kidney organoid generated from human pluripotent stem cells

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

Visiting Assoc. Prof.
OBATA, Fumiaki

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.

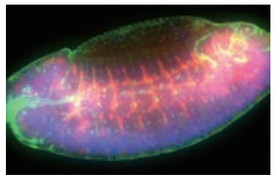
Drosophila intestine and gut microbiota

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

Visiting Assoc. Prof.
KONDO, Takefumi

Main theme

Embryonic development is a dynamic and beautiful phenomenon that proceeds with remarkable precision. Our goal is to elucidate the principles that ensure the accuracy of the entire developmental process. We view development as an information network system consisting of multiple hierarchies of "genome"-"cell"-"tissue", and study its feedback mechanisms between the layers by quantitatively measuring and analyzing the dynamics at each layer using techniques such as single cell genomics, imaging and large-scale data analysis.



A *Drosophila* embryo during development

https://www.bdr.riken.jp/en/research/labs/kondo-t/index.html Lab URL

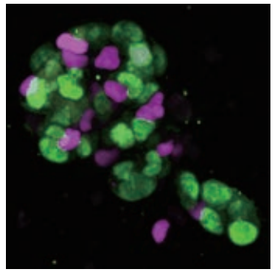
Visiting Assoc. Prof.
KONAGAYA, Yumi

Main theme

We aim to uncover the molecular mechanisms underlying the cell fate decision of intestinal epithelial stem cells by live imaging of mouse intestinal organoids, multiplexed tissue imaging, and quantitative analyses at the single cell level.

Research subjects

- Investigation of the coordinated control of cell proliferation and differentiation in mouse intestinal epithelium
- Analysis of the role of mechanical sensing in stem cell maintenance in mouse intestinal epithelium
- Development of fluorescent reporters using machine learning algorithms for protein structure prediction



An intestinal organoid expressing the cell cycle reporter FUCCI

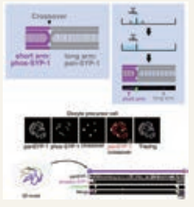
https://sites.google.com/view/yumi-konagaya-lab-en Lab URL

TOPICS

How do chromosomes measure themselves?

This study was published in Current Biology on Oct 11, 2024.

Researchers in the Laboratory of Chromosome Function and Inheritance have used the nematode *C. elegans* to uncover a novel facet of chromosome regulation in meiosis. Meiosis is a special cell division that separates chromosomes in two discrete steps to create haploid germ cells. In *C. elegans* meiosis, crossover recombination occurs once and only once on each chromosome pair. The position of this crossover is the key to orchestrating the two-step chromosome division: defining the stretch from the crossover to the nearer chromosome end as the "short arm", and to the farther end as the "long arm", it is the short arm that separates in the first meiotic division, followed by the long arm in the second division. However, very little was known about the mechanisms involved in this length measurement. This work shows evidence that crossovers are the source of a signal that diffuses through the chromosome and accumulates separately within the short and long arms; the signal accumulates to a higher density in the short arm, and it is this difference, rather than length *per se*, that is sensed and transduced into the decision to separate chromosomes at the short arm first. This work has brought us to a closer understanding of how information can spread along chromosomes and how cells can measure the size of their components.



Signal molecules accumulating in the short compartment faster than the long compartment designate the short arm of the chromosome

For further information, please refer to the URL below.
https://www.kyoto-u.ac.jp/ja/research-news/2024-10-15
https://doi.org/10.1016/j.cub.2024.09.034

Laboratory of Molecular Neurobiology

Professor
KIMURA, Ikuo

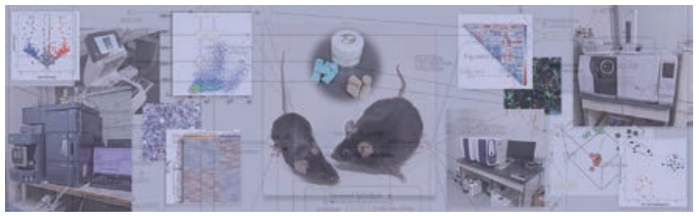
Assist. Prof.
IKEDA, Takako

Assist. Prof.
NISHIDA, Akari

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



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

Laboratory of Genetics

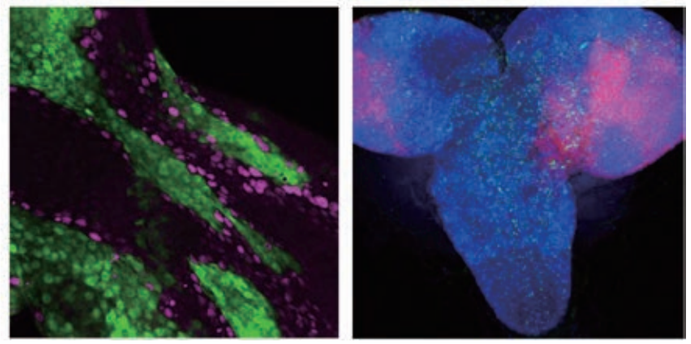
Professor
IGAKI, Tatsushi

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

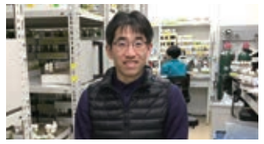
1. Mechanism of cell competition
2. Genetic basis of tissue growth regulation
3. Molecular basis of tumor progression and metastasis
4. Mechanism of aging



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.

https://igakilab.lif.kyoto-u.ac.jp/english/ Lab URL

Assoc. Prof.
KANDA, Hiroshi



Assist. Prof.
NAGATA, Rina

Laboratory of Functional Biology

Professor
ODA, Yukako

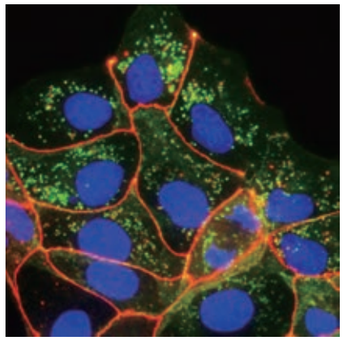
Program-Specific Assist. Prof.
OGAWA, Keigo

Main theme

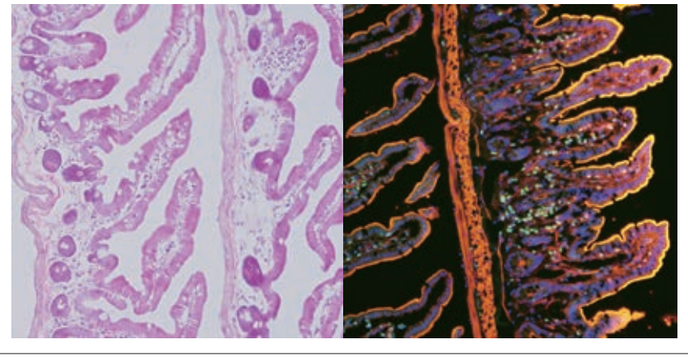
Cell-cell adhesion is essential for the construction of multicellular organisms. We aim to elucidate the regulatory mechanisms of cell–cell adhesion in epithelial tissues to understand the construction, maintenance, and repair mechanisms of multicellular organisms. We focus on peptides that induce cell–cell adhesion, which we have recently identified. We also aim to control various diseases caused by disruption of intercellular adhesion, such as inflammation, cancer, and aging, and to develop drug discovery.

Research subjects

- Induction and regulation of cell–cell adhesion
- Control of malignant cancer by regulating cell–cell adhesion
- Elucidation of stress response mechanism in epithelial cells
- Understanding of the aging based on the intestinal barrier function



Each cell adheres to form epithelial cell sheet, epithelial tissue
(Upper) MDCKII cells
(Bottom) Mouse small intestine tissue



Assoc. Prof.
GUY, Adam Tsuda

Laboratory of Science Communication

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.

Specially Assigned Professor
HEJNA, James Alan

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 programmed DNA double-strand break initiation during meiosis
- Phosphoregulation of the synaptonemal complex
- Analysis of chromosome structures using super-resolution microscopy

https://www.carltonlab.org Lab URL

Laboratory of Bioimaging and cell Signaling

Professor
IWATA, So

Assoc. Prof.
NOMURA, Norimichi

Assist. Prof.
IM, Dohyun

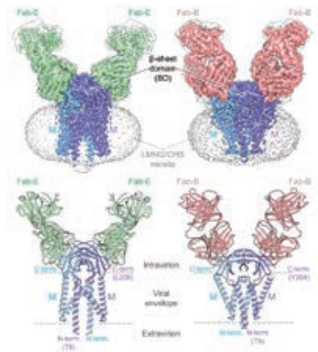
Main theme

Fundamental processes of various medically important biological phenomena, such as homeostasis and pathogenesis, are based on physical quantities such as biomolecular “shapes” and intermolecular interactions. In our laboratory, we are mainly interested in membrane proteins and their complexes, which are involved in the pathogenesis of various human diseases and are the targets of many pharmaceuticals. We are currently performing structural analysis of these membrane proteins at atomic resolution using X-ray crystallography and cryo-EM single-particle analysis. In addition, we are also studying on drug discovery and dynamics of membrane proteins using computational methods to explore the principles of cellular function control.

Membrane proteins play key roles in cellular functions such as signal transduction, molecular transport, and bioenergetics at biological membranes and are important research targets for drug discovery. Systematic elucidation of the 3D structures of membrane proteins such as G protein-coupled receptors (GPCRs), transporters, channels, and endogenous membrane enzymes will not only deepen our knowledge of molecular and cellular biology, but also enable us to efficiently explore lead compounds for drug discovery through structure-based drug design. However, it remains difficult to elucidate the crystal structure of human membrane proteins at high resolution. We are also developing technologies to production of human membrane proteins and to generate antibody fragments against membrane proteins to facilitate X-ray crystallography and cryo-EM single-particle analysis. In addition, a new state-of-the-art cryo-EM will be installed at Kyoto University, which we hope will accelerate our research.

Research subjects

Structural Biology of Membrane Proteins
Drug Discovery Based on Membrane Protein Structures
Development of technologies for X-ray structural analysis of membrane proteins
Development of technologies for single-particle cryo-electron microscopy of membrane proteins
Research using antibodies against conformational epitopes



Structures of membrane protein M of SARS-CoV-2 in two forms by Nomura et al. in our laboratory. It is considered as a new target for SARS-CoV-2 therapy (Nat. Commun. 2022)

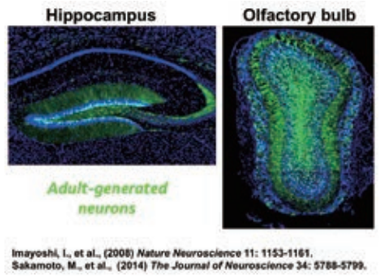
Lab URL https://cell.mfour.med.kyoto-u.ac.jp/en/index.html

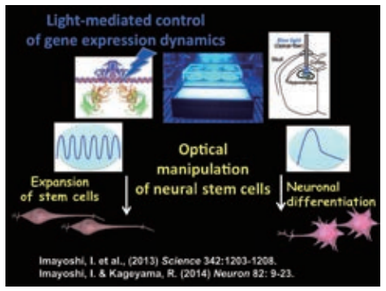
Laboratory of Brain Development and Regeneration

Professor
IMAYOSHI, Itaru

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.





https://brainnetworks.jimdofree.com Lab URL

Assoc. Prof. (Concurrent post)
GUY, Adam Tsuda

Assoc. Prof.
SAKAMOTO, Masayuki

Assist. Prof.
SUZUKI, Yusuke

Assist. Prof.
NAGASAKI, Shinji

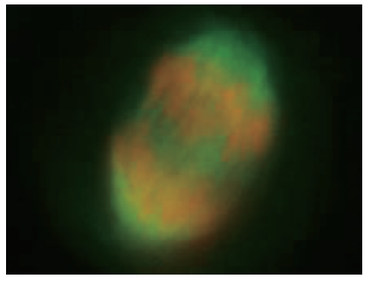
Laboratory of Genome Maintenance

Professor
MATSUMOTO, Tomohiro

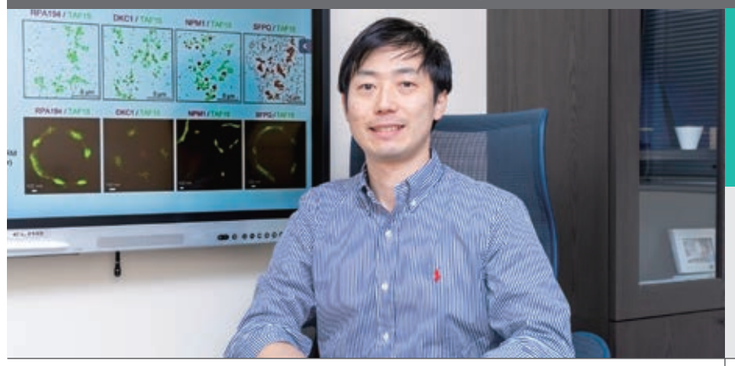
Junior Assoc. Prof.
FURUYA, Kanji

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.



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



Laboratory of Genome Stress Response

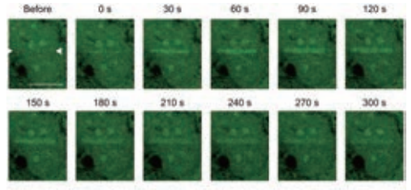
Professor
YASUHARA, Takaaki

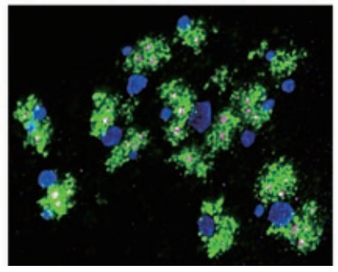
Main theme

Cells have sophisticated mechanisms to respond to cellular stresses from external stressors, thereby maintaining homeostasis. Our laboratory aims to elucidate the molecular mechanisms of cellular stress responses, especially the ones caused by genotoxic stresses, and the fundamental mechanisms underlying many types of diseases caused by inefficient stress responses. We hope to contribute to solving various problems in this age of long-life expectancy, such as cancer and infertility in reproductive medicine.

Research subjects

- The molecular mechanisms of cellular stress response
- Genomic instability induced by abnormal transcription-associated DNA repair pathways
- The stress responses mediated by phase separation of RNA-binding proteins
- Disease-related genome abnormalities caused by aging
- The fundamental mechanism of diseases, such as cancer and chromosomal anomaly
- Cellular responses to replicative stress
- Investigate mechanisms underlying rare diseases using iPS cells





Top: Real-time imaging of R-loop formation (green) at DNA double-strand break sites (white arrows)
Bottom: Condensates (green) formed at nucleoli (blue/magenta) upon cellular stress

Assist. Prof.
MU, Anfeng

Assist. Prof.
IMAMURA, Rikiya

https://www.rbc.kyoto-u.ac.jp/genome_stress/en/ Lab URL

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
- Pathophysiological causes of hypoxia-related diseases

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

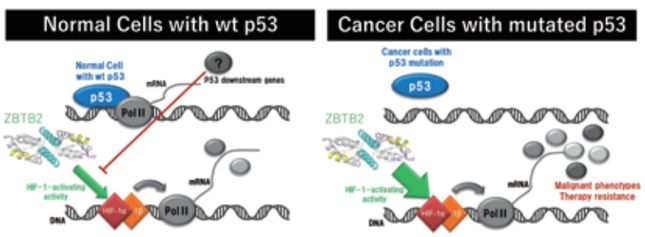


Figure 2: HIF-1-mediated gene networks responsible for both adaptive responses to hypoxia and malignant progression of cancer cells.

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

Assoc. Prof.
IKURA, Tsuyoshi

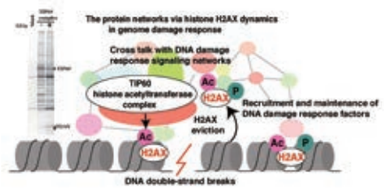
Laboratory of Chromatin Regulatory Network

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



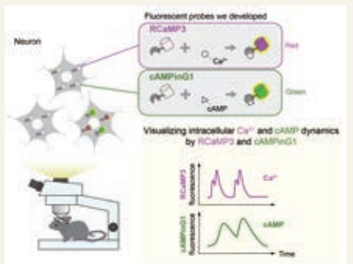
http://house.rbc.kyoto-u.ac.jp/mutagenesis2/index1 Lab URL

TOPICS

Development of Fluorescent Proteins for measuring Ca^{2+} and cAMP – Visualizing the Dynamics of Intracellular Second Messengers *in vivo* –

This study was published in Nature Methods on March 21, 2024.

Calcium ions (Ca^{2+}) and cyclic adenosine monophosphate (cAMP) are essential molecules involved in intracellular signal transduction in many living organisms. The concentrations of Ca^{2+} and cAMP are dynamically regulated as they influence each other, maintaining proper cellular functions. However, due to the lack of technology for simultaneously visualizing Ca^{2+} and cAMP dynamics with high spatiotemporal resolution in living animals, dissecting their relationship remained challenging. A research group led by Associate Professor Masayuki Sakamoto and Postdoctoral Researcher Tatsushi Yokoyama, in collaboration with RIKEN, University of Yamanashi, and the University of Tokyo, developed a red fluorescent Ca^{2+} indicator, RCaMP3, and a green fluorescent cAMP indicator, cAMPinG1. By utilizing these fluorescent proteins in neurons of living mice, they successfully visualized the dynamics of Ca^{2+} and cAMP and elucidated their relationship. This research contributes to a deeper understanding of intracellular signal transduction and is expected to aid in elucidating the pathology of neurological and psychiatric diseases, facilitating the development of new therapeutic strategies.



Visualizing the dynamics of intracellular second messengers *in vivo*

For further information, please refer to the URL below.
https://www.lif.kyoto-u.ac.jp/j/research/research_results/cat30/2024-03-22/
https://doi.org/10.1038/s41592-024-02222-9

Laboratory of RNA Viruses

Professor
TOMONAGA, Keizo
AFFILIATION :
Institute for Life and Medical Sciences

Assoc. Prof.
MAKINO, Akiko

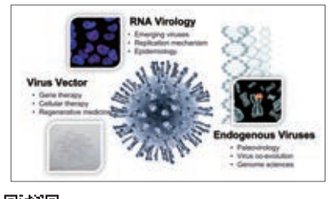
Assoc.Prof.
VANDENBON, Alexis

Main theme

All viruses utilize the mechanisms of infected cells to replicate and propagate repeatedly. Therefore, studying viruses is not only about understanding them, but also about uncovering the foundations of life more broadly. In our laboratory, we investigate the interaction between viruses and life, such as how viruses replicate, why they cause diseases, and how viral infections have impacted our evolution. Additionally, we apply the unique features of viruses to develop viral vectors for gene and cell therapy. Specifically, our research focuses on RNA viruses, such as bornaviruses, influenza viruses and novel coronaviruses.

Research subjects

- Analysis of the replication and pathogenicity of bornaviruses.
- Investigation of the evolutionary significance of endogenous RNA viruses.
- Development of novel viral vectors using the Borna disease virus.
- Bioinformatics methodology for the analysis of large biological datasets.



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

Laboratory of Cellular and Molecular Biomechanics

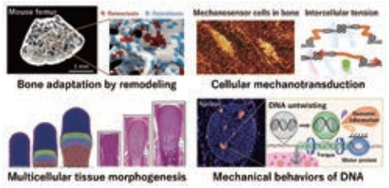
Professor
ADACHI, Taiji
AFFILIATION :
Institute for Life and Medical Sciences

Assoc. Prof.
MAKI, Koichiro

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.

- Biomechanics studies of functional adaptation in living systems
- Multi-scale modeling of tissue development, morphogenesis and growth
- Mechanosensing mechanisms by osteocytic network
- Cell fate determination under mechanical environment in a nucleus
- Bone remodeling and metabolism for multi-organ interaction



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

Laboratory of Mechanosensory Physiology

Professor
NONOMURA, Keiko
AFFILIATION :
Institute for Life and Medical Sciences

Junior Assoc. Prof.
GOTO, Teppei

Main theme

Our group aims to clarify the molecular mechanism of mechanosensation and their physiological roles among organs. For this purpose, we utilize mice lacking PIEZO1/2 mechanically activated ion channels, their reporter mouse lines, and also organoids.

Research subjects

1. Elucidating physiological roles of PIEZO expressing mechanosensory neurons innervating lung and/or other organs. We have been specifically investigating their contribution to breathing pattern of newborns, as starting breathing immediately after birth is critical for survival of mammalian newborns and its underlying mechanism is still mostly elusive.
2. Studying the contribution of PIEZO mediated mechanisensation in the brain, focusing on both developmental process and brain function.
3. Studying the mechanism in which PIEZO1 mediated mechanosensation contributes to venous/lymphatic valve formation, utilizing KO or reporter mouse lines and cultured endothelial cells.

https://kurs10808.sakura.ne.jp/nonomuralab/ Lab URL

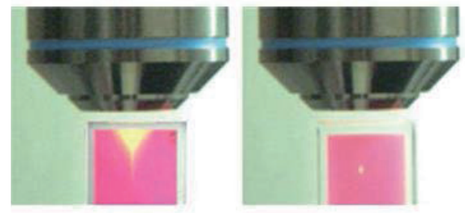
Laboratory of Spatiotemporal Optical Control

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



Radiation Biology Center (RBC)

Radiation Biology Center, Kyoto University

Message from Director of the Center

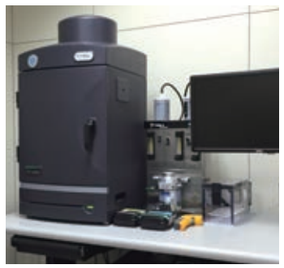
HARADA, Hiroshi

The Radiation Biology Center (RBC) was founded in 1976 to promote basic research on biological effects of radiation. 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 blessed 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 the CORE Program, but at the same time, each member of RBC pursues science with their own research direction.

Low Dose and Low Dose-rate Irradiation System



Optical In Vivo Imaging System

The 2nd RBC-CEA Joint Workshop

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 (Junior Assoc. Prof.)

Dept. of Mutagenesis

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 Late Effects Studies

We are studying the causes of diseases that occur after exposure to radiation, with a focus on DNA damage responses at the cellular level. An understanding of these molecular mechanisms will provide a deeper insight into the response of our body to radiation and will contribute to the fields of cancer and reproductive medicine.

[Staff] YASUHARA, Takaaki (Prof.) / MU, Anfeng (Assist. Prof.) / IMAMURA, Rikiya (Assist. Prof.)

Dept. of Genome Repair Dynamics

We are conducting studies on intracellular and extracellular factors that affect cancer radiation sensitivity/resistance, such as genetics deficiencies and tissue microenvironments. Our research focus is ranging from molecular, cellular, and tissue levels to experimental mice and further to cancer patients.

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

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.

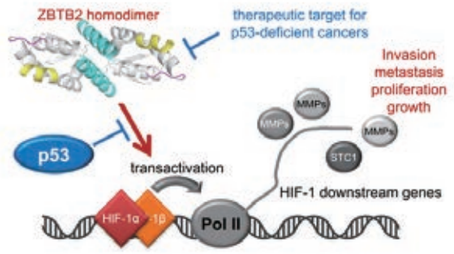
[Staff] CARLTON, Peter (Assoc. Prof.)

Reaserch Result

Aberrant activation of HIF-1 and p53 deficiency, which are both recognized as hallmarks of cancers, induce malignancy and resistance to radiation therapy and chemotherapy.

But functional and mechanistic relationship remains unknown. Department of Genome Dynamics found that ZBTB2 links activation of hypoxia signaling and tumor suppressor dysfunction, thereby promoting cancer aggressiveness, thus representing a target to treat p53-deficient cancers.

(Koyasu et al. *EMBO Rep*. 24:e54042. 2023.)



Center for Living Systems Information Science (CeLiSIS)

Message from Director of the Center

TOJU, Hirokazu

Modern life sciences now require researchers to master both advanced experimental techniques and big-data processing. The field has seen rapid growth in data-driven approaches, where large biological datasets are analyzed to uncover patterns and generate hypotheses.

Today's scientists must therefore be equally skilled at wet lab experiments and dry lab computational analysis.

To address this need, the Graduate School of Life Sciences launched the Center for Living Systems Information Science (CeLiSIS) in April 2023. While traditional training separated experimental biologists from computational specialists, CeLiSIS aims to bridge this gap through integrated education. Previous efforts to combine these disciplines relied on individual faculty initiatives, highlighting the need for institutional-level support.

CeLiSIS continues the work of its predecessor (the Research Center for Dynamic Living Systems) in advanced microscopy and image analysis, while expanding into genomic data interpretation and gene expression analysis. By incorporating these computational skills into graduate education, the center helps researchers develop hybrid expertise for innovative biological studies.

The center collaborates with the Center for Innovative Research and Education in Data Science (CIREDS), affiliated with the Institute for Liberal Arts and Sciences, the core facility network including the Innovative Support Alliance for Life Sciences (iSAL) and the North Campus Instrumental Analysis Station (NOCIAS), and other graduate schools and institutes across the university campus. These collaborations aim to train researchers who can work across traditional academic boundaries. Moreover, partnerships with the DNA Data Bank of Japan (DDBJ) at the National Institute of Genetics and the University of Zurich position CeLiSIS to advance life science research through combined experimental and computational approaches.

This integrated training prepares graduates to tackle complex biological challenges using modern multidisciplinary platforms.

Overview of educational activities

- Basic course (master's degree equivalent)
  Students and technical staff at Kyoto University can learn practical information analysis, based on their own knowledge of experimental science.
- Life science DX course (doctoral course equivalent)
  This course fosters world-class "two-way" researchers.

Departments

Strategic Education Program

This department plays a central role in consolidating and systematizing educational and research resources that were scattered throughout Kyoto University, and in promoting collaborations with other graduate schools, institutes, university core facilities and external organizations to develop practical DX education methods, together with other departments in CeLiSIS.

[Staff] TOJU, Hirokazu (Prof.)
NISHIKAWA, Seiya
(Program-Specific Junior Assoc. Prof.)
FUJITA, Hiroaki (Assist. Prof.)

Computational Genomics

To extract biological significance from big data generated by next-generation sequencers, curricula related to UNIX, R, Python, statistical basics, and various NGS analysis software are provided.

[Staff] TOJU, Hirokazu (Prof.)
YAMANO, Takashi (Assoc. Prof.)
YOSHITAKE, Yoshihiro (Assist. Prof.)
INOUE, Keisuke (Assist. Prof.)
KUMETA, Masahiro (Assist. Prof.)
FUJITA, Hiroaki (Assist. Prof.)

Computational and Systems Biology

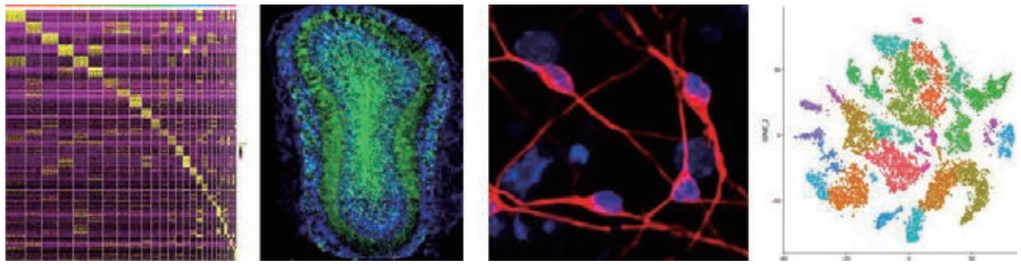
This department provides curricula related to programming languages, ordinary differential equations, partial differential equations, basic statistics, linear regression, nonlinear regression, machine learning, principal component analysis, and image analysis.

[Staff] IMAYOSHI, Itaru (Prof.)
SAKAMOTO, Masayuki (Assoc. Prof.)
USUI, Tadao (Junior Assoc. Prof.)
SUZUKI, Yusuke (Assist. Prof.)
NAGASAKI, Shinji (Assist. Prof.)

Advanced Big Data Analysis

This department provides curricula related to mathematical modeling and predictive simulation, AI, data science related to single cell gene expression and genome analysis, spatial transcriptomics, and large-scale database creation, as well as collaborative research opportunities for doctoral students.

[Staff] AOKI, Kazuhiro (Prof.)
GOTO, Yuhei (Assoc. Prof)
NISHIKAWA, Seiya
(Program-Specific Junior Assoc. Prof.)
HIRANO, Sayuki (Assist. Prof.)



From the left, a heatmap of gene expression analysis, a section of olfactory bulb, an image of neuronal primarily culture, a tSNE plot of single cell analysis.

A class scene (an in-person exercise style)

Data

Number of Students

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

(🧍=10) total 257

1st year	2nd year	3rd year	4th year	5th year
61	67	47	38	44

Number of International Students

(🧍=10) total 80

Government-sponsored	Personally funded
21	59

Number of Non-Degree Students

(🧍=1) total 10

Japanese Students	International Students
4	6

Number of International Students

total 80

Asia

Korea	6
Taiwan	9
China	38
Pakistan	1
Viet Nam	5
Hong Kong	2
Malaysia	3
Mongolia	4
Singapore	1
Indonesia	1
Philippines	1

Africa

South Africa	1
Kenya	1
Rwanda	2

Europe

Russia	1
Germany	1
France	2
Italy	1
UK	1

South America

Brazil	1
Honduras	1

North America

Canada	1
USA	1
Mexico	2

Male-Female Ratio of Students

(As of April 1 , 2025)

	Female	Male
Master's	42%(54)	58%(74)
Doctorate	54%(70)	46%(60)

Number of Faculty and Staff

*( )The numbers in parentheses indicate number of visiting academic staff.
*〈 〉The numbers in brackets indicate affiliated academic staff, in addition to the regular staff. Including specially contracted fixed-term faculty and staff

(🧍=10) total 124

Faculty total 59

Professor	Associate Professor	Junior Assoc. Prof.	Assistant Professor
16 (6) 〈8〉	18 (5) 〈4〉	5 〈3〉	20 〈3〉

Staff total 65

Administrative Staff	Technical Staff
26	39

Student Support

As of April, 2025

JSPS Research Fellowship for Young Scientists

	Selected	applicant	adoption rate
AY2024	18	41	44%
AY2023	11	21	52%
AY2022	12	21	57%

Kyoto University Division of Graduate Studies SPRING Program

	Selected	applicant	adoption rate
AY2024	4	32	13%
AY2023	6	24	25%
AY2022	7	29	24%

Career Paths of the GSB Graduates

Master's Degree Holder

	Employment	Promotion	Others
AY2024	53%	47%	
AY2023	58%	38%	4%
AY2022	58%	38%	4%

Employment of Doctoral Degree Holder

	Academia	Industry
AY2024	62%	38%
AY2023	33%	67%
AY2022	33%	67%

Number of Doctoral Degree Holder

(🧍=5)

AY2024	AY2023	AY2022
21	28	24

Major Places of Employment

Private Campanies

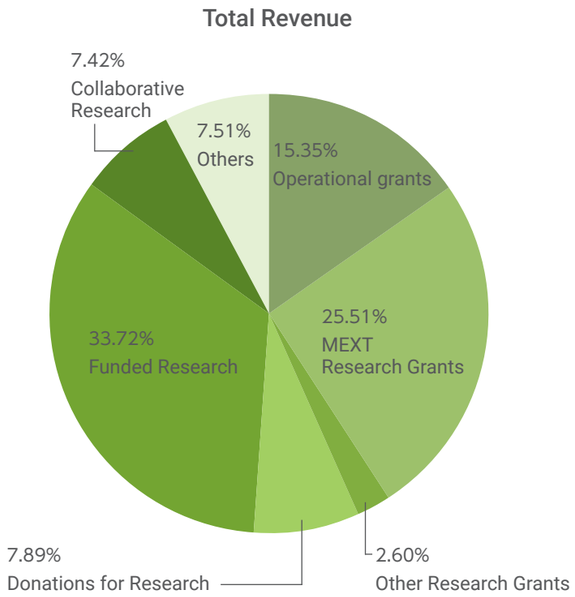
ARKRAY, Inc. / AIREX INC. / AOYAMA & PARTNERS / Accenture Japan Ltd / ASAHI SOFT DRINKS CO. / ASAHI KASEI CORPORATION / ASAHI BREWERIES, LTD / AJINOMOTO CO.,INC. / Astellas Pharma Inc. / Nihon Emsco Co. Ltd. / AOHATA CORPORATION / ISHIHARA SANGYO KAISHA, LTD. / Idemitsu Kosan Co.,Ltd / SDS Biotech K.K. / NTT DATA CORPORATION / Osaka Gas Co., Ltd / Otsuka Pharmaceutical Co., Ltd. / Oyatsu Company Ltd. / Oriental Yeast Co., ltd. / OncoTherapy Science, Inc / GAKKEN HOLDINGS CO.,LTD. / Calbee, Inc. / Kawasumi Laboratories, Inc. / KEYENCE SOFTWARE CORPORATION. / KISSEI PHARMACEUTICAL CO., LTD. / Kyowa Kirin Co., Ltd. / KYOWA HAKKO BIO CO.,LTD. / KYORIN CO., LTD. / KYOKUTO PHARMACEUTICAL INDUSTRIAL CO., LTD / Creatures Inc. / GLICO NUTRITION CO.,LTD. / Gekkeikan Sake Company, Limited / KOSÉ Corporation / KOBAYASHI Pharmaceutical Co.,Ltd. / SAPPORO BREWERIES LTD. / Sunstar Inc. / Santen Pharmaceutical Co., Ltd. / Suntory Holdings Limited / SANYO FOODS Co.,Ltd. / GL Sciences Inc. / Genex Partners / Shionogi & Co., Ltd. / SYSMEX CORPORATION / Shiseido Company, Limited / CMIC CMO Co., Ltd. / CMIC HOLDINGS Co., Ltd. / Sumitomo Life Information Systems Co.,Ltd. / SEIWA KASEI Co,Ltd. / DAIICHI SANKYO HEALTHCARE CO., LTD. / DAIKIN INDUSTRIES, LTD. / Sumitomo Dainippon Pharma Co., Ltd. / Taiyo Kagaku Co.,Ltd. / Takanofoods Co., Ltd. / TAKARA BIO INC. / TAKII & CO.,LTD / Takeda Pharmaceutical Company Limited. / Chugai Research Institute for Medical Science, Inc. / CHUGAI PHARMACEUTICAL CO., LTD. / THE CHUGOKU ELECTRIC POWER CO.,INC. / TSUMURA & CO. / TEIKOKU SEIYAKU CO., LTD. / TEIJIN LTD. / TEIJIN FRONTIER CO., LTD. / Denka Company Limited. / DENTSU INC. / TOHO CO., LTD. / TOYO SHINYAKU Co.,Ltd. / SHIGA INTERNATIONAL PATENT OFFICE / TOYOTA MOTOR CORPORATION. / Torii Pharmaceutical Co., Ltd. / choseido Pharmaceutical Co.,Ltd. / Nikon Corporation / NICHIREI BIOSCIENCES INC. / Nissan Motor Co., Ltd. / Nisshin OilliO Group, Ltd. / NISSIN FOODS HOLDINGS CO., LTD. / NIPRO CORPORATION / Nihon M&A Center Inc. / Bank of Japan / NIPPON STEEL CORPORATION / NIDEC CORPORATION / JAPAN POST Co., Ltd. / NIHON L'ORÉAL K.K. / Net Protections, Inc. / Noevir Holdings Co., Ltd. / Nomura Securities Co.,Ltd. / HOUSE FOODS CORPORATION / Panasonic Corporation / East Nippon Expressway Company Limited / HIKARI TSUSHIN, INC. / Pigeon Corporation / Hitachi High-Tech Corporation / Fixpoint, Inc. / FUJIFILM Business Innovation Corp. / FUJIREBIO Inc. / BLEACH / Marudai Food Co.,Ltd. / Maruho Co., Ltd. / MANDA FERMENTATION CO.,LTD. / mandom corp. / Mizuno Corporation / Mizuho Financial Group, Inc. / Sumitomo Mitsui Card Co., Ltd. / MUFG Bank, Ltd. / Mediscience Planning Inc. / MORINAGA MILK INDUSTRY CO.,LTD. / Yakult Honsha Co.,Ltd. / Yahoo Japan Corporation / Euglena Co.,Ltd. / Eurofins Analytical Science Laboratories, Inc. / Yoshindo Inc. / Lion Corporation / Rakuten Group, Inc. / Recruit Co., Ltd. / Linical Co.,Ltd. / ROHTO Pharmaceutical Co.,Ltd. / Roche Diagnostics K.K / ROKKO BUTTER CO., LTD. / Works Applications Co.,Ltd. / WORLD INTEC CO.,LTD. / AGC Inc. / Cygames, Inc. / EY Strategy and Consulting Co., Ltd. / H.U. Group Holdings, Inc. / JCR Pharmaceuticals Co., Ltd. / JERA Co., Inc. / Mizkan Holdings Co., Ltd. / NBC Meshtec Inc. / NTT DOCOMO, INC. / The P&G Japan Limited / PwC. / SOLIZE Corporation / Waqoo,Inc. / WuXi Biologics.

Others

Hokkaido University / The University of Tokyo / Kyoto University / Shiga University of Medical Science / Wakayama Medical University / Kumamoto University / Okinawa Institute of Science and Technology Graduate University (OIST) / Ministry of Education, Culture, Sports, Science and Technology / Ministry of Agriculture, Forestry and Fisheries / National Research and Development Agency RIKEN / Japan International Cooperation Agency / KYUSHU INTERNATIONAL UNIVERSITY HIGH SCHOOL. / Nara Institute of Science and Technology / Nagoya University / University College London / OSAKA UNIVERSITY.

Total Revenue in Fiscal 2024

Category	Total (yen)
Operational grants	217,324,364
MEXT Research Grants	361,057,521
Other Research Grants	36,849,000
Donations for Research	111,702,052
Funded Research	477,299,192
Collaborative Research	104,957,851
Others	106,270,423
Total	1,415,460,403



Successive Deans As of April 1, 2025

Name	Period	
	from	to
OHYAMA, Kanji	Apr 1, 1999	Mar 31, 2001
YANAGIDA, Mitsuhiro	Apr 1, 2001	Mar 31, 2003
INABA, Kayo	Apr 1, 2003	Mar 31, 2005
NISHIDA, Eisuke	Apr 1, 2005	Mar 31, 2009
YONEHARA, Shin	Apr 1, 2009	Mar 31, 2013
ISHIKAWA, Fuyuki	Apr 1, 2013	Mar 31, 2017
KAKIZUKA, Akira	Apr 1, 2017	Mar 31, 2021
FUKUZAWA, Hideya	Apr 1, 2021	Mar 31, 2023
IGAKI, Tatsushi	Apr 1, 2023	

Professors Emeriti As of April 1, 2025

Name	Laboratory	Enrollment period	
		from	to
SASAKI, Ryuzo	Biosignals and Response	Apr 1, 1999	Mar 31, 2001
TAKEICHI, Masatoshi	Cell Recognition and Pattern Formation	Apr 1, 1999	Mar 31, 2002
OHYAMA, Kanji	Plant Molecular Biology	Apr 1, 1999	Mar 31, 2003
KUMAGAI, Hidehiko	Applied Molecular Microbiology	Apr 1, 1999	Mar 31, 2004
YANAGIDA, Mitsuhiro	Chromosome Transmission	Apr 1, 1999	Mar 31, 2005
IZUI, Katsura	Plant Physiology	Apr 1, 1999	Mar 31, 2005
NAKANISHI, Shigetada	Neuroscience	Apr 1, 1999	Mar 31, 2005
YAMAMOTO, Kenji	Applied Molecular Microbiology	Apr 1, 1999	Mar 31, 2010
KOZUTSUMI, Yasunori	Membrane Biochemistry and Biophysics	Apr 1, 1999	Mar 31, 2012
TAKEYASU, Kunio	Plasma Membrane and Nuclear Signaling	Apr 1, 1999	Apr 30, 2014
INOUE, Tan	Gene Biodynamics	Apr 1, 1999	Mar 31, 2015
INABA, Kayo	Immunobiology	Apr 1, 1999	Mar 31, 2016
YONEHARA, Shin	Molecular and Cellular Biology	Aug 1, 2001	Mar 31, 2018
SATO, Fumihiko	Molecular and Cellular Biology of Totipote	Aug 1, 1999	Mar 31, 2018
NISHIDA, Eisuke	Signal Transduction	Apr 1, 1999	Mar 31, 2018
NEGISHI, Manabu	Molecular Neurobiology	Apr 1, 1999	Mar 31, 2019
HEJNA, James Alan	Science Communication	Nov 1, 2010	Mar 31, 2020
CHISAKA, Osamu	Bioeducation	Apr 1, 1999	Mar 31, 2022
ISHIKAWA, Fuyuki	Cell Cycle Regulation	Sep 1, 2001	Mar 31, 2023
TAKATA, Minoru	Genome Damage Signaling	Apr 1, 2018	Mar 31, 2023
FUKUZAWA, Hideya	Applied Molecular Microbiology	Apr 1, 1999	Mar 31, 2023
MATSUDA, Michiyuki	Bioimaging and Cell Signaling Center for Living Systems Information Science (CeLiSIS)	Apr 1, 2007	Mar 31, 2024
KAKIZUKA, Akira	Functional Biology	Apr 1, 2001	Mar 31, 2024
UEMURA, Tadashi	Cell Recognition and Pattern Formation	May 1, 2004	Mar 31, 2025
NAGAO, Masaya	Biosignals and Response	May 1, 2001	Mar 31, 2025

Honors As of April 1, 2025

Honors	Laureates	Year
L' Oréal-UNESCO For Women in Science International Awards	INABA, Kayo	2014
Japan Prize	TAKEICHI, Masatoshi	2005
The Order of Culture	YANAGIDA, Mitsuhiro	2011
	NAKANISHI, Shigetada	2015
The Order of the Sacred Treasure, Gold Rays with Neck Ribbon	INABA, Kayo	2023
Medal with Purple Ribbon	YANAGIDA, Mitsuhiro	2002
	NISHIDA, Eisuke	2010
	INABA, Kayo	2016
	MATSUDA, Michiyuki	2023
Person of Cultural Merit	YANAGIDA, Mitsuhiro	2004
	TAKEICHI, Masatoshi	2004
	NAKANISHI, Shigetada	2006
	INABA, Kayo	2024
Japan Academy Prize	YANAGIDA, Mitsuhiro	2003
	OHYAMA, Kanji	2008
	KUMAGAI, Hidehiko	2012
	SATO, Fumihiko	2012
	NISHIDA, Eisuke	2016
Member of the Japan Academy	TAKEICHI, Masatoshi	2000
	NAKANISHI, Shigetada	2009