

# UTSIP Kashiwa 2023 Program B

For UTokyo Undergraduate Students, Komaba - College of Arts and Sciences

## Host Laboratory List

### *Division of Transdisciplinary Sciences*

- Advanced Materials Science (AdvMS)
- Complexity Science and Engineering (CSE)

### *Division of Biosciences*

- Integrated Biosciences (IB)
- Computational Biology and Medical Sciences (CBMS)

### *Division of Environmental Studies*

- Environment Systems (EnvSys)
- Human and Engineered Environmental Studies (HEES)
- International Studies (Int'lStud)
- Graduate Program in Sustainability Science - Global Leadership Initiative (GPSS)

## 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
<a href="#">Mayumi Laboratory</a>	<a href="#">Assoc. Prof. MAYUMI Koichi</a>	<p>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, the fine control of 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. By combining the nano-scale structure/dynamics measurements, macroscopic mechanical tests, and molecular dynamics simulations, we aim to establish molecular understandings of toughening mechanisms for polymeric materials and discover novel molecular designs for tough materials.</p>	<p>Polymer, Soft Material, Mechanical Property, Nano Structure, Scattering Techniques</p>	<p>We are interested in the microscopic structural change of polymeric materials under stress fields. 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.</p> <p>In 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.</p>

## Division of Transdisciplinary Sciences

### Department of Complexity Science and Engineering

Laboratory	Faculty	Introduction of research activities and laboratory	Key words	Projects or activities summer program students can participate
<a href="#">Ejiri-Tsuji Laboratory</a>	<a href="#">Assoc. Prof. EJIRI Akira</a>	In Ejiri-Tsuji laboratory, fusion-oriented high-temperature plasma research is performed. The main research topic is the start-up and sustainment of a spherical tokamak configuration using RF wave power. This is an important issue to realize an economical reactor producing energy from the nuclear fusion reaction of deuterium and tritium. Besides the issue, we also study various MHD instabilities and wave induced nonlinear phenomena in plasma. We have a spherical tokamak device (TST-2) in our laboratory located at the Kashiwa campus, and we are running it by ourselves. The major radius of the plasma is 0.36 m, and the maximum electron temperature is about 400 eV, and the density is up to about $2 \times 10^{19} \text{ m}^{-3}$ , and the discharge duration is less than about 0.1 sec. In order to study the above topics, RF wave technology, plasma measurements, analysis and simulation techniques are important. Please visit our website <a href="http://fusion.k.u-tokyo.ac.jp/index-e.html">http://fusion.k.u-tokyo.ac.jp/index-e.html</a> for more information.	plasma physics; nuclear fusion; tokamak; RF wave physics; nonlinear phenomena	The following shows the three planned projects. The participant may also propose another project, which we can discuss after the assignment. (1) Analysis of power spectrum. The strong waves in plasma often induce nonlinear phenomena, and parametric decay instability (PDI) is one typical nonlinear phenomenon. Although such phenomena are clear in the power spectrum of magnetic fluctuations, the spectra show various detailed features. One approach is the application of the machine learning techniques to classify or extract different features. This would provide new information on the nonlinear phenomena. (2) Impurity injection. The majority components of the wave sustained plasmas in our lab are electrons and deuterium ions. The other atoms, such as oxygen, carbon, nitrogen, are called impurity. Although the fraction of the impurity is small it can affect the plasma through radiation cooling, slowing down of fast electrons, etc. In our lab, we can inject helium gas, nitrogen gas, and carbon particles. The project is to see the impurity effects. (3) Electrostatic probe measurement. An electrostatic probe measurement, where a small electrode is inserted to a plasma and the voltage vs current (V-I) curve is analyzed, is a typical low temperature plasma measurement method. When fast electrons (generated by wave-electron interaction) exist, the V-I curve is deformed. From the deformation, we can extract information on the fast electrons.

## 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
<a href="#">Laboratory of Signal Transduction</a>	<a href="#">Prof.OHYA Yoshikazu</a> <a href="#">Assoc. Prof. SUZUKI Kuninori</a>	<p>The budding yeast <i>Saccharomyces cerevisiae</i> 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) system biology based on cell imaging, (2) function of cell wall and cell wall integrity checkpoint, and (3) autophagy.</p> <p>(1) To understand biological system as the network of logical and informational process, one of the invaluable tools is genetics. Global analysis of the mutant phenotypes can provide relationships between knockout of the gene and function in the network. We developed CalMorph image analysis system useful to examine high-dimensional quantitative phenotypes under the fluorescent microscope. This method can be applied to identifying intracellular drug target, monitoring fermentation process during culture and studying biological diversity. Our ultimate goal is to place all yeast genes and their corresponding products on a functional signaling network based on phenotyping.</p> <p>(2) The cell wall is an essential cellular component in yeast. The cell wall is dynamic, because it undergoes remodeling during the cell cycle. We demonstrated that small rho type GTPase Rho1 is regulated by the progression of the cell cycle. We also found that there is a new cell cycle checkpoint mechanism called "cell wall integrity checkpoint" which functions to control cell cycle progression in response to cell wall perturbation. We are now studying such signaling mechanism as well as biosynthesis of the cell wall in yeast.</p> <p>(3) 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 are now studying the mechanisms of autophagosome formation and its degradation. Moreover, we have a particular interest in physiological significance of autophagy.</p>	Budding yeast <i>Saccharomyces cerevisiae</i> ; systems biology; imaging, cell cycle; autophagy	<ol style="list-style-type: none"> <li>(1) Live imaging and biochemical analysis of autophagosome formation and its degradation</li> <li>(2) Cell biological analysis of membrane sources of autophagosomes</li> <li>(3) Chemical genetic analysis of yeast autophagy</li> <li>(4) Multivariate analysis of high-dimensional morphometric data to our understanding of the pharmacology of antifungal drugs.</li> <li>(5) High-Content, image-based profiling to identify drug target.</li> <li>(6) High-dimensional quantitative phenotyping of yeast haploinsufficient genes</li> <li>(7) Single-cell phenomics with morphological data to reveal biodiversity and intraspecies variation in yeast.</li> <li>(8) Genetic study of multiple functional domains of the yeast 1,3-<math>\beta</math>-glucan synthase subunit by quantitative phenotypic analysis of temperature-sensitive mutants.</li> <li>(9) Phenotypic robustness contributed by the cell wall by protecting the intracellular functional network from environmental conditions.</li> </ol>
<a href="#">Laboratory of Evolutionary Anthropology</a>	<a href="#">Assoc. Prof. NAKAYAMA Kazuhiro</a>	We all suffer from diseases. In particular, noncommunicable diseases related to modern lifestyles, such as metabolic syndrome, affect many people. The susceptibilities to such diseases are related to the genetic variants inherited from our ancestors. What was the significance of the disease-prone/resistant variants before the modern lifestyle prevailed? Our primary interest is in the relationship between obesity and adaptation to starvation and cold. We are seeking evidence that environmental adaptations in our ancestors were involved in shaping the susceptibility of modern humans to disease. To achieve this goal, we are developing research that combines a variety of methods, including phenotyping experiments on human subjects, statistical analysis using genome-wide DNA variation data, and population genetic analysis to detect traces of natural selection.	Evolution of modern humans; genome variation; adaptation; lifestyle related diseases	We plan to conduct molecular anthropological experiments on the simple measurement of brown adipose tissue function in humans. Students will learn the basic methodology of a human association study, including DNA extraction from human specimens, small-scale genotyping methods for single nucleotide polymorphisms (Taq-Man real-time PCR, for instance), genotype-phenotype statistical analyses, and measurements of cold-adaptive thermogenesis using a thermal camera. If time permits, students may be able to learn evolutionary genetic studies using genome-wide SNP genotype data. Additionally, students will join the journal club co-hosted with Prof. Shoji Kawamura, Laboratory of Evolutionary Anthropology, GSFS.

<a href="#">Laboratory of Plant Functional Analyses</a>	<a href="#">Assoc. Prof. OHTANI Misato</a>	<p>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.</p>	<p>plant cell; xylem vessel; transcription factor; totipotency; pre-mRNA splicing</p>	<p>As part of the summer program, we propose the following two projects. Students will choose one of them and carry out the research.</p> <p>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.</p> <ol style="list-style-type: none"> <li>1. Sowing and growing plants by aseptic manipulation</li> <li>2. Induction of xylem vessel cell differentiation</li> <li>3. Microscopic observation of plant cells</li> <li>3. Examination of transcriptional activity by transient expression system</li> </ol> <p>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.</p> <ol style="list-style-type: none"> <li>1. Sowing and growing the wild type and mutant plants by aseptic manipulation</li> <li>2. Tissue culture of explants derived from the wild type and mutant plants</li> <li>3. Observation of resultant explants</li> <li>3. Examination of gene expression level and splicing patterns</li> </ol>
<a href="#">Molecular Recognition Laboratory</a>	<a href="#">Prof. NAGATA Shinji</a>	<p>My research interest is to investigate the instinctive behavior observed in insects. We are particularly interested in feeding strategies such as carnivorous, herbivorous, and omnivorous characteristics. 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.</p>	<p>Insect; feeding behavior; endocrine factors; knockdown; metabolism</p>	<p><b>【Experimental projects】</b> Using crickets <i>Gryllus bimaculatus</i>, 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, for example. Finally, program students must evaluate if those target molecules can influence innate feeding behavior and/or metabolisms in crickets.</p> <p><b>【Experience during UTSIP activity】</b> 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.</p>

**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
<a href="#">Frith Laboratory</a>	<a href="#">Prof. FRITH Martin</a>	<p>Our aim is to find interesting and useful information in genetic sequences, and to develop algorithmic and mathematical methods for this purpose. We recently 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 collaborate with medical geneticists to understand complex chromosome rearrangements and tandem repeat expansions / contractions that cause disease. We discovered the cause of neuronal intranuclear inclusion disease: a tandem repeat expansion in a human-specific gene. In related work, we have detected recombination events between LINE and SINE repeat elements, showing that recombination of repeat elements generates somatic complexity in human genomes. Another project found significant non-existence of sequences in genomes and proteomes, providing clues about immune recognition and pathogen/host adaption. Finally, we are developing a mathematically-optimal way to sample big sequence data, so it can be analyzed quickly, based on minimally-overlapping words.</p>	<p>Genome; evolution; probability; algorithms</p>	<p>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).</p>

**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
<a href="#">Akizuki Laboratory</a>	<a href="#">Lecturer AKIZUKI Makoto</a>	<p>“Supercritical fluid” refers to a fluid in which the material’s critical points of temperature and pressure are being exceeded. Dramatic physical changes are possible depending on the operating conditions of the material. In particular, the ionic content and dielectric constant of supercritical water changes extensively based on temperature and/or pressure. As a result of this, it becomes possible to select a reaction based on one’s objective: from an ionic atmosphere suitable for acid/base reactions, to one implementing the dissolving 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 broad range of topics: Degradation of harmful waste products using the oxidation reaction in supercritical water, organic synthesis using solid catalysts, and synthesis of inorganic materials such as nanoparticles. In regards to all of these fields, by designing, analyzing, and controlling reactions based on a study of chemical reaction rate and reaction engineering, we are advancing extensive research, from fundamental research related to the chemical reaction of supercritical fluids, to the cultivation of new engineering application technologies.</p>	Supercritical Water; Reaction Engineering; Organic Synthesis; Tunable Solvent; Catalysis	Supercritical water is a promising reaction medium for organic reactions because its solvent properties can be varied with the temperature and the pressure, and these properties affect reaction kinetics and mechanisms. The aim of this study is to propose a methodology which enables to control the reaction rate and the selectivity of organic synthesis reactions only with the change of temperature and pressure of supercritical water.
<a href="#">Geosphere Environment Systems Laboratory</a>	<a href="#">Prof. TOKUNAGA Tomochika</a>	<p>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. Research methods include laboratory experiments, field measurements and monitoring, geophysical exploration, and numerical modeling.</p>	Groundwater; coastal zone; seawater intrusion; modeling; field survey	<p>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.</p>

## 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
<a href="#">Simulation of Complex Systems Laboratory</a>	<a href="#">Prof. CHEN Yu</a>	A wide range of research topics are studied in our lab, including social-economics, complex fluids, and biological systems. There are three 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 studied. Apart from research, visits to related laboratories at other universities, and/or scenic sites surrounding Tokyo, etc., will also be scheduled.



**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
<a href="#">Honda Laboratory</a>	<a href="#">Prof. HONDA Riki</a>	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; natural disaster; community resilience	(1) To discuss how community's attitude for disasters is developed, statistical analysis of survey data using Bayesian approach or social network analysis will be conducted. (2) To synthesize earthquake ground motion for seismic design using machine learning and information theory based approach.

## Division of Environmental Studies

### [Graduate Program in Sustainability Science – Global Leadership Initiative](#)

Laboratory	Faculty	Introduction of research activities and laboratory	Key words	Projects or activities summer program students can participate
<a href="#">Yasuko Kameyama</a> <a href="#">(Sustainable Society Design Center)</a>	<a href="#">Prof. KAMEYAMA Yasuko</a>	<p>My research activity covers wide range of climate change mitigation policies' policy making and policy introduction. Among those policy options, policies that stimulate voluntary actions of business sector is becoming important. Carbon pricing, including carbon tax, emissions trading scheme and Carbon Border Adjustment Mechanism (CBAM), is one of those that are becoming increasingly popular. It is also important to focus on business sectors' alliances and initiatives that could make great changes in our society. My laboratory wish to continue making a thorough assessment as to what kind of policies, or what type of voluntary initiatives of non-state actors, could be most effective in reducing GHG emissions, while caring for other aspect of sustainability such as social justice and equity.</p>	<p>climate change; policy assessment; carbon tax; CBAM; taxonomy</p>	<p>Carbon Border Adjustment Mechanism (CBAM) is one of climate change mitigation policies that aims at balancing different price on carbon in and outside of region in scope. There are argument both for and against CBAM, and it is important to know its consequences. The research aims at making an overall assessment of CBAM by collecting the latest information of discussions related to CBAM in major countries and economies, as well as those related to taxonomy of products, and emissions trading scheme.</p>