UTSIP Kashiwa 2025 Program B

Host Laboratory List

Division of Transdisciplinary Sciences

- Advanced Materials Science

Division of Biosciences

- Integrated Biosciences
- Computational Biology and Medical Sciences

Division of Environmental Studies

- Ocean Technology, Policy and Environment
- Environment Systems
- Human and Engineered Environmental Studies
- International Studies

Division of Transdisciplinary Sciences

Department of Advanced Materials Science

Laboratory	Faculty	Introduction of research activities and laboratory	Key words	Projects or activities summer program students can participate
Mayumi Laboratory	Assoc. Prof. MAYUMI Koichi	The research goal of our group is to reveal molecular mechanisms for macroscopic properties of soft matter systems. One of our targets is to understand toughening mechanisms of polymeric materials. Recently, controlling nano-structure has improved significantly the mechanical toughness of polymer-based materials. The tough polymeric materials are expected to be applied for biomaterials, soft robots, and structural materials for automobiles and airplanes. We study nano-structure and dynamics of the tough polymeric materials by means of neutron, X-ray, and light scattering techniques. Based on the observed nano-scale structure/dynamics and macroscopic mechanical properties, we aim to establish molecular understandings of toughening mechanisms for polymeric materials and discover novel molecular designs for tough materials. For example, we have for the first time discovered reversible strain-induced crystallization of polymer chains in hydrogels and developed tough and highly reversible polymer gels (Science, 372, 1078 (2021)). The reversibility of the strain-induced crystallization allows the tough hydrogels to rapidly recover from mechanical stress, which is important for artificial ligaments and joints.	Polymer; Soft Material; Mechanical Property; Nano Structure; Scattering Techniques	We are interested in the microscopic structural change of polymeric materials under stress fields. For the summer programme, we propose the microscopic structural analysis of polymer gels/solutions under external stress fields by using scattering techniques combined with deformation devices. From the observation of the microscopic structural change under stress fields, we reveal the molecular origin of macroscopic mechanical properties of polymeric materials.

Division of Biosciences

Department of Integrated Biosciences

Laboratory	Faculty	Introduction of research activities and laboratory	Key words	Projects or activities summer program students can participate
Laboratory of Plant Functional Analyses	Prof. OHTANI Misato	Plants develop and grow in ways that are completely different from animals: they are born without deciding the number of organs they will make during their lives, and they develop and grow to suit the environment where they take root. In addition, they continue living by regenerating lost organs through their advanced organ regeneration abilities, while some of their cells choose death for the benefit of other cells. Our aim is to obtain molecular information on how plants sense and react to environmental conditions, and how control flexibly cell proliferation and differentiation, for an active control of their life system. For this purpose, we focus on “dynamics of RNA metabolism” and “dynamics of cell wall polymer”, which are key regulatory elements of gene expression and cell function in plants. Furthermore, we aim to develop new technologies that can contribute to a sustainable society, by maximizing plant functions and/or creating new functions by artificial modification of these molecular factors.	plant cell; xylem vessel; transcription factor; totipotency; pre-mRNA splicing	As part of the summer program, we propose the following two projects. Students will choose one of them and carry out the research. 1) “Molecular mechanisms of xylem vessel cell differentiation” project Xylem vessels are one of essential tissues of vascular plants for their survival. Student will participate this project to learn molecular biological techniques using our original induction system VND7-VP16-GR for xylem vessel cell differentiation, as shown below. 1. Sowing and growing plants by aseptic manipulation 2. Induction of xylem vessel cell differentiation 3. Microscopic observation of plant cells 3. Examination of transcriptional activity by transient expression system 2) “RNA metabolic regulation for plant cell potency” project Totipotency is a characteristic property of plant cells. We have shown the importance of RNA metabolic regulation, especially pre-mRNA splicing, in the expression of totipotency of plant cells. Student will participate this project to learn RNA biological and plant cultural techniques using tissue culture system as below. 1. Sowing and growing the wild type and mutant plants by aseptic manipulation 2. Tissue culture of explants derived from the wild type and mutant plants 3. Observation of resultant explants 3. Examination of gene expression level and splicing patterns
Laboratory of Innovational Biology	Assoc. Prof. KOJIMA Tesuya	Living organisms adapt to their environments by evolving their shapes and forms in a wide variety of ways. Our research focuses on the mechanisms underlying the formation of various life forms, such as how shapes are formed, how differences in shapes arise, and how shapes evolve. While we have a deep understanding of the mechanisms by which cell properties are determined during development, how these fate-determined cells establish the final shape remains a mystery. One of our primary subjects of study is the formation of adult leg shapes in the fruit fly, Drosophila. Using live imaging techniques to continuously observe cell dynamics during the final shape formation process of the leg, we recently discovered that the final shape is achieved through surprising morphological changes, the transient formation of unexpected structures which we named the "Parthenon"-like structure, and unique interactions between cells and the apical and basal extracellular matrices. Through such research, we aim to understand the molecular mechanisms that underlie the shaping of organisms.	shape formation; live imaging; fruit fly; leg	The project we are planning involves observing the process of adult leg shape formation in wild-type flies as well as flies with knocked down or artificially expressed presumptive important genes. We will use flies expressing proteins labeled with fluorescent markers and conduct live imaging with a confocal laser scanning microscope. Once we have obtained the live imaging data, we will analyze it on a PC using image analysis software to assess the functions of these genes and understand the shaping processes. By conducting this project, we aim to deepen our understanding of the mechanisms behind adult leg shape formation. By participating in this project, you will learn how to handle fruit flies, prepare samples for live imaging, operate the confocal laser scanning microscope, acquire and analyze live imaging data, and more.

Laboratory of Signal Transduction	Assoc. Prof. SUZUKI Kuninori	The budding yeast Saccharomyces cerevisiae is a very attractive model organism for studying the fundamental theories and concepts of eukaryotic cells. We applied the power of yeast genetics to understand many aspects of yeast cells. Our current research is mainly focused on (1) molecular mechanism of autophagosome formation using live imaging techniques, (2) molecular mechanism of autophagic body degradation by biochemistry, (3) screening of new membraneless organelles, and (4) analysis of intracellular phospholipid dynamics. (1) Autophagy is a major pathway of bulk degradation of cytoplasmic materials. In yeast, autophagy has been studied as a cellular response for survival during nutrient-limited conditions. During autophagy, cytoplasmic components are enclosed in a membrane compartment, called an autophagosome. We have been studying the molecular mechanism of autophagosome formation by live imaging and quantitative analysis of microscopic images. (2) The autophagosome fuses with the vacuole, to become an autophagic body. The cytoplasmic components to be degraded are sequestered from the hydrolytic enzymes in the vacuolar lumen by the autophagic body membrane. Thus, degradation of the autophagic body membrane is necessary for proteolytic enzymes to access the cargoes of the autophagic body. We are trying to elucidate the molecular mechanism of autophagic body membrane degradation by biochemical analysis. (3) Nucleolus is a membraneless organelle that has been known for a long time. Recently, membraneless organelles have become known not only in the cell nucleus but also in the cytoplasm. However, no comprehensive screening has been performed so far. We have screened novel membraneless organelles from a unique viewpoint. We have been analyzing the obtained candidates using bioimaging techniques. (4) Phospholipid is a main component of biological membranes. Recent studies have shown that phospholipids dynamically traffic between membrane organelles via membrane contact sites. We are analyzing phospholipid dynamics using a fluorescent probe which we have found and biochemical methods. Our ultimate goal is to draw a comprehensive map for phospholipid dynamics in eukaryotic cells.	autophagy; cell biology; live imaging; membrane organelles; membraneless organelle	(1) Live imaging of autophagosome formation by fluorescence microscopy. (2) Analysis of phospholipid transfer from the endoplasmic reticulum to autophagosome membranes by FRAP (fluorescence recovery after photobleaching) analysis. (3) Analysis of the autophagosome formation process by deep learning. (4) Morphological classification of autophagosome formation by multivariate analysis of high-dimensional morphometric data. (5) Molecular analysis of domains of the yeast vacuolar phospholipase Atg15. (6) Live imaging of autophagic body degradation by fluorescence microscopy. (7) Biochemical analysis of autophagic body degradation by biochemistry. (8) Live imaging of membraneless organelles by fluorescence microscopy. (9) Regulation of the formation of membraneless organelles by chemical reagents and temperature changes. (10) Live imaging of lipid dynamics using a fluorescent probe. (11) Analysis of phospholipid dynamics by thin-layer chromatography.
Molecular Recognition Laboratory	Prof. NAGATA Shinji	My research interest is to investigate the instinctive behavior observed in insects. We are particularly interested in selevtive nutritional feeding behavior between carnivorous and herbivorous feedings in the omnivore insects. To explore the mechanisms of host preference and feeding motivation observed in insects, we focus on the endocrine control in the nervous system and metabolic mechanisms. In the lights of biology, biochemistry, molecular biology, and chemical biology, we run our projects to address the insect's innate behavioral motivation.	Insect; feeding behavior; endocrine factors; knockdown; metabolism	【Experimental projects】Using crickets Gryllus bimaculatus, program students will experience the functional assay of feeding behavior. Program students will also experience a transcriptional knockdown technique of RNA interference targetting several genes, which encode endocrine factors or metabolism-related molecules. Finally, program students must evaluate if those target molecules can influence innate feeding behavior and/or metabolisms in crickets. 【Experience during UTSIP activity】RT-PCR, quantitative RT-PCR, GC-MS, MALDI-TOF MS, and generally using techniques of molecular biology and chemical biology, and behavioral analyses using crickets.

Division of Biosciences

Department of Computational Biology and Medical Sciences

Laboratory	Faculty	Introduction of research activities and laboratory	Key words	Projects or activities summer program students can participate
Frith Laboratory	Prof. FRITH Martin	We look for interesting information in genetic sequences, and develop algorithmic and mathematical methods to do that. For example, we found animal DNA segments that have been conserved since the Precambrian ancestors of most animals: these segments control gene expression for embryonic development. This reveals a control system for animal development conserved since the common ancestors of humans and corals. In another project, we discovered the oldest ever "protein fossils", segments of formerly protein-coding DNA, by sensitive probability-based analysis. This revealed a great diversity of transposable elements in vertebrate ancestors of the Paleozoic Era. We also found the oldest ever virus fossils: relics of viral DNA inserted into host genomes. In addition, we collaborate with medical geneticists to understand complex chromosome rearrangements, tandem repeat expansions/contractions, and viral DNA insertions that cause disease. We discovered the cause of neuronal intranuclear inclusion disease: a tandem repeat expansion in a human-specific gene. Another project found significant non-existence of sequences in genomes and proteomes, providing clues about immune recognition and pathogen/host adaption. Finally, we developed a mathematically-optimal way to sample a subset of positions in a sequence, for fast analysis of big sequence data.	Genome; evolution; probability; algorithms	Students are encouraged to pursue their own ideas on analyzing genetic sequences. There are broadly two types of project: biological investigation, and method development. Examples of biological investigation: survey the evolution of gene structure by gain or loss of splice sites, frameshifting, gene fusion or fission, etc; compare the evolution of mitochondrial versus plastid genomes; compare genome evolution to major body-form evolution (e.g. snakes, whales). Examples of method development: make a sensitive probabilistic model for finding distantly-related DNA sequences; devise a beautiful way to visualize complex sequence rearrangements; develop a way to extract specific rearrangement events from pair-wise alignments of long sequences (e.g. long DNA reads or whole genomes).

Division of Environmental Studies

Department of Ocean Technology, Policy and Environment

Laboratory	Faculty	Introduction of research activities and laboratory	Key words	Projects or activities summer program students can participate
Ocean Environmental Modelling Laboratory	Prof. SATO Toru	Our researches are aimed to form concepts of environmentally harmonizing systems, which coexist with natural environments for the global sustainability. For this purpose, we are developing computational models of environments using physics, chemistry, and biology, etc. Then these models are synthesized into simulation systems in order to predict environmental impacts and construct public acceptance. Our research interests are CO2 storage in the deep ocean and in subsea underground, biological CO2 fixation, formation and dissociation of methane hydrate, CO2 geological storage by hydrate, the effects of CO2 on marine biota, and offshore recovery of floating marine plastic debris.	Carbon capture and storage; CO2 hydrate; Numerical simulation; Sub-seabed; Offshore geological formation	CO2 capture and storage is a promising strategy against global warming. Although there is concern about the risk of CO2 leakage from deep saline aquifers, it is expected that CO2 hydrate formation suppresses the leakage in the sub-seabed sediment, depending on the water depth of a storage site. Therefore, hydrate formation in the sub-seabed sand sediments is one of key factors in lowering the risk of CO2 leakage and it is important to know conditions under which CO2 leakage is suppressed by hydrate formation. To estimate the sealing effect of CO2 hydrate against CO2 leakage beneath the seabed, a numerical simulation method of hydrate formation in sand sediments can be a useful tool. In this project, numerical simulations will be conducted using an existing code to investigate condotions under which CO2 hydrate is safely formed and performs a proper sealing effect.

Division of Environmental Studies

Department of Environment Systems

Laboratory	Faculty	Introduction of research activities and laboratory	Key words	Projects or activities summer program students can participate
Energy and Environment Laboratory	Lecturer AICHI Masaatsu	Current approaches to energy supply and consumption face problems such as climate changes and dwindling resources. The development of key technologies for saving energy, switching to renewable energy resources, and appropriate CCUS is required. Our goal is to perform research that will contribute to the development of these technologies, especially by taking advantages of the characteristics of subsurface formations. For example, we study ways of developing a sustainable energy system, especially through hydrogeological and thermo-poro-mechanical modeling of geothermal heat pumps, geothermal power plants, and the geological sequestration of carbon dioxide. On the other hand, we also start to study how to adapt to global warming. Combining mitigation and adaptation is an attractive choice but it is not simple because one countermeasure possibly causes another environmental effects. For example, though the groundwater becomes more important water resource under changing climate, the overexploitation of groundwater possibly causes another environmental problem such as land subsidence, sea water intrusion in coastal area, so on. We try to predict and prepare for this kind of domino-like propagation to other environmental problems in advance.	subsurface resource; land subsidence; numerical modeling; anomaly detection; uncertainty analysis	Detection of the start of plastic land subsidence from time series monitoring data Subsurface fluid resources such as groundwater, natural gas, etc., are important for our societies. On the other hand, land subsidence caused by subsurface fluid abstraction has been one of the severe environmental problems. It is important to avoid the land subsidence problems for the subsurface resource production to be sustainable. The subsurface formation elastically deforms under small disturbance while the plastic deformation occurs if the load exceeds the yield stress. Then, controlling the abstraction rate so that the effective stress does not exceed the yield stress of geological formations is important. However, this is practically difficult because of the limitation of our knowledge on subsurface structures. One of the possible ideas is a monitoring-based approach to check whether the plastic deformation occurs or not and stop the production before the land subsidence becomes large. The research questions concerning this idea are what kind of and how accurate monitoring system is required, and how we can detect the elastic-plastic transition from the monitored data. In this theme, we tackle these questions with combinations of numerical simulation, laboratory experiments, time series data analysis, and/or machine learning approaches.
Akizuki Laboratory	Assoc. Prof. AKIZUKI Makoto	"Supercritical water" refers to water whose temperature and pressure are above the critical point. Water near and above the critical point offers dramatic physical changes depending on the operating conditions. In particular, the ionic and dielectric constants of water change significantly with temperature and/or pressure. As a result, it becomes possible to select a reaction based on the objective: from an ionic atmosphere suitable for acid/base reactions to one that implements the dissolution of organics, which is equivalent to a non-polar solvent. Taking advantage of these properties, it is expected that this new, inexpensive, environmentally friendly reaction medium will replace conventional organic solvents. Our laboratory has many research goals covering a wide range of topics: Organic synthesis without catalyst or with solid catalysts, waste decomposition by supercritical oxidation reaction, and synthesis of metal oxide nanoparticles. In all of these areas, through the design, analysis, and control of reactions based on the study of chemical reaction kinetics and reaction engineering, we are advancing extensive research, from fundamental research related to chemical reactions in subcritical and supercritical water to the development of new engineering applications.	Supercritical Water; Reaction Engineering; Organic Synthesis; Catalysis; Nanoparticle synthesis	Supercritical water is a promising reaction medium for organic synthetic reactions and inorganic nanoparticle synthesis because its solvent properties can be varied with temperature and pressure, and these properties affect the reaction kinetics and mechanisms. In this project, we will investigate how the reactions in supercritical water can be controlled by changing the temperature and pressure of supercritical water and how this reaction control affects the yield and properties of the products.

Geosphere Environment Systems Laboratory	Prof. TOKUNAGA Tomochika	Underground geosphere environment has been extensively used to support highly developed human society; e.g., extraction of energy resources and groundwater, waste disposal, construction of tunnels and underground spaces. Because of these activities, environmental problems which affect the sustainability of our society have emerged. The target of our laboratory is to understand and predict the change of geosphere environment caused by human activities, and to develop necessary engineering measures to attain sustainable use of geosphere environment. Current research topics include, studying and evaluating geosphere environmental changes caused by energy resources development and proposing necessary technological measures for sustainable resources development, securing stable and safe freshwater resources and development of efficient management schemes, and modeling long-term fluid flow and material transport processes through geosphere and its application to waste disposal and energy resources exploration.	Groundwater; coastal zone; seawater intrusion; modeling; field survey	Fresh groundwater in shallow unconfined aquifers is an important water resource for many coastal zones worldwide which, however, is threatened by seawater intrusion. The occurrence of seawater intrusion is controlled by both anthropogenic activities and natural factors. Anthropogenic activities such as land reclamation, abstraction of freshwater and other natural resources, construction of structures such as riverbanks and ditches, and alternation of land surface conditions, could disturb freshwater-seawater interactions from the natural conditions. To what extent seawater intrusion occurs is also dependent on natural factors such as aquifer properties, tidal river dynamics, and meteorological conditions. In this study, computer-based techniques such as numerical modeling combined with field-based geophysical exploration techniques such as 1D and 2D resistivity surveys will be applied to understand seawater intrusion situations both from conceptual cases and realistic sites. Students will learn fundamental knowledge of coastal hydrological processes and gain the ability to analyze environmental issues through hands-on practice of using advanced modeling tools as well as participating field investigation. Also, students will have chances to get involved in other research activities in this laboratory, such as GIS-based mapping, water sampling, and water quality analysis.

Division of Environmental Studies

Department of Human and Engineered Environmental Studies

Laboratory	Faculty	Introduction of research activities and laboratory	Key words	Projects or activities summer program students can participate
Kotani & Shimba Laboratory (Mathematical Biology and Bioengineering)	Prof. KOTANI Kiyoshi	Recent advances of experimental and analytical techniques have shown that biological systems are far more precise in achieving various functions than we have previously imagined. Our laboratory explores a wide range of projects spanning from fundamental research into life phenomena to the development of life-supporting technologies. Biological systems are organized into a hierarchical structure from molecules and cells to organs and individuals enabling them to perform diverse functions. The essence of life phenomena can be understood through mathematical analysis and modeling that integrates data from various levels of biological systems, leveraging nanotechnology and multimodal measurement. Within this overall laboratory direction, this internship focuses primarily on macroscopic human measurement and analysis, as well as mathematical modelling and analysis.	Brain Computer Interface; Computational Neuroscience; Medical ultrasound imaging; Nonlinear Dynamics; Brain dynamics	Applicants are required to carry out one project during the internship term. This project will focus on a subject of interest from areas such as brain-machine interfaces, medical ultrasound measurement support devices, and computational neuroscience, while taking into account the current situation of the laboratory. Examples of specific projects include (1) Experimental research for reliable Brain-Computer Interfaces, (2) Analysis of non-linear and collective dynamics and functions of biologically plausible neuronal models, (3) Improving the quality of medical ultrasound imaging for health management outside hospitals. Please note that English is okay for communication and research during the internship.
Simulation of Complex Systems Laboratory	Prof. CHEN Yu	A wide range of research topics are studied in our lab, including modeling and analysis of social-economics, complex fluids, and biological systems. There are three main research directions: (1) Multi-agent cooperative evolutionary games for modeling and simulations of financial markets; (2) Discrete kinetic models for simulation of complex fluids; (3) Cellular automata and heterogeneous stochastic agent models for simulations of cancer and aging.	Complex Systems; Agent-Based Modeling; Stock Price; Aging; Tumorigenesis	As part of the program, a student will be assigned a small project, involving model construction and computer simulation. The specific complex system for study will depend on the student's interest. A financial market, a solution containing colloid, or a growing tumor could be the target of study. Apart from research, visits to related laboratories at other universities, and/or scenic sites surrounding Tokyo, etc., will also be scheduled.
Laboratory for Intelligent Systems Design	Prof. HIEKATA Kazuo Dr. NAKASHIMA Takuya	Societies and industries can be thought as a system of people, technology, and institutions. Although these social and industrial systems have evolved and met the high expectations of humans, the mechanisms of the systems have become more complex, giving rise to difficult problems to solve, such as global warming and aging populations. This laboratory is engaged in research that contributes to solving such problems by supporting human intellectual activities such as decision-making related to systems with simulation, sensing, and data analysis technologies.	Climate Change Adaptation; Flood Risk Management; System Dynamics; Agent Simulation; Policy Making	In our laboratory, we are working on the construction of a simulation model to examine appropriate adaptation measures that take into account multi-sectoral synergies and trade-offs in response to the effects of climate change, such as an increase in flood risk. Based on the simulation model we constructed for Japanese local area, the internship student will customize and develop the model so that it can be used to approach issues in their home country, or desired region. This research will be conducted with Dr. Takuya Nakashima, an assistant professor at the Hiekata Laboratory.

Division of Environmental Studies

Department of International Studies

Laboratory	Faculty	Introduction of research activities and laboratory	Key words	Projects or activities summer program students can participate
Honda Lab	Prof. HONDA Riki	Our society is exposed to various types of risks including natural disasters. Preparation for such risks is essential, but no countermeasure can provide perfect protection against severe disasters. In the presence of various threats such as climate change, huge earthquakes and tsunamis, society needs to be endowed with capability of adaptation and resilience. In our group, mechanism of collective behavior observed in the society coping with the situation with severe uncertainty is discussed from the viewpoints of social networks, game theory, adaptive systems theory, etc. Innovative mathematical approach for uncertainty management, such as financial problems is also in our scope. Development and management of infrastructure systems, advanced design methods, asset management and international technology transfer are also of our interest.	Infrastructure; community resilience; disaster management; information theory; deep learning	(1) Statistical analysis of survey data to discuss community's attitude for disasters, using Bayesian approach or social network analysis. (2) Methodologies for seismic design/infrastructure maintenance, based on deep learning and information theory.