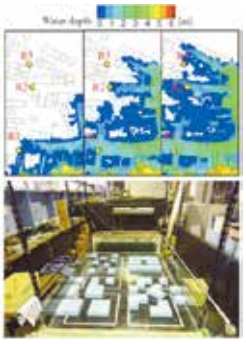
Division of Environmental Science

Research Area : Hydraulic Engineering

Prof. (Special appointment)
MAENO Shiro
Assoc. Prof.
YOSHIDA Keisuke
Assoc. Prof.
AKOH Ryosuke

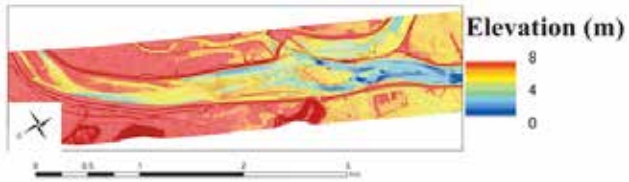
Developing practical numerical flood simulations in urban areas



Numerical simulations of floods in urban areas are useful for establishing evacuation programs and revising future city planning. In the present study, a set of shallow water equations was used to simulate the swift current on the streets to characterize horizontal flow diversion and concentration considering actual building configurations. The finite volume method was applied to an unstructured triangular mesh system to express the orientation and physical characteristics of each building based on a detailed city map. Recently, we conducted laboratory experiments and applications for actual events to develop more accurate and practical simulations of floods in urban areas.

ALB measurements of channel bathymetry for river management tasks

Recently, an airborne laser bathymetry (ALB) system using simultaneously pulsed lasers of two kinds (green and near infrared types) has attracted the attention of river and coastal engineers for use as an efficient cost-saving surveying tool. This technology is effective for high-resolution measurement of planar bathymetry including the underwater bed profile. For this study, we applied a developed ALB system and examined the accuracy in the targeted section by comparing the ALB data of 2 m horizontal resolution with existing survey data obtained using the conventional method. Then we evaluated the effects of using high-resolution ALB data in river flow analysis.



Research Area : Geotechnical and Groundwater Engineering

Prof.
TAKESHITA Yuji

Development of a simple and compact ground survey, and in-situ test method

Since most of ground disasters occur in the unsaturated region, soil tests and ground surveys on unsaturated soils have been performed in order to measure the geotechnical characteristics in unsaturated state. In addition, because it is necessary to evaluate quantitatively the ground behavior at the time of ground disasters, the following two themes are proposed: (1) an in-situ position test on a local scale with a simple and compact test equipment, (2) a ground scale survey on a field scale using a non-destructive measurement method from the ground surface. These would be contributed to evaluate of the safety of levees and slopes.

Development of monitoring method and numerical modeling method for safety assessment of levee failure caused by seepage flow

A monitoring method of the soil water content and pore water pressure by the infiltration behavior of the river levee has been proposed for the purpose of contributing to the design and construction work of the river levee by appropriately evaluating the safety of river levee. The construction method of a simulation model that can faithfully reproduce the measurement data by saturation and unsaturated infiltration analysis is developed.

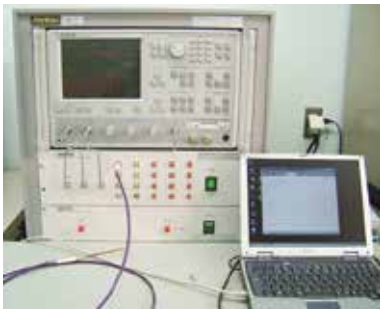
Research Area : Geotechnical and Groundwater Engineering

Prof.
KOMATSU Mitsuru

Developing a flexible and robust communication infrastructure system for a network of sensors used to remotely monitor damage during natural disasters

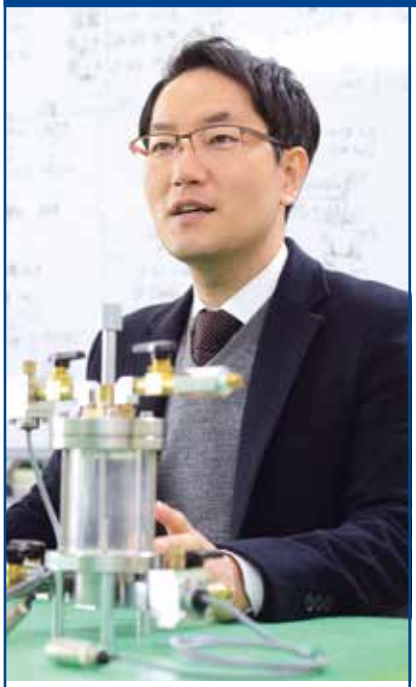
When a large-scale disaster occurs, it is crucial to have stable data transfer from a network of sensors. For a region considered as high-risk, it is essential that the sensor network and data communication infrastructure be installed and configured within several hours. This study aims to develop a novel sensor network and data communication system for a test site for monitoring slope stability during intense precipitation events.

Establishing a technique for monitoring soil and groundwater contamination using Frequency Domain Reflectometry



The purpose of this study is to apply a measuring system for subsurface contamination; the FDR (Frequency Domain Reflectometry) and FDR-V (with Vector network analyzer) system are employed to measure salinity and oil contaminants.

Research Area : Geotechnical and Groundwater Engineering



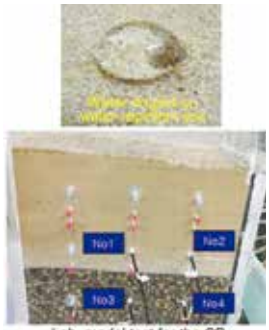
Assoc. Prof.
KIM Byeongsu

Evaluation of the shear strength and deformation characteristics of unsaturated soils

In order to prevent and reduce ground disasters in unsaturated earth structures (slope, levee, embankment, etc.) caused by a rainfall, it needs to grasp the failure mechanism of soil structures due to the rain infiltration. For this, the shear tests with the water retention test in the laboratory are carried out according to the confining stress state reproducing the state of ground as well as the deformation mode of soil structures. The shear strength and deformation characteristics of the soil structures are examined based on the obtained results.

Slope failure (Typhoon No.9, 2009)

Applicability of water repellent soil to overlayer of capillary barrier using laboratory model test



Lab. model test for the CB

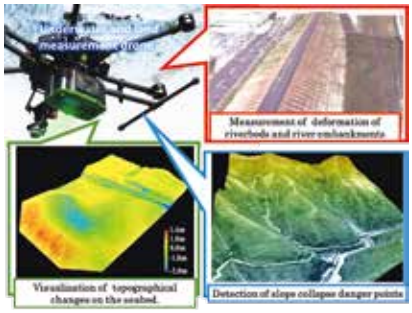
According to the past research results, since the maximum division length (L_D) in the laboratory model experiment is less than 300cm, it would be difficult to realize the application to unsaturated ground structures. Thus, laboratory model tests for the capillary barrier (CB) using the wettable and water repellent soils according to rainfall condition in this study are performed, and the applicability of the water repellent soil based on the obtained results is examined. It is expected that the more stable unsaturated ground structure would be realized by applying the water repellent soil to the sand layer of the CB system.

Research Area : Design of Steel Structures

Prof.
NISHIYAMA Satoshi

Development of disaster prevention / mitigation technology using ICT technology

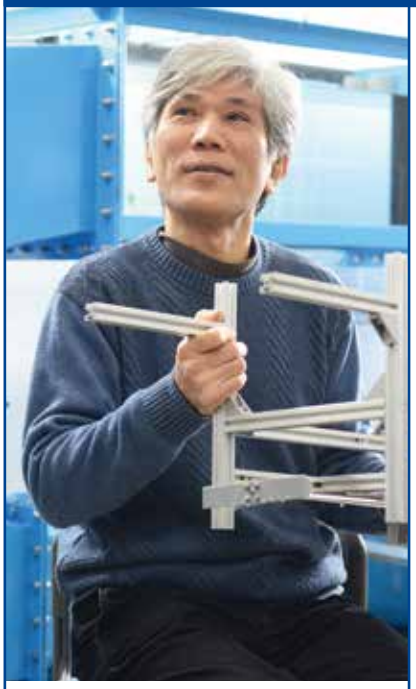
Disasters caused by typhoons, heavy rains and earthquakes occur frequently in Japan. In my laboratory, we are developing cutting-edge monitoring technology that Japan boasts to the world, such as digital images and UAV laser measurement. By using this technology to diagnose the soundness of infrastructures, we aim to create a country that is resilient to disasters. We are developing 3D measurement methods using IoT technology using UAVs and vehicles, and big data analysis technology using artificial intelligence. This ICT (Information and communication technology) makes it possible to discover slope collapse danger points, measure deformation of riverbeds and river embankments, and visualize topographical changes on the seabed.



Development of civil engineering design, construction and maintenance technology by BIM using 3D data

The ground survey results and structure design data are expressed as a three-dimensional model in the virtual space on the computer. This 3D data is used to perform a simulation to investigate how much seismic motion the structure can withstand. Furthermore, using AR (Augmented Reality) and VR (Virtual Reality) technologies, we will create an efficient construction plan using automatically moving construction machines. In addition, by superimposing the data of structures measured at different times and investigating the location where deformation has occurred, effective maintenance of the structure is possible. In this way, in my laboratory, you can learn the latest civil engineering structure design, construction and maintenance technology in Japan using BIM (Building Information Modeling).

Research Area : Design of Steel Structures

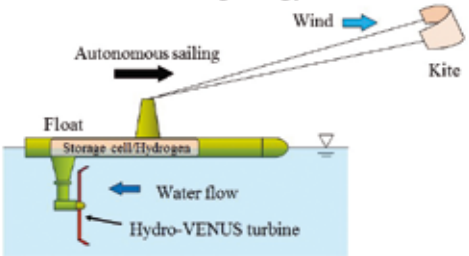


Prof.
HIEJIMA Shinji

Autonomous Kite-Sailing Energy Harvester: Innovation of offshore wind energy technology

Offshore wind power is the most promising energy source for a 100% renewable energy society. But conventional wind turbines can harvest only small amounts of nearshore wind energy due to the constraints of water depth, long distance electric power transmission or competition against fishery industry.
The **Autonomous Kite-Sailing Energy Harvester** generates power using a kite-sailing float with hydro turbines. Due to its sailing-based highly movable system, it can harvest vast amounts of wind energy in the pelagic zones and does not compete with fishing operations. The hydro turbines are more compact than wind turbines, and this system does not require tall supporting towers or deep water anchoring.
We also have been developing the **Hydro-VENUS** turbine to apply to the Autonomous Kite-Sailing Energy Harvester. It is a flow-induced oscillation based hydro turbine using columnar pendulums. Due to the simple geometrical shapes of the pendulums, the Hydro-VENUS is cost-effective, lightweight and high-strength. Its patents are acquired in Japan, EU, US, China and Australia. We have established the Hydro-VENUS Co., Ltd. start-up company.

Autonomous Kite-Sailing Energy Harvester



Medium scale test model

Hydro-VENUS

Research Area : Design of Concrete Structures

Prof.
AYANO Toshiki
Assoc. Prof.
FUJII Takashi

Practical Application of Precast Concrete Member with Super-High Durability Concrete

Objectives

In order to extend the lifespan of damaged bridge girders and to shorten the period of traffic regulation during renewal construction, precast concrete member with high durability is developed with blast furnace slag sand.

- PC (Prestressed Concrete) PCa member
  ⇒ Strong to traffic load under water supply condition
- RC (Reinforced Concrete) PCa member
  ⇒ High resistance to freeze and thaw with out AE agent

① BFS for High Durable Concrete

- Establishment of Quality Standard of BFS
- supplying system of BFS in the Domestic

② PC PCa Products

The characteristics of products are as follows;

- High resistance against freezing and thawing attack and fatigue in water
- The loss of restress is small by small shrinkage and creep of concrete

③ RC PCa Products

The characteristics of products are as follows;

- High resistance to freezing and thawing attack without AE Agent
- High resistance to chloride attack

Research Area : Architecture and Urban Spatial Planning

Assoc. Prof.
HORI Hirofumi

Discretionary architectural design review in North American cities

I am analyzing the actual situation of sustainable infill type of building renewal in North America, the way of public participation in the development review process, and the actual living environment created by it. In particular, focusing on the case of renewal of individual buildings in the city center, from the viewpoint of the balance of pre-determined standards (zoning, etc.) and discretionary development review, how can the living environment and landscape that meet the needs and characters of the community be achieved? Regarding that, we are examining effective frameworks and methods based on changes in the minutes and drawings of actual neighborhood meetings and design review public hearings. Case study cities are Seattle, Toronto, Miami, etc.

Transfer of Development Rights system and its implementation for preservation of historical buildings

Many historic buildings have been demolished in the center of Japan, and development is being conducted that does not match the characteristics of the area. In Japan, there are issues such as the looseness of zoning and the existence of many development bonus systems, and there is a need for an effective Transfer of Development Rights system. This study clarified the actual operation of Transfer of Development Rights system in Vancouver from the viewpoint of historic building preservation. As a result, strict zoning, discretionary development review system, and rezoning system that enables development bonus were cited as conditions for effectively operating the Transfer of Development Rights system.

Research Area : Vegetation Management

Asst. Prof.
NAKASHIMA Yoshitaka

Study on conservation of ecosystem based on weed vegetation and risk evaluation of invasive plants

In all over the world, raising concern about declining ecosystem services by development and environmental pollution.
Weed vegetation supports the ecosystemic base while contacting with human activities.
Therefore, we tackle improvement of environmental problem by understanding and utilizing a function of the weed vegetation.

On the other hand, the disturbance of an ecosystem caused by the invasive alien species is serious, too.
We propose ecosystemic precise management method by grasping seasonal variation in emergence and elucidating the influence to environment of alien plants.

Research Area : Applied Ecology

Prof.
NAKATA Kazuyoshi

Study on conservation ecology of endangered freshwater animal species

Many native species of freshwater animals are endangered due to factors such as the negative effects of river or agricultural channel improvements and predation or competitive exclusion by invasive species. To conserve such endangered native freshwater animals, we have to clarify the basic ecology (e.g., reproductive behavior and habitat preference) and then develop effective conservation methods. In our recent studies, we clarified the habitat preference of the endangered bitterling fish species (*Rhodeus atremius suigensis*; Fig. 1) in agricultural channels, and wintering site environment of the endangered Nagoya Daruma Pond Frog (*Pelophylax porosus brevipodus*) inhabiting paddy fields. Also, we have studied the effectiveness of restoration methods in agricultural channels for freshwater fish conservation.

Fig. 1 An endangered bitterling fish (*R. atremius suigensis*).

Study on ecology of invasive crayfish species and development of effective eradication methods

Fig. 2 An endangered Japanese crayfish (*C. japonicus*) being preyed on by an invasive crayfish (*P. leniusculus*).

Invasive freshwater animal species have a negative impact on native species. Especially, the impact of invasive crayfish is strong. In our previous studies, the invasive North American crayfish species (*Pacifastacus leniusculus*) was shown to be able to cause species replacement for the endangered native Japanese crayfish species (*Cambaroides japonicus*) due to direct predation (Fig. 2) or in competition for preferred sized shelters. In the present study, we have tried to clarify the life cycle of the North American invasive crayfish species *Procambarus clarkii* inhabiting water areas in Japan and also to develop effective eradication methods.

Research Area : Applied Ecology

Asst. Prof.
KATSUHARA Koki

Coexistence mechanisms among native, congenetic plant species

Plant species is the most important part of biodiversity and it provides various ecosystem functions. To clarify the coexistence mechanism of closely related plant species is a challenging subject because they often share a very similar resource demand and reproductive biology. We have examined the coexistence mechanism between native Commelina species under pollinator-mediated competition (Fig. 1). Our studies are basically based on field observations and combined with experiments of population genetics and theoretical models. Now, we are working on elucidating the mechanisms that the evolution of plant mating systems promote the coexistence among related species.

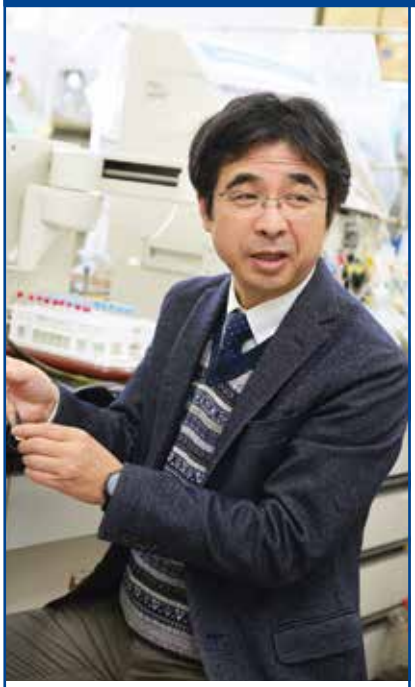
Fig. 1. *Commelina communis* (left) and *C. communis* f. *ciliata* (right).

Population persistences of native plant species in the urban environment.

Fig. 2. Rural (left) and urban (right) populations of *Commelina communis.*

From now and probably in the future, land-use change has been thought to be the most severe driver of changes in biodiversity. Urbanization, which is intensifying human impacts, is a major driver of habitat loss for plants and pollinators. Our study species, Commelina communis, is largely distributed from rural to urban areas (Fig. 2) although many habitats of native plant species are lost related to urbanization. We are now examining what determines the robustness or vulnerability for human impact via focusing on plant mating systems and plant-pollinator interaction.

Research Area : Soil Management



Prof.
MAEDA Morihiro

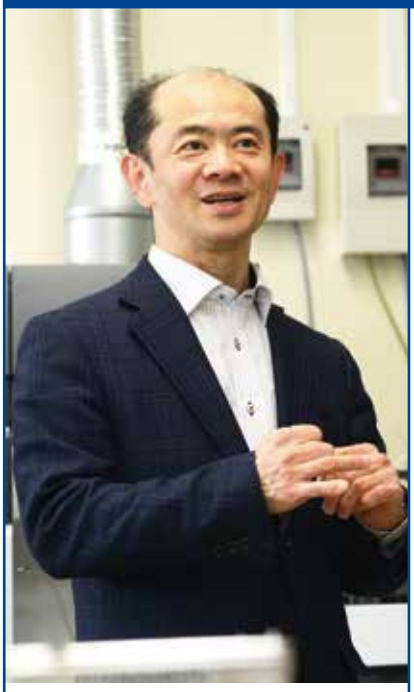
How to reduce greenhouse gas emissions from soil amended with organic matter?

Agriculture is responsible for emissions of greenhouse gases such as carbon dioxide (CO_2) and nitrous oxide (N_2O). Production of these gases in soil results from the biological processes like organic matter decomposition, nitrification and denitrification. These processes are regulated by easily decomposable carbon, mineral nitrogen, temperature, pH and moisture content in soil. We aim at analyzing effects of these parameters on CO_2 and N_2O emissions. In particular, we are interested in agricultural soil amended with livestock compost.

Analysis of groundwater contamination with inorganic N in Central Vietnam by using stable isotopes and microbial technologies

High concentrations of inorganic nitrogen (NH_4-N and/or NO_3-N) were found in groundwater below vegetable fields in the downstream areas of the Huong River, Central Vietnam. The objective of the study is to determine the contamination sources and mechanisms of nitrogen contamination in groundwater by using ^{15}N natural abundance ($\delta^{15}N$) and functional genes of microorganisms. We have developed a new method to collect NH_4-N, NO_3-N, and organic N in water samples for $\delta^{15}N$ analysis. Functional genes like *narG, napK,* and *nosZ* are quantified to obtain the information on nitrogen dynamics in deep soil.

Research Area : Agricultural Land Engineering



Prof.
MORI Yasushi

Installing artificial macropore to enhance infiltration and increase organic matter in soils.

Soil is the largest carbon storage body at terrestrial area. Our previous research showed that macroporous soils conduct surface water without clogging and that bypass flow by macropores segregated organic matter from the surface. Organic matters will be effectively conserved by these physical processes, which contributed greatly to carbon storage as well as bio-chemical processes.

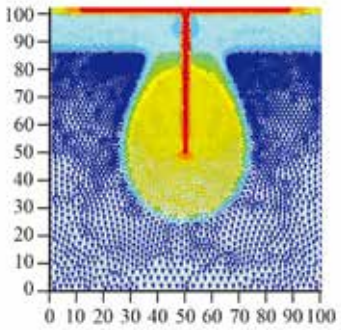


Figure Rainfall was effectively conducted by artificial macropore which contributed to organic matter conservation.

Linear Macropore Installation for Reducing Red-soil Erosion at Sugarcane Field.

Figure Surface water caused by heavy rain removes nutrient rich surface soil, but macropore structure reduces them greatly.

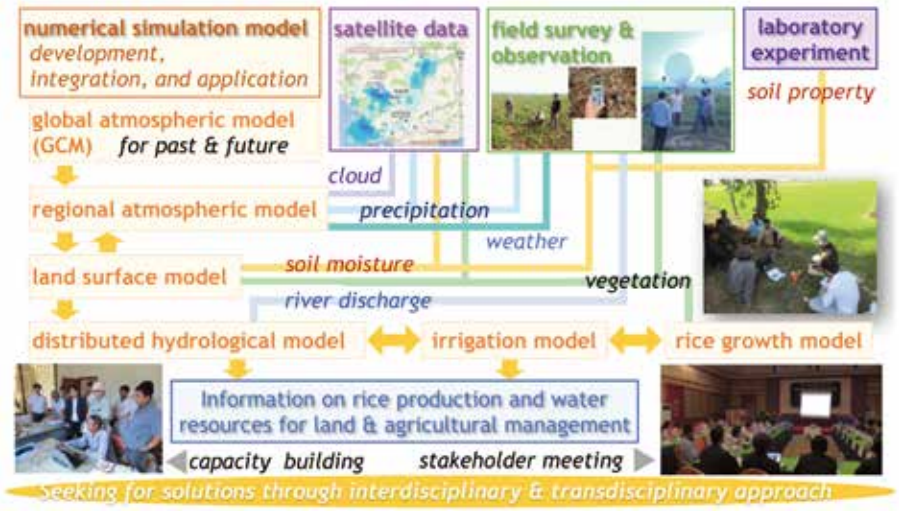
Red-soil erosion in sugarcane fields has been reported as a significant agricultural and environmental problems in Ishigaki Island in Okinawa, where such erosion has led to loss of nutrient-rich agriculture soil and also negatively impacted coral reefs. We introduced linear-macropore to the field. The result showed that the erosion almost cancelled the conservative land management and installation of linear macropre reduced surface water and erosion amount to 1/7.

Research Area : Agricultural Land Engineering

Asst. Prof.
TSUJIMOTO Kumiko

Observation and Modelling of Soil – Plant – Atmosphere Interaction for Sustainable Land Management

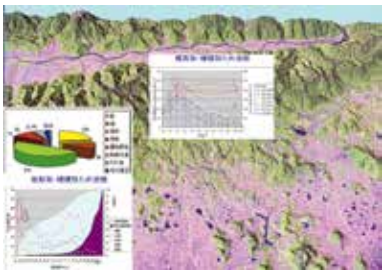
My research interest is *"soil-plant-atmosphere interaction"* in regional to country scale: how land surface condition affects local rainfall and climate through water and energy fluxes between land and atmosphere. *Current research topics are* (i) estimation of pedotransfer function and dielectric behavior of soils in regional scale to improve the algorithm of microwave satellite remote sensing of soil moisture; (ii) development of an integrated system of remote sensing, field observation, and numerical model simulations (data assimilation) for environmental monitoring & projection; (iii) process-based study on the mechanism of the soil-plant-atmosphere interaction; (iv) assessment of land-use change and global warming on food production and water resources; *etc*. *Research methodology* involves field survey, in-situ observation, laboratory experiment, satellite remote sensing, and numerical model development & simulations. Capacity building and implementation into the society especially in the developing countries are also the key.



Research Area : Terrestrial Information Management

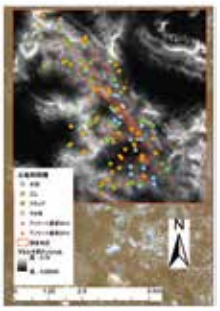
Prof.
MORITA Hidenori

Study on rural environment using terrestrial information processing



In recent years global environmental problems such as desertification, the forest decrease, the degradation of the farmland have become serious, also in our imminent place, local environmental problems such as the Satoyama landscape(rural landscape) have become serious. These environmental problems have large or small spatial scale, but those are all phenomenon occuring on the real field, and the thing which can describe such spatial phenomenon is a map (geography space information). In our laboratory, we have been trying to analyze various environmental problems using a digital map and the artificial satellite image which we can treat with a computer.

Monitoring of land use/cover change and mathematical modeling



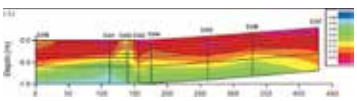
Land use/cover is greatly influenced by local environment and has a significant influence at the same time to area environment, also greatly influenced by the global environment and have a significant influence on the global environment. When thinking about local and global environment, It become fundamental problem how to control land use/cover. This study aims to bring useful result for planning, to make clear the cause and effect relationship of land use/cover change by modeling it.

Research Area : Irrigation and Drainage

Prof.
MOROIZUMI Toshitsugu

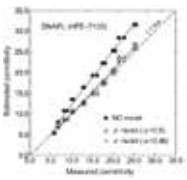
Study on evapotranspiration and soil water content for water resources

Evapotranspiration and soil water content are very important as key factors of hydrologic cycle and water resources. In our laboratory, the following two researches on evapotranspiration and soil water are carried out: (1) There are some methods for estimating the evapotranspiration, it, however, is not so convenient to use those methods because they often needs the meteorological data at two heights. We aim to develop the simple method for estimating evapotranspiration using one heig ht meteorological data. (2) We estimate the potential water resources for agricultural products using soil water content, evapotranspiration, and other data.



The results of these researches would be contribute to not only agriculture and irri gation but also the recent variation of hydrologic cycle.

Developing a technique for estimating soil and groundwater contamination utilizing permittivity, thermal properties, and other physical properties



Soil and groundwater contamination by NAPLs (nonaqueous-phase liquids) has become a serious environmental issue in Japan and around the world. It is difficult to detect or monitor the transport rates of NAPLs under field conditions, because the NAPLs are immiscible with water. In addition, because chemical solutions are often mixed with NAPLs, the detection of contaminant is more complicated. In our laboratory, we aim to develop the fundamental techniques to detect the soil and groundwater contaminated with both NAPLs and chemical solutions using some physical properties such as permittivity, thermal properties, and self - potential.

Research Area : Irrigation and Drainage

Assoc. Prof.
SOMURA Hiroaki

Study on balancing agricultural practices with nature to protect water resources

Agriculture is essential to modern civilization but often has unintended negative effects upon the natural environment, especially regarding water quality. Overuse of fertilizers is costly both economically and environmentally. We evaluated regional agricultural cultivation practices to determine optimal irrigation and fertilizer, timing and amounts, to maximize production while minimizing nutrient-driven eutrophication of local water bodies.

Agricultural fields are used not only by farmers, but also by wildlife. We studied the effects of the Tundra Swan on nutrient levels in rice paddies. Tundra Swans, from Far East Russia, overwinter in flooded paddy-fields from November to March. They roost in the paddy-fields at night and forage nearby in other agricultural fields during the day. We measured Tundra Swan manure-nutrient component of paddy-field soil and water nutrient concentrations to determine optimal farmer-applied fertilizer amendments required for rice production, without over-applying.

Our ultimate goal is to find a win-win-win relationship among the environment, humans (farmers), and wildlife with respect to water quality.

Study on irrigation management for stabilizing agricultural production

Water is critical for agriculture and irrigation practice is an important part of farm management. Irrigation water is often wasted or poorly applied (i.e., amount or timing) leading to lowered agricultural production from poor crop health or damage. It is important to evaluate water resource availability to effectively manage irrigation timing and amounts required for efficient crop production.

We assessed watershed-level water availability upon a local irrigation scheme. Data were gathered through field observations and farmer questionnaires. Data were evaluated by computer modeling. At the watershed level, irrigation water allocation is spatially unbalanced among upstream, midstream, and downstream observations. We attempted to determine alternative management methods and/or improve current methods for efficiently allocating irrigation water equally to the fields.

By improving irrigation water use efficiency through better allocation management, there is an apparent increase in water availability. This will lead to an expanded cultivation area, higher production, and ultimately, better agricultural stability.

Research Area : Catchment Hydrology

Prof.
CHIKAMORI Hidetaka
Assoc. Prof.
KUDO Ryoji

Development of real-time forecasting system using hydrological model and data assimilation technique

Recently, flood damage has become serious problem around the world due to the changes in climate condition. Flood forecast system using hydrological model is useful tool to mitigate the flood damage. One of the main topics in our research team is to develop real-time flood forecasting system using distributed/lumped hydrological models and radar rainfall data. In addition, to improve forecasting accuracy, we introduce data assimilation techniques like Kalman Filter and Particle Filter into the forecasting system, and investigate the uncertainties caused by hydrological modeling including parameter setting and by weather/climate forecasting data as an input to the hydrological models.

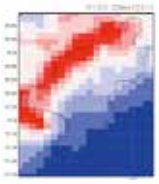


Figure 1 Spatial distribution of rainfall based on radar data

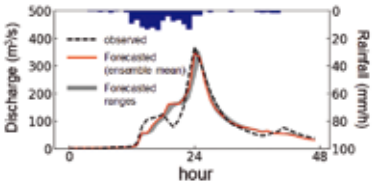


Figure 2 Example of real-time flood forecasting.

The impact assessment of climate change on hydrological cycle using hydrological model and climate scenarios. -Uncertainty analysis of impacts of climate change on snow processes-

The impact of climate change on snow water equivalent (SWE) and its uncertainty were investigated in snowy areas in Japan by using a snow process model and climate projections derived from general circulation models (GCMs). In particular, we examined how the uncertainty due to GCMs propagated through the snow model, which contained nonlinear processes defined by thresholds. The uncertainty analysis demonstrated that when the peaks of the distributions of daily mean temperature projected by GCMs cross the key thresholds set in the snow model, the GCM uncertainty, even if tiny, can be amplified by the nonlinear propagation through the snow process model. This amplification results in large uncertainty in projections of CC impact on snow processes.

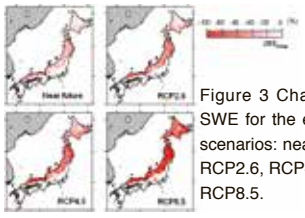


Figure 3 Changes in SWE for the emission scenarios: near future, RCP2.6, RCP4.5, and RCP8.5.

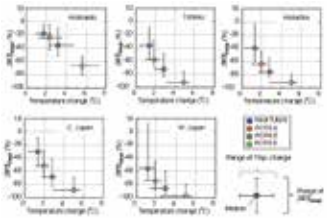
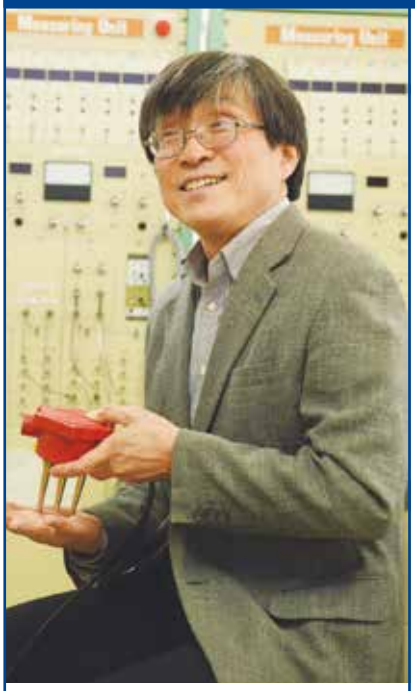


Figure 4 Projection ranges of regionally averaged changes in winter-mean temperature and SWE.

Research Area : Design of Environmental Infrastructures

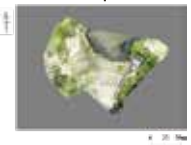


Prof.
NISHIMURA Shin-ichi

Reliability analysis of geo-structures

The stability of the geo-structures, and the natural slopes need to be analyzed against the severe natural disasters, namely, the earthquakes and heavy rains. Based on the analytical results, the appropriate counter measures can be determined. The concept of the reliability -based design can be conveniently used for the decision making for the optimum alternative of the counter measures. The phenomena of the earthquakes and the rains are probabilistic, and the soil parameters have great variability. The reliability-based design can include the uncertainties into the designs. The reliability-based design method is mainly applied to the earth-fill dams here. In Japan, about 160,000 of earth-fill dams exist, and many of them are deteriorated, and the countermeasures are rushed. The reliability based-design method can determine the priority of the earth-fill dams for the countermeasures.

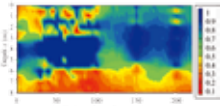
Breached earth-fill dam by earthquake



3-D model of earth-fill dam site for stability analysis

Subsurface survey inside and under geo-structures

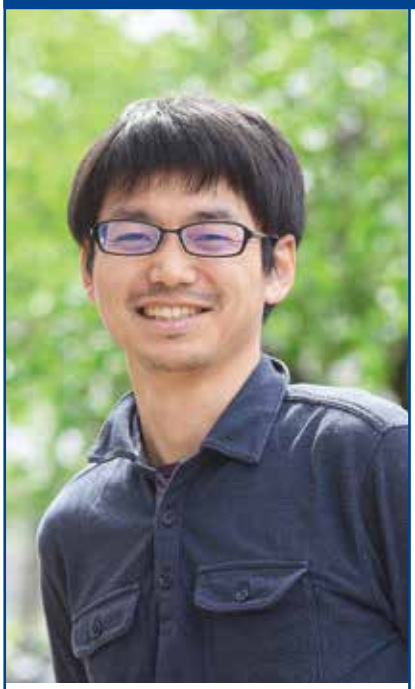
In-situ investigation of subsurface layer by CPTu



Visualized strength distribution of subsurface layer
-Probability for strength of soil to be low-

To evaluate the stability of the geo-structures, the subsurface survey inside or under the geo-structures are important. The geophysical survey and the sounding tests are convenient. In our research, the electric Cone Penetration Test (CPTu) is employed, and spatially long and short-interval tests are mixed to efficiently evaluate the stability of an embankment. The geostatistical method is used to simulate the N value (strength value) distribution and to predict the weak locations inside the embankments. The synthesized approach of the CPTu and the Surface Wave Method (SWM), which is one of the geophysical methods, is proposed to compensate for the shortcoming of each approach with use of the geostatistical approach. Consequently, the insides of the embankments can be identified accurately, the high resolution of the spatial distribution of the strength can be visualized.

Research Area : Design of Environmental Infrastructures



Assoc. Prof.
SHUKU Takayuki

Inverse analysis/data assimilation in civil engineering

Inverse analysis/data assimilation is a methodology to assimilate observation data into numerical simulation models for realistic predictions and parameter identifications. We have developed inverse analysis methods and demonstrated the effectiveness by applying the methods to numerical experiments, model tests, and actual construction projects. Figure 1 shows conceptual illustration of cross-hole tomography which is typical inverse analysis method and is designed to visualize subsurface in a non-destructive way. Figure 2 shows a comparison between the true image of the ground and the reconstructed image by the cross-hole tomography.

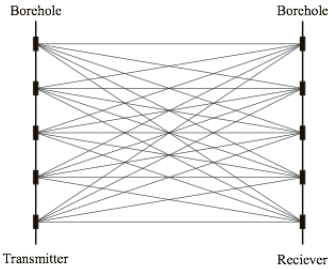
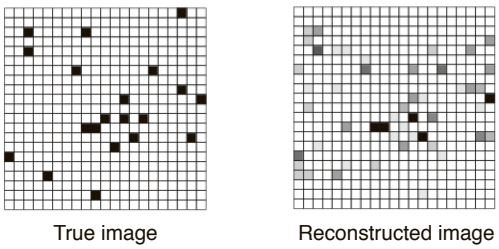


Figure 1 Cross-hole tomography



True image　　Reconstructed image

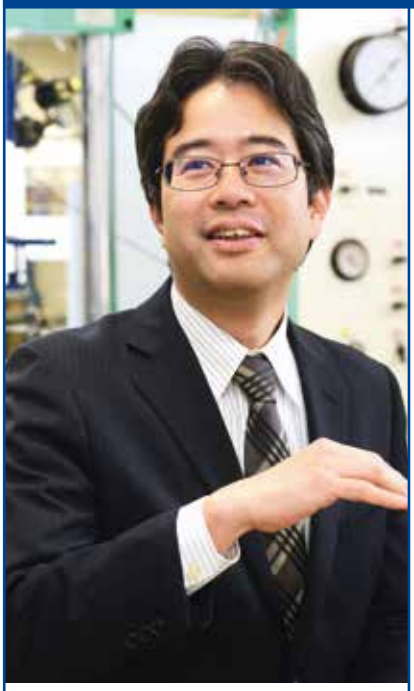
Figure 2 Comparison between true image and reconstructed image

Numerical Simulations using particle-based methods

We have developed simulation codes of the moving particle semi-implicit (MPS) method to predict large deformation and failure behavior in geomaterials such as clay, sand, gravel and their mixtures. Figure 3 shows a breach process of an earthen embankment due to overflow simulated by the developed MPS method.

Figure 3 Embankment breach process simulated by MPS method

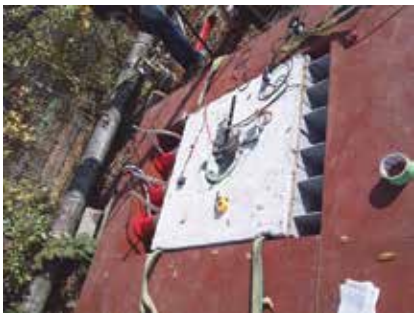
Research Area : Management of Environmental Infrastructures



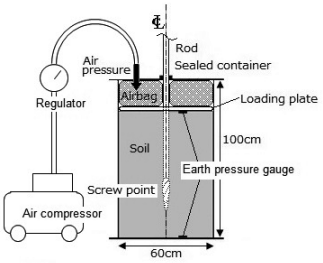
Assoc. Prof.
SHIBATA Toshifumi

Interacting behaviors between ground and tunnel lining with voids

The maintenance of damaged irrigation tunnels has become a major social concern; and thus, evaluating the damage conditions of current tunnels is of crucial importance. Voids behind the tunnel lining may be created during or after construction by the conventional method, and these voids are the main factors in its failure. Hence, it is imperative to comprehend the behaviors of the ground, the tunnel lining and the voids. We investigate the interacting behaviors between the ground and a tunnel lining with voids by numerical simulation and model tests.



Soil classification and correlation between Swedish weight sounding test results and strength parameter



Characterizing the properties of soils is of importance due to design and maintenance concerns. These properties are generally evaluated by laboratory and in-situ tests. Swedish weight sounding (SWS) tests are field tests used to obtain the static penetration resistance. From the value of the resistance, the N-value, the unconfined compressive strength, and the bearing capacity can be computed in order to evaluate the soil strength. However, the strength parameters, such as cohesion and the angle of internal friction, is not presented. We investigate the soil classification and the correlation between the SWS test results and the strength parameters.

Research Area : Environmental Economics

Prof.
UBUKATA Fumikazu

Political economy of natural resource development and its social impact in Southeast Asia

Recent economic growth in Southeast Asia has resulted in rapid depletion of natural resources. Yet many villagers near the resource development area have not enjoyed improvements in their lives as expected. Rather, some are even sacrificed by resource development projects and environmental conservation policies. Our research examines how relevant stakeholders, such as governments, firms, villagers, and external agencies, have interacted in certain resource development projects, such as in the palm oil industry, pulp and paper industry, aquaculture, forest conservation, and climate change adaptation, and how this interaction has affected rural societies in Southeast Asia.

Harvesting oil palm by an Indonesian plantation worker (Sarawak, Malaysia, 2011)

Political processes and impacts of capitalization/financialization of nature in Southeast Asia

Photo：Vanishing Tropical Forest in Southeast Asia. Deforestation is believed to be a significant source of carbon emission. (Sarawak, Malaysia, 2008)

In recent years, many agencies in developing coutries have applied the approach to procure funds by the use of financial instruments and direct payments to mitigate environmental problems. Common examples include the use of carbon credits and systems to pay for environmental services. Taking examples from Southeast Asia, we examine processes that lead to the formulation of these funding mechanisms, and regards them as new developments that mainstream the commodification of nature (capitalization/financialization of nature). At the same time, we also examine its socioeconomic impacts and the changes in governance of society and the environment.

Research Area : International Rural Studies

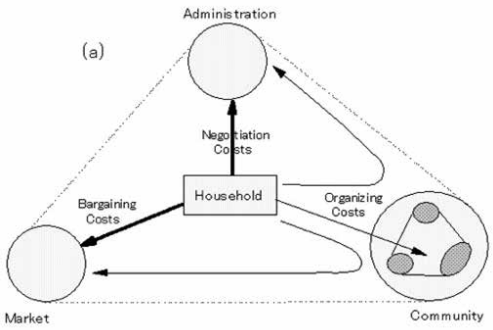
Prof.
KIM Doo-Chul

Natural resource management in Asian countries

The commons are the cultural and natural resources accessible to all members of a community, which are not often managed by the "invisible hand" under a market system. It is the local community that uses the commons sustainably, and endogenous self-organization plays a crucial role in forming norms for sustainable resource exploitation. In this context, my research interests focus on rural communities in exploiting natural resources, with study areas including Japan, Korea, China, and Vietnam.

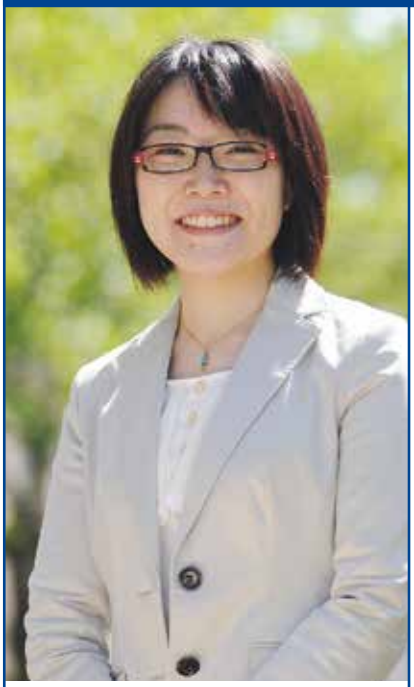
Terraced paddy fields in Sapa, Vietnam
(photo on July 2011)

Roles of endogenous self-organization in rural communities



Development is a process that involves not only money and agencies but also people. The framework for organizations in a rural community can provide a clue to identifying who should be the real actors for sustainable rural development in either developed or less developed countries.

Research Area : International Rural Studies



Assoc. Prof.
HONDA Yasuko

Conditions of participatory management of regional resources

Farmland and irrigation and drainage facilities serve as agricultural infrastructure for paddy fields and also contribute to society in other ways, for example, in reducing damage caused by heavy rains or in developing visually favorable landscapes. In recent decades, depopulation and aging of farmers have made it difficult for rural communities to properly maintain this infrastructure. Therefore, there is growing awareness that addressing this problem requires new participation in the maintenance by non-farmers. This research clarifies how rural communities actually maintain them and the factors affecting resident participation in maintenance.

Sustainable management of community-based renewable energy

The expanding use of renewable energy can help prevent global warming and reduce air pollution. Especially, community-based renewable power derived from local initiatives (community energy) is expected to provide an alternative energy resource and serve as a catalyst for rural development. Between the 1950s and 1960s, local communities became active in the construction of small hydropower plants, many in the Chugoku region. This study considers community energy projects in the Chugoku region in Japan to illuminate what conditions have enabled the studied organizations to succeed in securing resources needed for the operation of their renewable energy plants.

Research Area : Rural Planning

Prof.
KUKI Yasuaki

Construction of community planning theory led by residents

There have been cases where local residents in Japanese rural areas are embarking on planning and revitalizational development themselves in decades. In this research, we focus on such movements within the settlements scale, and try to clarify difference and characteristics compared to the conventional administration-led form. The results will allow us to construct a planning theory peculiar to the Japanese rural area and can be expected to be useful as a guideline for future regional development.

Practical study on construction of measures to damage by wildlife based on planning perspective

The damage of agricultural products caused by wildlife such as deer, wildboars and monkeys is becoming more serious in Japanese rural area. The purpose of this research is to develop the program to prevent from the damage that will lead to the farmland conservation and the local communities' sustainability. So we look into the consciousness of the residents in the affected area and the local government officers to clarify the issues for solution, and consider the technical requirements for the measures from the field survey. And we propose the solution of the reduction of the damage at the municipal level and practice them to verify the effects. The followings have been obtained from the previous studies: 1. the animals prefer forested former paddy fields and abandoned farmland when they invade rural communities; 2. the effectiveness of damage prevention can be improved by mowing abandoned farmland around the fences. Based on these findings, we proposed a method for managing the marginal space when implementing measures based on the fences to prevent agricultural damage by wildlife.

Research Area : Physiological Plant Ecology

Prof.
SAKAMOTO Keiji

Stand dynamics and regeneration in natural forests

Tree population in the forest stand has been changed and maintained in the process of recruitment, survival, and growth of tree individuals, which are determined by different disturbances and environmental factors including biotic and abiotic factors. The tree population show slow temporal changes and spatial heterogeneity. Therefore, it is necessary to conduct long-term and large-scale ecological researches for demonstrating tree population, stand dynamics, and regeneration of the forests. I have conducted long-term and large-scale ecological researches with adding tree ring analysis in different natural forests. In beech forests of Japan, the researches have been demonstrating dynamics of seedlings, understory trees, and canopy trees in different environmental conditions and the regeneration processes and mechanisms. In boreal forests of Mongolia, the researches have been demonstrating effects of disturbance by forest fires and logging on the regeneration and degradation mechanisms after large-scale forest fires.

Boreal forest in Mongolia

Stand dynamics of secondary forests, *Satoyama* forests, and the conservation

Deciduous oak forest in Japan

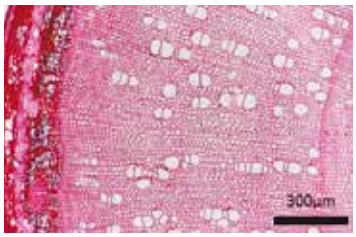
Satoyama forests are secondary forests that were maintained by natural processes and human's activities. They sustainably supplied bio-resources because regeneration occurred after the harvesting. However, these *Satoyama* forests have been abandoned since energy regimes changed from bio-resources of forests into fossil fuel around 1960s. The abandonment has caused degradation of biodiversity, expansion of disease damages, and expansion of abandoned bamboo forests. On the other hand, these abandoned forests have been reevaluated as sustainable bio-resources recently. Therefore, it is necessary to demonstrate the degradation processes of abandoned forests and restore them. I have conducted ecological researches on the stand dynamics of *Satoyama* forests. The researches have been demonstrating degradation of the stand structure and possibility of the artificial regeneration in pine forests damaged by pine wilt disease, expansion processes and mechanisms of abandoned bamboo forests, and regeneration processes after logging in deciduous oak forests.

Research Area : Physiological Plant Ecology

Prof.
MIKI Naoko

Study on water transport function of trees

In many tree-dominated ecosystems, drought-induced hydraulic dysfunction has been associated with the sudden death of trees exposed to critical drought stress and is one of the most important factors that determines the survival and distribution of trees. For various tree species from arid to humid regions, therefore, we aim to elucidate the mechanism of maintaining the xylem water transport under variable soil moisture conditions and the physiological properties related to it.



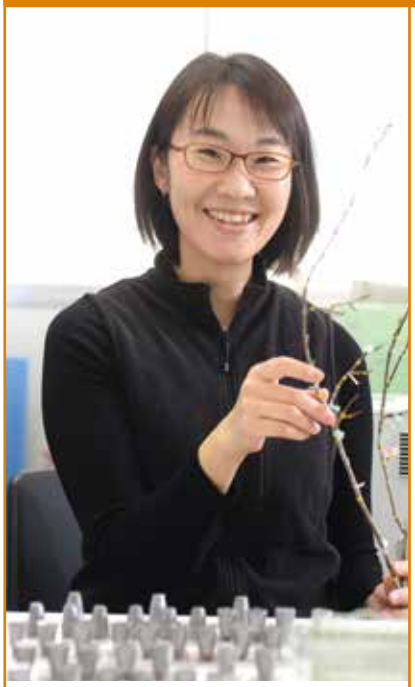
↑ Optical microscope image of stem cross section in *Carpinus tschonoskii*

Study on water use properties of trees growing in dry land

↑ Dominant tree species, *Juniperus sabina,* growing in semiarid area of China

Plants acquire carbon through stomata of leaf for photosynthesis, however, at the same time they lose water through the stomata. Therefore, it is essential for growth and survival to develop various properties of suppressing water loss and rapidly supplementing water loss. Water availability to plants in dry land is limited. Therefore, it is important how efficiently plants use water resources. For various species in dry land, we aim to elucidate the water use properties and survival strategy of whole tree from various organ levels through evaluation of transpiration of leaves, water transport properties of stems, water absorption properties in roots. From these aspects, we also work on research related to revegetation in the water-limited environment of dry land.

Research Area : Forest Ecology



Assoc. Prof.
MIYAZAKI Yuko

Effects of intermittent reproduction on forest regeneration in *Fagus crenata*

Fagus crenata is one of the characteristic tree species that produces a large amount of flowers and seeds every few years. Environmental factors, such as temperature and nutrient content, play a role in this intermittent reproduction mechanism, but it is not clear how seed production will be affected by recent climate change. Seed production is not only an important factor underpinning forest regeneration, but it also provides food for the diverse organisms that survive within forest ecosystems. We are attempting to clarify how this intermittent reproduction contributes to seedling regeneration through analysis based on long-term surveys.

Study on the mechanism of environmental flower sex determination in plants and its adaptive significance

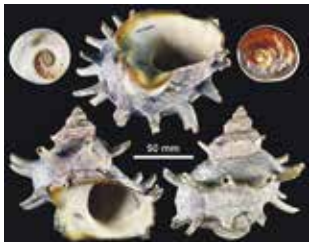
More than 90% of all seed plants do not have sex chromosomes and produce a combination of hermaphroditic, female, and male flowers in an individual plant. However, the sex determination mechanism of individual flowers remains unclear and how environmental factors (e.g., day length, temperature, and nutrient status) act on sex determination. We are trying to elucidate the mechanisms of environmental factors, especially short-day conditions and nutrient status, that induce hermaphroditic flower in relation to flower initiation, using *Commelina communis* f. *ciliata*. We also examine the adaptive significance of these environmental conditions as signals of floral sex determination and attempt to predict future climate change impacts.

Research Area : Conservation of Aquatic Biodiversity

Assoc. Prof.
FUKUDA Hiroshi

Taxonomy, nomenclature and conservation of molluscan taxa

Molluscs including shellfish, snails, slugs and so on are a very diversified animal group and consist of more than 80,000 Recent species in the world, but their taxonomy and recognition of species are still poorly understood. For example, *Turbo sazae* is one of the most well-known marine snails in Japan since ancient age, but nevertheless the species has long been misidentified with *Turbo cornutus*, a species endemic to China, until recently and documented to be unnamed in 2017. Another edible species *Tegula kusairo* exhibited the similar case and it was described as a new species in 2020. Furthermore, many species become extinct or critically endangered by artificial environmental changes before recognizing their presences by human beings. The alpha-taxonomy of this group is thus highly important and an urgent matter in terms of biodiversity conservation.



Turbo sazae Fukuda, 2017.

Collection and databasing of molluscan specimens

Sunetta beni Fukuda, Ishida, Watanabe, Yoshimatsu & Haga, 2021.

Molluscs live in most habitats on land and in water. Because they have poor migration ability, they are closely linked to the environmental conditions of the place than any other organisms, and are useful for understanding the historical transition and current status of environment. It is the best as an environmental indicator. We are collecting molluscs from all over Japan, preparing specimens, and making a database. As of June 2021, about 30,000 lots of specimens have been registered.

Research Area : Evolutionary Ecology

Prof.
MIYATAKE Takahisa

Study on evolutionary ecology using insects

All of organisms including agricultural products of material are product of evolution. All of them are influenced from environmental and ecological factors. Therefore, understanding of evolutionary ecological mechanisms is important to consider all living thing. We are grappling with researches in the mechanism of evolutionary ecology using mainly insect species. We focus on insect behaviors including anti-predator behavior, courtship and mating systems, biological interactions of insect species. Concretely, there are specialized research theme concerning mating system, sexual selection, sperm competition, insect immobility, dispersal tactics, interaction between environments and insect behaviors, using insects.

Research on insect behaviors for applied entomological techniques

In addition to the basic researches in evolutionary ecology, we can apply these results to output concerning applied entomology and insect pest control. Understanding insect behavior connect to some applied entomological techniques; for example, monitoring and detecting the beetles using lights and/or pheromone in a laboratory and a storehouse, attraction methods using ultra violet l or blue lights and lure, or breeding of flightless beetles. In addition to these researches, we concern some relationships between native and invasion insects from the world including common pill bug, sweet potato weevils, fruit flies, and broad-horned flour beetles.

Research Area : Bioproduction Systems Engineering

Assoc. Prof.
NAMBA Kazuhiko

Optimization of Sawdust-Based Shiitake Growth with Cultivation Facility Environments

Shiitake is one of the most popular mushroom in Japan. Dried one is also famous as a soup stock. The history of cultivation started more than 100 years ago, logs had been used for fungi culture. Now a days, logs are replaced with sawdust and they started to culture in a environmental controlled facility which may called as a plant factory. Temperature is the most important factor, fungi is damaged with high temperature, but not optimized yet. So that we started to optimize environmental factors for better outputs, not only yield but also quality. Among others, lighting has a possibility for controlling qualities, such as a size, shape or color, as shown in right pictures.

Influence of Environmental Conditions on the Chrysanthemum Leaf Yellow Spot

Chrysanthemum is one of the most popular flowers in Japan. It is used in various ways, for a funeral, flower arrangement and so on. In addition there is a demand all year round, so it's cultured in an environmental controlled green house. In recent years, yellow spots appear on the leaf in many species. In chrysanthemums, the state of a leaf involves commercial values, not only flower quality. The mechanism how it occurs isn't still found out clearly and techniques to prevent it occurring aren't established. We focused to the environmental conditions as a case. For an objective measurement, a portable image taking device was made, shown in a left picture, and image processing has been adopted.

Research Area : Resources Management

Assoc. Prof.
DATAI Hisashi

Development of Sustainable and Stable Social Systems in Southeast Asian Countries

In Southeast Asian countries, people's economic activities are becoming more and more active due to rapid economic development. Under such circumstances, the demand for land, capital, and labor for agricultural production is changing in rural areas.It is essential to ensure the sustainable use of resources in the future through appropriate resource management.We are investigating the current status of agricultural production activities in such areas and conducting research on the development of sustainable and stable social systems.
We use selective conjoint analysis, CVM, and other methods for analysis.Recently, we are also working on GIS-based analysis.

The Interview Survey in Orchards in China

The Potential for Creating Ethical Value with Agricultural Production

The Interview Survey in Organic Pepper Farms in Vietnam

Ethical consumption is a new trend in which consumers choose businesses and products that are engaged in solving social issues when they consume.
We are investigating the possibility of creating ethical values by analyzing consumer preferences for agricultural products produced through cooperation between agriculture and welfare, and environmentally friendly agricultural products produced in developing countries.

Research Area : Farm Management Systems and Information Processing

Assoc. Prof.
OHNAKA Katsutoshi

Study on Japanese farmer's management and Agricultural corporative

Generally speaking, Japanese farmers' scale are smaller than other countries. But, Japanese farmers' scale are expanding now. Some rice farmers have more than 100ha paddy field, and some vegetable farmers have more than 100ha dry field. These farmers are mostly expanding by lease.
And, these expansion of farm size, farmers' management need to change. For example, some farmer need to employ worker, some farmer are forced to change selling agriculture products. In addition, one farm corporative had changed to a stock corporation.
We aim to focus on changing agricultural management in Japan.

Study on Japanese agriculture policy and rural policy, EU, USA, Asia country's trade policy

Why do Japanese farmers change? How do Japanese farmers change? And, who promotes to change Japanese agriculture management?
The key to solving these questions are "policy". After WW2, Japanese government hoped to change Japanese agriculture structure. It promoted to be established large scale farmers. Imperfectly, Japanese agriculture structure is changing now. Near the future, many Japanese old farmers will be retired. Therefore, Japanese government supports large scale farmers for accumulating these old farmers' farmland by agriculture policy.
Moreover, agriculture policy is effected by trade negotiation.
We are comparing and analyzing other countries' policy.

Research Area : Mathematical Science for Data Engineering

Prof.
OBAYASHI Ippei

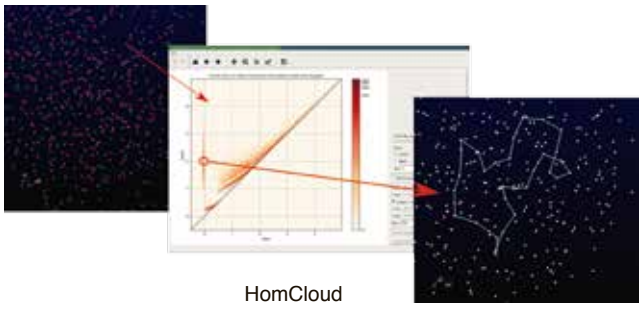
Mathematical theory of persistent homology

Möbius strip and its boundary

TDA enables us to utilize the mathematical concept of topology for data analysis, and the research is actively conducted from theory to applications. It does not follow a unidirectional flow from mathematical theory to application, and new mathematical problems often arise from applications. We work on such mathematical problems. I already have worked on inverse problem on persistence diagrams and field choice problem on persistent homology.

Development of HomCloud, data analysis software based on PH

In order to connect the theory of persistent homology with applications, data analysis software is indispensable. For this reason, we develop "HomCloud", data analysis software based on PH. We focus on applications, and practical functionalities such as visualization, machine learning/statistics, and inverse analysis. HomCloud is a test platform to see if mathematical theories work effectively, and we are implementing ideas from our research as soon as possible.



HomCloud

Research Area : Applied Mathematics

Assoc. Prof.
HAYASAKA Futoshi

Commutative Algebra: Theory of integral closure and multiplicity for modules

My research interests lie in the area of commutative algebra, homological algebra, combinatorics, and computational algebra. Among the topics I am particularly interested in are the theory of Buchsbaum-Rim multiplicity and integral closure for modules, and the ring structure of Rees algebra of modules. These are general notion of the classical one for ideals and relatively new topics in commutative algebra.

In recent years, I have been working on some basic problems concerning the Buchsbaum-Rim multiplicity and the asymptotic behavior of various invariants such as length, grade and associated primes associated to multigraded modules.

I am now interested in the theory of integrally closed modules over a two-dimensional regular local ring, and I am working on problems about constructing indecomposable integrally closed modules of higher rank, the theory of Buchsbaum-Rim coefficient of modules and the ring structure of Rees algebra of integrally closed modules.

Computational Algebra: Applications to mathematical and data sciences

I am also interested in computational aspects of commutative algebra and its applications to mathematical and data sciences. Recently, I have learned a few topics about applied aspects of algebra, especially algebraic statistics, with my students.

I will start to learn these topics and continue to study them with students towards applications to mathematical and data sciences. Among a number of topics, I am interested in computing Groebner basis of ideals and modules systematically appearing in polynomial models in statistics.

Research Area : Mathematical Analysis of Models

Prof.
SASAKI Toru

Mathematical analysis of models describing infectious disease

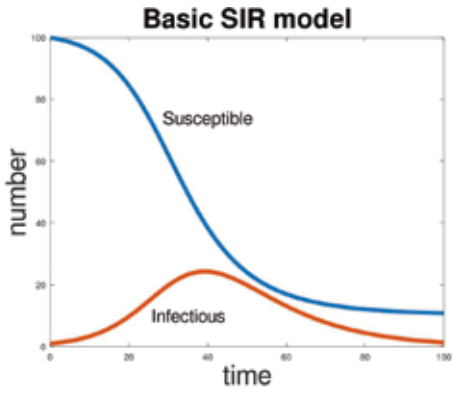
Propagation of an infectious disease in a population, and the dynamics of density of pathogen in vivo are investigated by using mathematical models. Those mathematical models consist of systems of functional equations, such as ordinary differential equations and partial differential equations. For example, in the case of spread of an infectious disease, a susceptible becomes an infectious by a contact with an infectious, and the numbers of susceptible and infectious agents change. The numbers as unknown variables satisfy functional equations. If the population is uniformly mixing, then the equations are ordinary differential equations. If age-structure or spatial diffusion is considered, then the equations are partial differential equations. We investigate those models in a mathematical point of view, and develop the method of analysis for those models.

Basic virus dynamics:

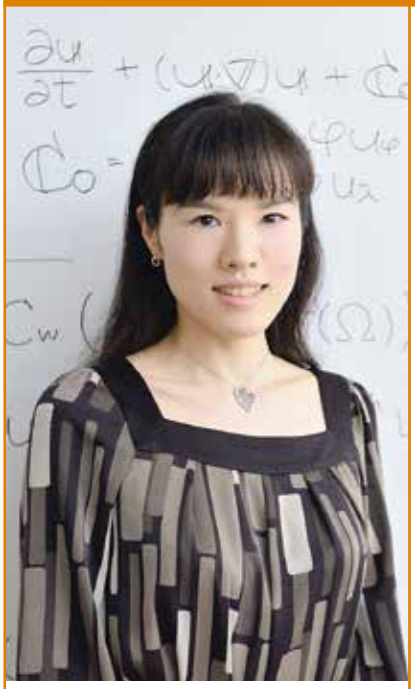
$$\frac{dx}{dt} = \lambda - mx - \beta xv$$
$$\frac{dy}{dt} = \beta xv - ay$$
$$\frac{dv}{dt} = ary - bv - \beta xv$$

SIS model with diffusion:

$$\frac{\partial NS}{\partial t} = \nabla \cdot (\kappa \nabla (NS)) - \lambda SNI + \gamma NI + \mu N - \mu NS$$
$$\frac{\partial NI}{\partial t} = \nabla \cdot (\kappa \nabla (NI)) + \lambda SNI - \gamma NI - \mu NI$$



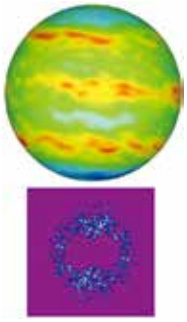
Research Area : Mathematical Analysis of Models



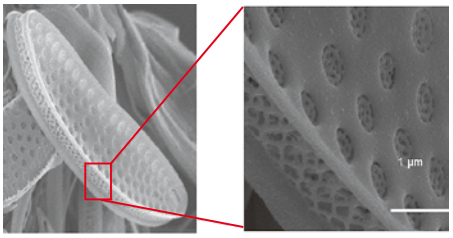
Assoc. Prof.
OBUSE Kiori

Study on Zonal Flow Formations in Two-Dimensional Turbulence on a Rotating Sphere

A two-dimensional incompressible flow on a rotating sphere governed by the two-dimensional Navier-Stokes equation is one of the simplest mathematical models for planetary atmospheres. Although this mathematical model is highly simplified and does not contain many physical processes that may be actively functioning in real atmospheres, the flow field shows rich and interesting phenomena, including a spontaneous formation of large-scale zonal flows. However, these phenomena are the results of very complicated interactions between many factors, and even the mechanisms of simple and typical flow dynamics are not necessarily clear. I am especially interested in the emergence and the development of large-scale structures in two-dimensional turbulence on a rotating sphere, and investigating these by both numerical and analytical methods.



Analysis on Characteristic Features/Structures of Creatures



Pseudoleyanella lunata

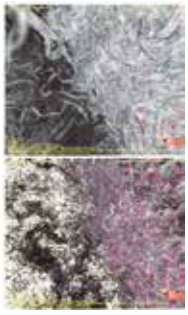
Some creatures possess highly unique body structures and biological properties. In order to obtain knowledge and information of essential factors related to the appearance and formation of such characteristic features, I am performing two different kinds of investigations. One is data analysis of genetic and some biological data obtained by experiments (collaborative research with an experimentalist), and the other is based on mathematical modellings and numerical simulations.

Research Area : Numerical Analysis of Flow Phenomena

Prof.
ISHIHARA Takashi

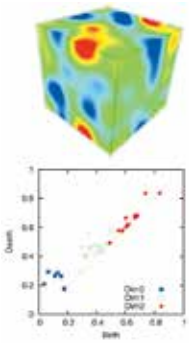
Computational and data science of multiscale/multiphysics complex flow phenomena

Transport and diffusion of dust particles by atmospheric air turbulence and highly efficient and clean combustion in internal combustion engines are themes related to environmental problems. These are multiscale/multiphysics complex flow phenomena. To solve these phenomena, a more comprehensive understanding of turbulence physics is important. By developing reliable and effective methods for direct numerical simulations (DNSs) of the Navier-Stokes equations, performing large-scale DNSs of turbulence using supercomputers, and conducting data science based on the DNSs, we are studying turbulence physics related to various complex flow phenomena.



Cluster structure of high vorticity regions in high Reynolds number turbulence obtained by large-scale DNS

Mathematical and scientific information reduction and visualization of large-scale time series data



A method for efficiently extracting important information from huge time series datasets obtained from large-scale numerical simulations is required. Flow visualization and analysis of conditional statistics are effective for understanding turbulence phenomena. Persistent homology analysis enables us to systematically extract remarkable "changes" in the spatio-temporal space of a scalar field. By combining these, we are developing methods for detecting and understanding important events in complex turbulent flow phenomena.

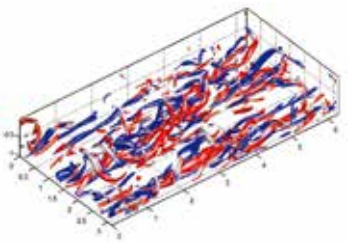
A scalar field and its persistent diagram

Research Area : Numerical Analysis of Flow Phenomena

Assoc. Prof.
SEKIMOTO Atsushi

Data-driven computing for prediction and control of wall-bounded turbulence

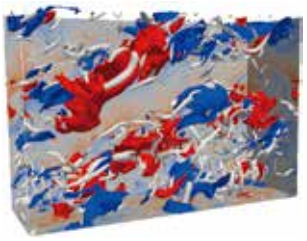
Wall-bounded turbulence significantly contributes to heat transfer and drag on a wall surface, and the prediction and control of turbulent phenomena leads to the efficient use of energy, and the time-series data of turbulent flow fields have been obtained by the numerical simulation. In the future, it is necessary to develop the data-driven prediction and control technique based on a deep understanding of the turbulent flow for the wide application in engineering.
We will carry out numerical calculations for various engineering problems and challenge the turbulent flow problem, which is so-called the final problem of classical mechanics, using new techniques of information science such as machine learning in addition to statistical analysis and dynamic system theory.



The coherent vortical structures in turbulent plane Poiseuille flow. Flow is from left to right. (red) clockwise, (blue) anti-clockwise vortices.

Data-driven dynamical system for modeling and optimization of nonlinear phenomena

We can consider turbulent flow as a vector with a large dimension of freedom and a dynamical system, then we can numerically find invariant solutions such as equilibrium solutions and periodic orbits of Navier-Stokes equations or turbulence model equations. Understanding the role of invariant solutions in the turbulent flow phenomenon would provide some insights into the development of turbulence models and flow control techniques. The dynamical system approach can also be applied for the understanding of the mathematical model itself obtained by machine learning such as deep learning, since it must be common for the phenomenon with strong nonlinearity.
Our research aims are following:
development of simulation technique of the complicated process in which we can obtain the data of real phenomena, such as multiphase flow, chemical reaction, combustion, mixing of various particles, separation and aggregation processes, although the knowledge of macroscopic or statistical behavior is limited or the detailed simulation is not realistic; and then, development of the technique of optimization and control method which can be applied in a wide range of the engineering field.



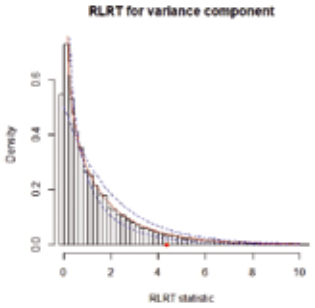
The stratified homogeneous shear turbulence. (Red, blue), low and high density fluctuation, (gray) vortical structures.

Research Area : Environmental Statistics

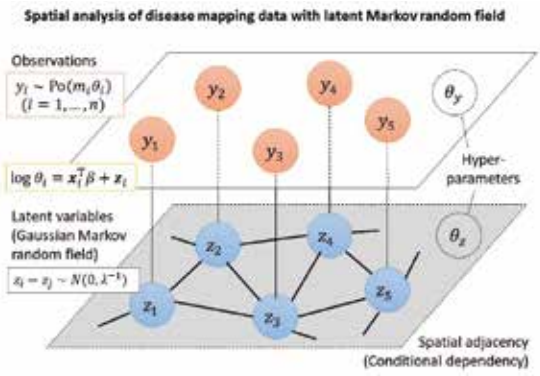
Prof.
SAKAMOTO Wataru

Statistical Science for environmental and life science

In modern society, we are required to have grounds for judgement in various situations. For example, in order to solve environmental issues, it is important to have calm discussions with showing scientific evidences, without being influenced by personal feelings.
The statistical science provides the most effective means of showing such grounds objectively. We wish to contribute to solving issues on environmental and life science through researches on statistical science, with making use of computer ability developing drastically.



Statistical modeling and computation for analyzing environmental and epidemiological data



We develop statistical models for analyzing complicated phenomena that occur in environmental and life science, such as penalized spline regression models, mixed effect models, and Markov random fields, and develop methods of selecting an optimal model.

The figure shows a graphical model for spatial analysis of disease mapping data.

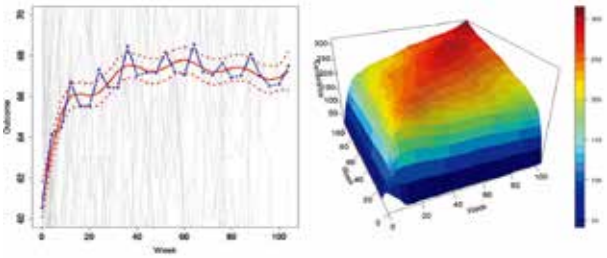
Research Area : Environmental Statistics

Assoc. Prof.
YAMAMOTO Michio

Statistical data analysis and statistical machine learning

Statistical data analysis and statistical machine learning are indispensable for understanding phenomena in environmental and life sciences based on data. I am developing those methods and studying their theoretical properties. Specifically, I am developing various multivariate analysis methods, including dimension reduction techniques such as clustering and principal component analysis, for addressing various problems in life sciences.

Functional data analysis for temporally and spatially dependent data



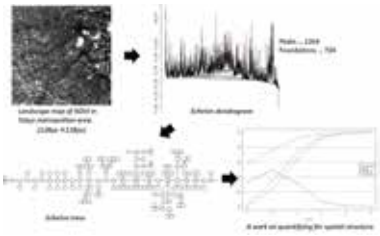
Functional data analysis is a method that handles measurements as points in a function space, and is one of the main methods for analyzing data that change continuously with respect to time or spatial position. I am developing functional data analysis methods and studying their theoretical properties.

Research Area : Design and Analysis of Environmental Survey and Experiments

Prof.
KURIHARA Koji
Assoc. Prof.
ISHIOKA Fumio

Visualization of spatio-temporal information and structural analysis by Echelon tree structure

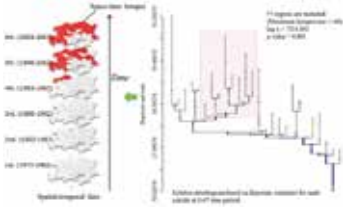
In recent years, the analysis target of statistical science has become complicated, especially in spatial data, it is necessary to analyze the data with time series and multi-dimension in addition to usual fixed time and space situation. Furthermore, the amount number of data has been increasing.



For these complicated and large-scale spatial data, we will develop the hierarchically representational approaches based on "Echelon analysis" by using the geographical and temporal positional information of each region. The echelon provides a dendrogram representation of the surface topology of graph-theoretic analysis and surface structure comparison. The echelon dendrogram is a powerful tool that expresses a unified framework to handle lattice data with visualization.

Detection of spatial cluster for large scale spatial data

The detection of problems such as the generation status of infective diseases or hazard maps of natural disasters is very basic and important. Some powerful and useful tools such as geographical information systems (GISs) are available, but it is very difficult to determine the location of space-time clusters for various types of spatial data in large quantities or with large time series. The aim of this study is to establish methods to identify a disease cluster or a contaminant cluster, so-called hotspot, for various kinds of spatio-temporal spatial data and to develop software for that.

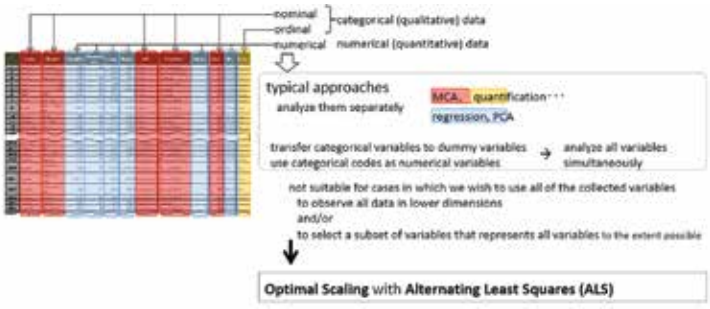


Research Area : Design and Analysis of Environmental Survey and Experiments

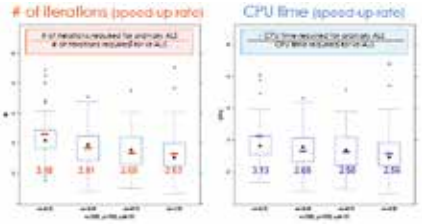
Prof.
IIZUKA Masaya

Some applications in multivariate methods with alternating least squares

In recent years, we can obtain a huge data which have quantitative and qualitative variable. We call this type of data as mixed measurement levels data. The alternating least squares (ALS) algorithm is a most popular iterative computational method for mixed measurement levels data. The ALS algorithm alternates between the optimal scaling step and the parameter estimation step. The optimal scaling step is to obtain optimal scaled data by quantifying nominal and ordinal scaled data. The parameter estimation step is to compute parameters for the optimal scaled data. However, the drawback of the ALS algorithm is that its convergence is linear and very slow for very large data with mixed measurement levels.



In order to circumvent the problem of slow convergence of the ALS algorithm, we provide an acceleration algorithm. The algorithm converges faster than the original sequence of ALS iterations.

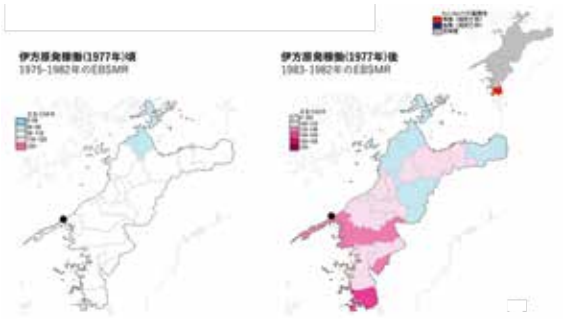


Research Area : Environmental Epidemiology

Prof.
TSUDA Toshihide

Quantitative assessment of the effects of environmental pollution on the humans

In recent years, the human health effects of environmental pollution are an important concern for society. The main types of environmental exposures that affect human health are physical, chemical, biological, psychological, social, and cultural exposures. However, the actual scientific methods for clarifying these effects and the institutions that compile the results are not well known to the public. Moreover, because this is not known, many media and people do not know how to read the results of new studies, let alone benefit from them. They also don't know how the results are incorporated into social and legal systems. In other words, the scientific knowledge of human impact is not well utilized in Japan. We are researching the promotion of scientific literacy on the environment and human health effects.



Assessment of the effects of biological exposures on humans

In the case of biological exposures, bacterial and viral exposures are the representatives of human health effects of the environment. Currently, a new coronavirus is causing a pandemic in the world. The transmission of new coronaviruses is thought to be through respiration and through contact. Along with this, food poisoning through food and drink is the most common form of bacterial and viral exposure. We are conducting research to collect these cases and study them, including legal developments, for future prevention.

Research Area : Solid Waste Management and Recycling

Prof.
FUJIWARA Takeshi

Regional waste material recycling towards low carbon society: Sanitary waste treatment is a fundamental in solid waste management, moreover, it is required that "from waste to material" and "from waste to energy" to mitigate green house gases emission. Solid waste processes, such as waste separation at source, segregated waste collection, optimal waste transportation, material and energy recovery treatment, and safe landfill disposal, should be combined appropriately so as to shorten the environmental burden. Our laboratory studies on designing methods to establish a sophisticated solid waste management that is suitable for sustainable regional society, specially in Asia.

(Waste characterization tests in Okayama city)

(Mixing kinds of biomass waste for composting)

Evaluation of the biomass waste recycling in university campus: From view point of carbon neutral, biomass waste should be more utilized in a sound material-cycle society. By considering characteristics of various kinds of solid waste generated in our campus, such as kitchen waste, mowed grass, dead leaves, pruned branches, agriculture waste, animal dung in different seasons, our laboratory researches on effective biomass waste recycling methods.

Development of a disaster waste management training system: Japan is exposed by many risks of natural disasters such as earthquake, land sliding, tsunami, flooding and so on. Once a big natural disaster comes like the Great East Japan Earthquake, a huge amount of disaster waste generates in a short period. In order to recover the town from the damage speedy, initial countermeasure actions for disaster waste treatment by local government are quite important. Therefore, our laboratory is constructing a knowledge base of the actions and also developing a training support system for the local government.

(Disaster waste in Iwate prefecture)

Research Area : Solid Waste Management and Recycling

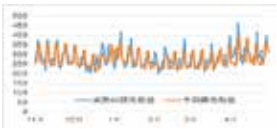
Assoc. Prof.
MATSUI Yasuhiro

Modeling on waste generation and discharge

To support rational and effective decision making on municipal solid waste management toward sustainable society, our laboratory aims to accumulate the scientific base by the following research activities:

- ✓ Detail survey on municipal solid waste generation, demographics, 3R behavior, pro-environmental attitudes, lifestyle, and household expenditure in Japan and Vietnam
- ✓ Exploring influence factors and Bayesian modeling of waste generation and 3R behavior
- ✓ Political effect prediction on 3Rs and reliability verification
- ✓ Accuracy improvement on sales prediction of food items by Deep Learning toward food loss reduction

Conceptual framework on relationships between 3R promotion measures and 3R behavior



Actual daily sales variation of rice balls and Predicted sales amount by deep learning

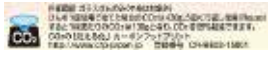
Behavior modification on 3Rs

To establish and expand 3R good practices toward sustainable society, our laboratory tries some pilot studies including 3R promotion and effect measurement as the following activities:

- ✓ Experience-based activity for 3Rs in cooperation with trial dining event in downtown by gamification
- ✓ Development of beverage by returnable bottle with Carbon Footprint Ecolabel
  To enhance the citizens understanding on the effect of Reuse, the label indicated "When you discard in one, you discharge 430g-CO_2e. When you reuse 5 times, you discharge 130g-CO_2e in one which means you can decrease 69% of GHGs.

Experience-based 3R promotion

Flyer of the carbonated drink provided by returnable bottle



Ecolabel instruction on GHG mitigation effect by repeated use of returnable bottle

Research Area : Solid Waste Management and Recycling

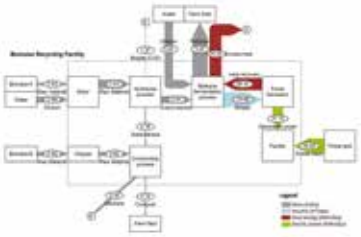
Asst. Prof.
HABUER

Study on anthropogenic mercury releases for the evaluation of the effectiveness of the Minamata Convention on Mercury

The combination of anthropogenic activities and long-term atmospheric transport has resulted in a sustained increase in global mercury concentrations in air, in water and on land. The Minamata Convention on Mercury (MCM), is a global treaty with the goal of protecting human health and the environment from anthropogenic releases of mercury. This study aimed to quantify the mercury inputs and outputs in China in 2016–2019 according to source category and investigate the effect of scenario/technology transformation required by the MCM on the subsequent distribution of mercury among environmental and intermediate reservoirs. This is the first attempt to provide a systematic evaluation of the validity of the MCM. As the MCM moves into the implementation phase, further information from scientific data and studies is critically needed to support decision-making and management. The results of this study can provide such information, facilitating the creation of strategic management policies for mercury as the MCM is implemented.

Feasibility Study of Biomass Waste Recycling System in University Campus

Okayama University has an expansive campus in Japan and generates much biomass that is usually disposed of by outsourcing waste treatment to private companies. The university should tackle reducing and recycling waste within the campus as a regional society member to establish a sound material-cycle society. We evaluated the potential to recycle the biomass waste on the campus by first measuring or estimating the amount of biomass waste generated almost through a year. Secondly, we conducted feasibility studies such as analysis of methane gas and compost production, power consumption, and CO2 emission of a methane fermentation facility and a composting facility.



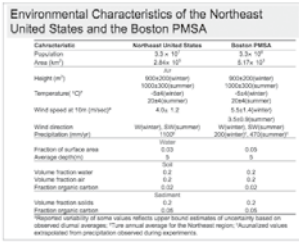
Biomass Recycling Facility Process Flow in Campus

Research Area : Environmental Measurement and Control

Prof.
KAWAMOTO Katsuya

Assessing the fate of chemicals in the environment and engineered processes

Concentration changes and dynamics of environmental chemicals are predicted and evaluated based on partition equilibrium properties of chemical compounds and their conversion/degradation kinetics. The target compounds are organohalogen compounds, PAHs, and other emerging pollutants. The target engineering processes include water treatment and gas cleaning, and solid/liquid waste treatment in such environmental media as water, air, soil, and sediment.

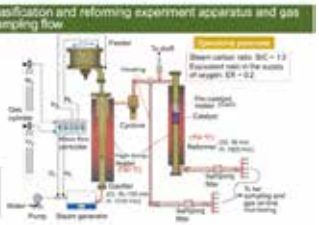

Environmental Characteristics of the Northeast United States and the Boston PMSA

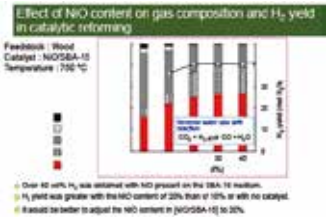
Mass balance equation of MTBE in Boston urban air:

$$\left(\frac{dC_{air}}{dt}\right)_{steady-state} = 0 = \left(\frac{Emission \cdot rate}{V_{air}}\right) + \left(\frac{C_{air,in}\, dV_{air}}{V_{air}\, dt}\right) - \left(\frac{C_{air}\, dV_{air}}{V_{air}\, dt}\right) - k_{OH}(*OH)C_{air}$$

Safe and appropriate disposal treatment of waste water, flue gas, and solid/liquid waste, and developing further technology for recovering materials/energy from waste

Various exhausts, such as wastewater, flue gas, and other anthropogenic waste emissions should be appropriately and safely disposed. Currently, material and energy recovery is highly desired in the context of establishing a sound material recycling society.


Gasification and reforming experiment apparatus and gas sampling flow


Effect of NiO content on gas composition and H_2 yield in catalytic reforming

Biomass gasification and reforming

Because energy recovery from waste treatment plays a key role in eliminating fossil fuel use and GHG emissions, research and development corresponding to the type and properties of waste are performed. Safety assessments of the systems are also conducted.

Research Area : Urban and Transport Planning

Prof.
HASHIMOTO Seiji

Research on the realization of walkable cities

In order to realize walkable cities, various studies are required to make it easier for people to walk, such as improving public transportation and traffic calming. In this research, we will study the design of an easy-to-walk space that supports daily life such as children and the elderly, mainly focusing on living roads. Specifically, road space design in which automobiles running speed are unconsciously controled, and space design in which children in the process of growth can unconsciously take safe actions.

Research on public transportation in depopulated areas

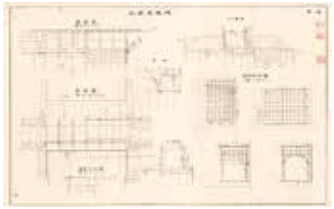
In this study, we will evaluate the impact of the existence of public transportation on the consciousness of living in depopulated areas, the role played by the area in order to maintain public transportation, and measures to improve sustainability through mixed cargo and passengers.

Research Area : Urban and Transport Planning

Assoc. Prof.
HIGUCHI Teruhisa

Historical studies in civil engineering, disaster recovery and urban formation

It is important to look back on the history in order to develop the town in the future. What kind of civil engineering technology did the predecessors develop, how did they recover after the disaster, and how did they build the city? We reveal their history by collecting and analyzing archives (documents, drawings, oral histories).



Preservation and utilization of historical civil engineering structures

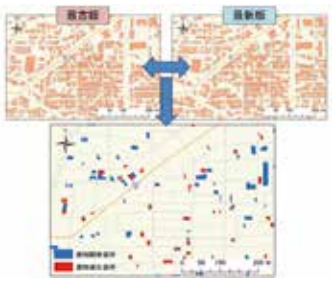
If not rescued, historical civil engineering structures will be lost. We will conduct a survey and evaluate the value of these in order to promote their preservation and utilization, and to utilize them as a "regional asset" in regional development. Then, we will consider and implement ways to preserve and utilize the civil engineering heritages.

Research Area : Urban and Transport Planning

Assoc. Prof.
UJIHARA Takehito

Developing a road map for urban planning adapting to declining population

1) This study elucidates the status and issues of change in land use during a period of declining population.
2) Based on quantitative evidence, a road map for urban planning adapted to a declining population is developed as a step toward realizing an urban structure with low environmental load.



Identifying an urban structure model for Eco-livable cities

A low-carbon, environmentally-friendly lifestyle often has the negative reputation of introducing limitations and burdens into our daily lives. However, reviewing global success cases in urban planning shows that many of these cities are actually low-carbon and livable (Eco-livable cities). Even more interestingly, many of these cities have used past serious environmental issues as an opportunity to achieve their ideal urban vision over several decades.
This research (1) identifies an urban structural model for “eco-livable cities” that simultaneously achieve low-carbon and livability, and (2) constructs a planning theory to achieve this through a survey and analysis of Japanese and international regional cities as case studies.

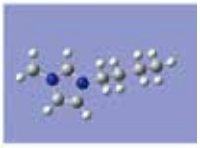
Research Area : Water Environment and Sanitation

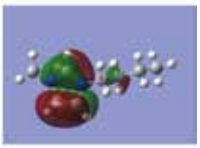
Prof.
NAGARE Hideaki

Wastewater to food production ~ a new wastewater treatment process with resource recovery

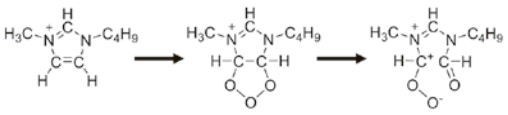
We are working on wastewater treatment process that is economically beneficial, and resources in wastewater are recovered and recycled for sustainable food production.
Fertilizer including phosphorus is necessary to produce food. The demand of the fertilizer has been increasing to supply food for increasing population. However, fertilizer reserve is limited, and its production causes environmental pollution. To protect the environment and supply enough food for our children, we have been developing a new wastewater treatment process not only to treat the wastewater but also recover nutrients for fertilizer.
More than that, we have been trying to increase the “value” of the recovered products using microalgae. This microalgae produces carotenoids such as b-carotene and astaxanthin, those are high value antioxidative pigments and are dealt with at a high price. The production of the pigment is the economical driving force of recovering nutrients from wastewater, finally to establish the sustainable food production.

Understanding of chemical and biological reaction mechanisms by computer simulation





Computer simulation is a powerful tool to understand the mechanism of reactions such as degradation of pollutants in water treatment process, and oxidation reactions in microbial cell. Using the computer skills and the knowledge of physical chemistry including thermodynamics, we have been doing the simulation researches. One of the example is the degradation of ionic liquid with ozone. From which chemical bond does the degradation reaction occur? The simulation gives us the insight of the reactions.

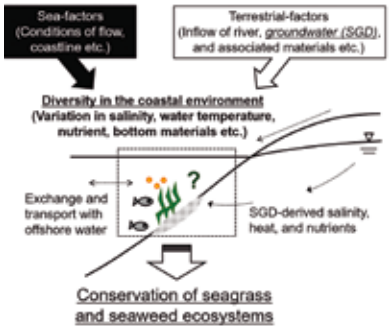


Research Area : Water Environment and Sanitation

Assoc. Prof.
SAITO Mitsuyo

Evaluation of the groundwater function for conservation of coastal ecosystems

Seagrass and seaweed meadows are regarded as an important coastal ecosystems for their functions of "ecosystem service", such as carbon stock and habitats. Though conservation of these meadows is a global issue for the healthy cycles of food and materials, their biomass has been decreasing worldwide. Diversity in the coastal environment (e.g. variation in salinity, water temperature, nutrients, bottom materials etc.), produced by both sea-factors and terrestrial-factors, is important for seagrass and seaweed meadows to coexist with the other primary producers. We evaluate the function of "submarine groundwater discharge (SGD)" for diversity production in the coastal environment by field observations, satellite data, and hydrological models.



Potential diversity-creating factors in the coastal environment

Human and climate impacts on water environment and water resources

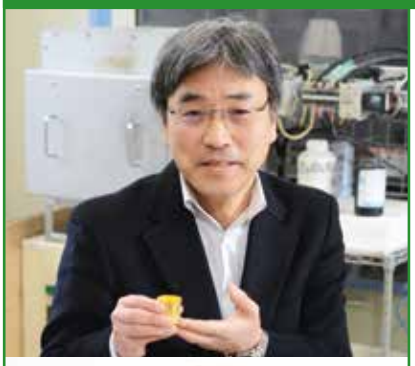
Human activities in urban and rural areas alter the natural hydrologic and material cycles in watersheds. For example, overdrawing groundwater for drinking, irrigation, and industrial use increase the risks of water deficiency, land subsidence, contamination and salinization.

Increase of nutrients (e.g. nitrogen, phosphorus) entering the environment by human activities(e.g. agriculture, industries) cause eutrophication of surface water environments and contamination of groundwater resources.

We evaluate the current status and future outlook of water resources and environments based on field observations, chemical and isotopic analysis, and hydrological models for several countries in different climate zones, urbanization status, and cultures. We will also suggest the solutions for sustainable water-nutrient cycles for the future.

Land subsidence (left) and surface water pollution (right) in Jakarta metropolitan area, Indonesia

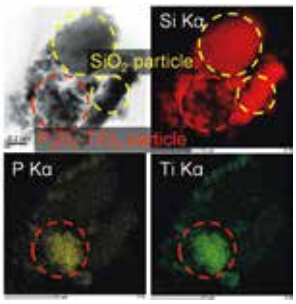
Research Area : Ceramic Materials



Prof.
NANBA Tokuro
Assoc. Prof.
BENINO Yasuhiko

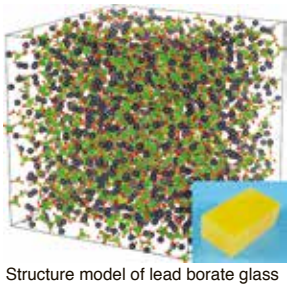
Effect of acid treatment conditions on the dissolution behavior of constituent elements in molten slags and ashes of municipal waste

In municipal waste molten slags, valuable elements such as Si, P and Ti are present. Our research group has developed a new recycling method in which P and Ti-containing SiO_2-rich solid phase is recovered after acid treatment of B_2O_3-added molten slag glasses. We also found that the SiO_2 phase is formed by dissolution reprecipitation process. It is hence expected that by changing treatment conditions, selective recovery of a specified element will be realized. Then, in this project, we are investigating elution behavior of constituent elements in molten slags and ashes of municipal waste by changing basicity of slag glass, where an alkali oxide was added to the molten slag to prepare slag glasses having different basicities.



Recovered solid after acid treatment
[DOI: 10.1016/j.jascer.2013.03.003]

Development of novel glasses for immobilization of radioactive iodine



Structure model of lead borate glass and Iodine-containing vitrified waste
[DOI: 10.1016/j.pnucene.2016.05.008]

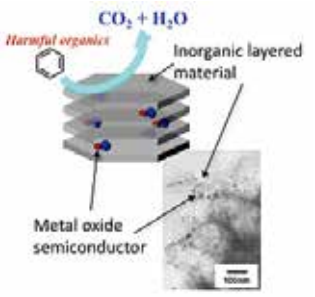
TRU (TRans-Uranic) waste contains radionuclides such as Iodine-129. Iodine-129 has extremely long half-life of 15.7 million years, and hence it is a key nuclide at the safety assessment for the geological disposal of TRU waste. However, it has high volatility so that the conventional vitrification technique is not applicable. Then, new iodine-129 immobilization technique is required. A lead borate glass with low melting temperature is a candidate for the vitrification technique. In our research group, structure (atomic arrangement) of the iodine-containing lead borate glasses has been studied by using combination of experiments and computer simulations to clarify the relation between glass structure and iodine immobilization property.

Research Area : Inorganic Functional Material Chemistry

Prof.
KAMESHIMA Yoshikazu

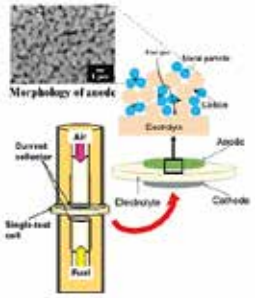
Development of new environmental purification materials based on inorganic layered materials

Water purification is one of the important issues of the present day. Although TiO_2 is the most prevalent and practical photocatalyst for elimination of hardly decomposable organic materials, both improvement of an affinity with target materials and development of decomposition performance under visible light are required for TiO_2 materials. One of the solution methods of the former is hybridization of TiO_2 and an inorganic layered material. With this hybridization, the synergy effect of layered material and TiO_2 can improve the decomposition performance of organic materials. In this research, we will develop an environmental purification system with high efficiency and ecofriendly by preparing hybrids of various metal oxide semiconductors and inorganic layered materials.



Development of solid oxide fuel cells (SOFCs) for various types of fuels

Solid oxide fuel cells are a class of fuel cells characterized by the use of a solid oxide material (ceramic material) as the electrolyte. SOFCs use a solid oxide electrolyte to conduct negative oxygen ions from the cathode to the anode. The electrochemical oxidation of the hydrogen, carbon monoxide or other organic intermediates by oxygen ions thus occurs on the anode side. In this research, we will develop new anode materials that are compatible with the supply of methane and other organic intermediate fuels.

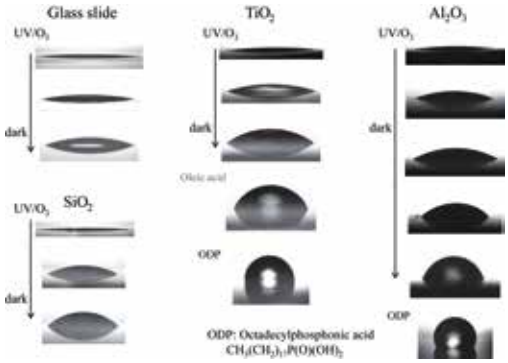


Research Area : Inorganic Functional Material Chemistry

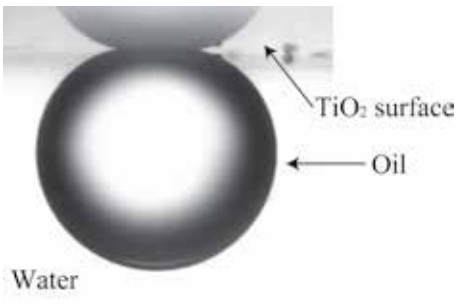
Assoc. Prof.
NISHIMOTO Shunsuke

Study on photocatalytic self-cleaning surfaces

Wettability of solid surface is interesting. Also it is important for our daily life. Titanium dioxide (TiO_2) surface shows super-hydrophilicity (water contact angle less than 5 degree) by the irradiation of ultra violet light. TiO_2-coated materials such as glasses and tiles of buildings have been widely used as self-cleaning materials. Recently, we focus on niobium oxide-based photocatalyst as high functional self-cleaning material. We are trying to develop next environmentally friendly self-cleaning coatings.



Study on underwater super-oleophobic surfaces



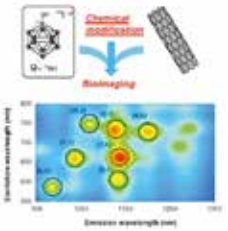
Oil wettability of solid is an important physical property of the materials. We have developing functional materials with underwater super-oleophobic surface (oil contact angle larger than 150 degree). underwater super-oleophobic mesh can be applicable as a speedy oil-water separation filter. Recently, we succeeded to develop TiO_2 photocatalyst oil-water separation filter. Moreover, we are currently investigating calcium-based materials as oil-water separation filter.

Research Area : Advanced Organic Materials

Sr. Asst. Prof.
TAJIMA Tomoyuki

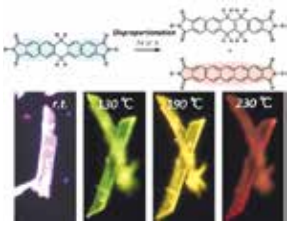
Physical modification of carbon nanotubes with a dendrimer bearing terminal mercaptoundecahydrododecaborates ($Na_2B_{12}H_{11}S$)

The functionalization of dodecaborates has attracted much attention, both for the development of boron neutron capture therapy (BNCT),where ^{10}B nuclei capture thermal neutrons to emit ^{7}Li nuclei and alpha particles that destroy cancer cells. Increasing focus has been placed on the conjugation of the thiol-substituted B_{12}-cluster mercaptoundecahydro-*closo*-dodecaborate ($Na_2[B_{12}H_{11}SH]$; BSH). This is mostly due to the fact that BSH offers great biological advantages, which includes higher boron content, ionic nature, higher solubility in water, significantly lower toxicity based on its boron content, and its clinical use in the treatment of cancer (BNCT). For a boron delivery agent to be successful in BNCT, both high tumor-targeting selectivity and the possibility for in vivo imaging are required. However, reports on the conjugation of BSH with bioimaging agents remain scarce. We have successfully synthesized a new water-soluble dendrimer that bears B_{12}-cluster terminals, with potential applications in BNCT. Moreover, the physical modification of SWCNTs with boron-cluster dendrimer furnished SWCNT/(boron-cluster dendrimer) nanohybrids that exhibit NIR-I-to-NIR-II fluorescence. Further investigations into the cellular uptake and cytotoxicity of our materials are currently in progress.



Disproportionation-induced solid-state fluorescence in 6,13-dihydropentacenes

The molecular design of π-conjugated systems is crucial for the development of new functional materials. Nevertheless, reports on π-conjugated systems exhibiting disproportionation-induced photoluminescence changes are relatively rare. Against this background, we decided to explore the utility of disproportionation reactions for the development of fluorescent chromic materials. The thermally and photolytically induced disproportionation of 6,13-dihydropentacene derivatives into tetrahydropentacenes and pentacenes results in unique solid-state fluorescence. The fluorescence thereby depends on the molecular structure and the molecular arrangement in the solid state. The molecular structure and conformation in the crystals strongly influence the disproportionation reaction. Upon heating or photoirradiation of 6,13-dihydropentacene derivatives in the solid state, the fluorescence color gradually changed from bright blue to red. The solid-state fluorescence behavior induced by disproportionation may serve as an example for guided molecular engineering, providing fascinating possibilities to tune materials for sensing, as well as optical and thermal recording applications.

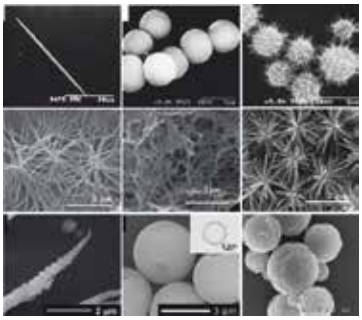


Research Area : Environmental Polymer Chemistry

Prof.
KIMURA Kunio
Assoc. Prof.
YAMAZAKI Shinichi
Asst. Prof.
ATARASHI Hironori

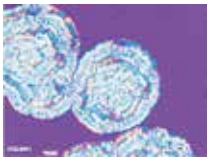
Creation of environmentally benign polymerization system and polymer materials

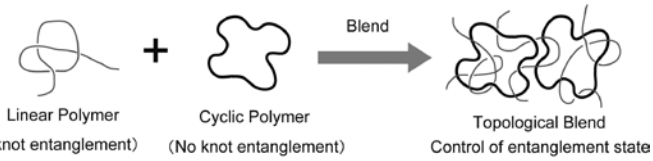
Aromatic polymers are used in various industrial fields as high-performance materials due to their excellent properties, such as thermal stability, mechanical properties, or chemical stability. However, processing of these polymers is extremely difficult because of their intractability. We have been studied the unique polymerization system for morphology control of aromatic polymers. As a result, we obtained various morphologies such as whisker, ribbon, helical, sphere with dimple, and so on. This polymerization system and materials are one of the answer towards sustainable development of society.



Studies on biodegradable polymers with unique topology based on crystallization control

This study conducts the development of high-performance biodegradable polymers with the tunability of physical properties such as mechanical strength and thermal resistance using the unique topology of cyclic homopolymer and topological blend polymer having cyclic polymer as a component. The cyclic homopolymer and topological blend polymer are capable of control of crystalline and entanglement state. The unique morphology and crystallization behavior have been clarified.



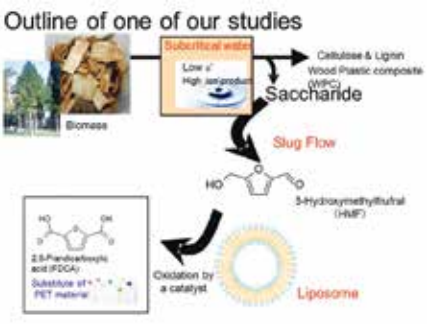


Research Area : Environmental Process Engineering

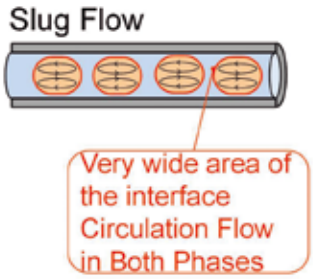
Prof.
KIMURA Yukitaka

Study on proposing some environmental-friendly chemical processes

In order to convert an unusable material to a valuable material, we research to propose an environmental-friendly chemical processes. We proposed the three chemical processes shown in the figure to produce a monomer to make a bioplastic from woody biomass. As the first process, we used subcritical water to hydolyze cellulose and hemicellulose. We converted monosaccharide to 2,5-Hydroxymethylfrufral (HMF) by the quick extraction as called as “Slug Flow” as the second process. We proposed a converting chemical process using a metal catalyst with liposome, which is an artificial cell membrane, to produce 2,5-frandicarboxylic acid.



Study on a mechanism of transport phenomena between immiscible organic-water phases in Slug Flow



As mentioned above, the quick extraction is effective to produce HMF. The key factor is transport phenomena between immiscible organic-water phases in Slug Flow. We try to elucidate what is an important factor for the transport. The depth of the interface is one candidate to effect the transporting rate of HMF. The depth depends on variety of organic solvent. We also research the effect of surfactants on the depth of the interface.

Research Area : Environmental Reaction Engineering

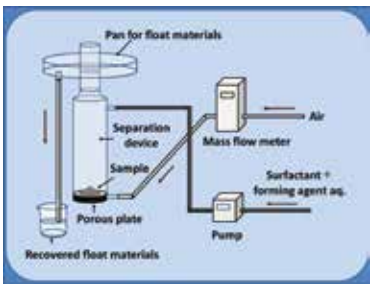
Prof.
UDDIN Md. Azhar

Prof.
(Special appointment)
KATO Yoshiei

Research on waste recycling for building a recycling-oriented society, and biomass and green hydrocarbon cycles for global environmental issues

We aim to solve environmental problems with a chemical engineering (reaction engineering) approach, focusing on four fields: building a recycling-based society, global environmental problems, environmental conservation, and basic reaction engineering technology. We are conducting research mainly focusing on waste recycling for building a recycling-oriented society, researching biomass and green hydrocarbon cycles for global environmental issues, developing environmentally friendly adsorbents and catalysts effective for air, groundwater and soil pollutions protection technologies.

Research on recycling of valuable components in pulverized waste silicon-based solar cells by flotation separation method



Flotation separation has been widely applied in the mining industry to concentrate valuable elements in a raw mineral for many years. The multiple components with the difference in surface property such as hydrophobicity and hydrophilicity are efficiently separated by the gas bubble and surfactant. As recent development for a recycling process, we are investigating the study on collecting a high purity of valuable elements in pulverized scraped silicon-based waste solar cells by flotation. A chemical engineering approach is taken to this study and the goal is put to practical use.

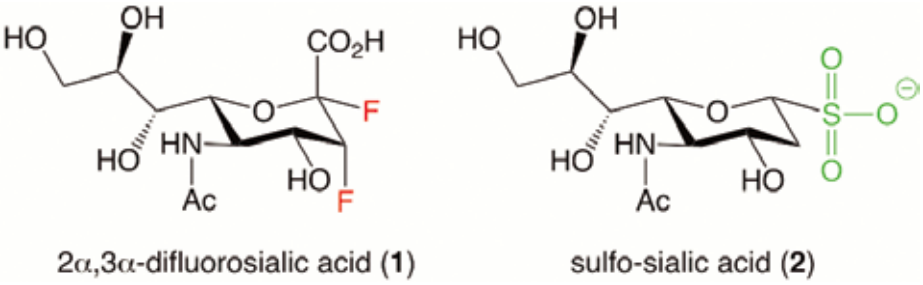
Division of Agricultural and Life Science

Research Area : Applied Natural Product Chemistry

Prof.
KIYOTA Hiromasa

Investigation of inhibition mechanism of sialidase of influenza virus and development of novel inhibitors: difluorosialic acid and sulfo-sialic acid

Development of improved influenza sialidase inhibitors is critical to prepare for potential influenza pandemics. Based on the hypothesis that Tyr406 forms an acetal intermediate in the catalytic cycle of sialidase, we synthesized 2a,3a-difluorosialic acid (**1**) as a suitable probe to test if a covalent intermediate can be captured. As expected, X-ray crystallographic analysis revealed that **1** forms a covalent complex with Tyr406 of influenza silalidase. This indicated that Tyr406 attacks from the b-face of the substrate, leading to hydrolysis with retention (inversion and inversion) of the configuration. In addition, **1** possessed potent anti-influenza activity (including that of Tamiflu resistant virus) with IC_{50} inhibitory constants of 10 to 1000 nm, providing the first proof-of-concept for mechanism-based influenza sialidase inhibition.
In addition, a next-generation inhibitor, sulfo-sialic acid (**2**), was developed. The sialidase inhibitory activity of **2** was more potent than the corresponding carboxy and phosphono derivatives, presumably due to stronger attraction to the triarginyl binding site of the enzyme.



2α,3α-difluorosialic acid (**1**) sulfo-sialic acid (**2**)

Research Area : Applied Natural Product Chemistry

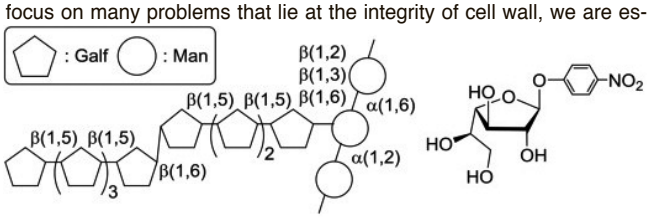
Assoc. Prof.
IZUMI Minoru

Solid-Supported Combinatorial and Parallel Synthesis of Bioactive Compound Libraries.

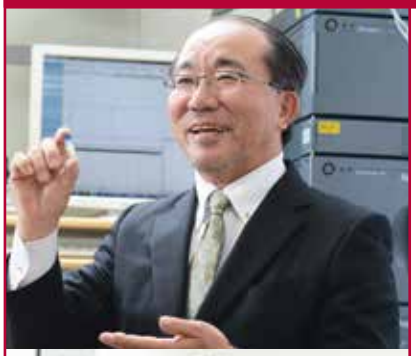
The solid-phase strategy is a strong tool for high throughput synthesis and combinatorial chemistry. Synthetic intermediates are retained on the support and can be, therefore, quickly separated from the reaction mixture without extraction, concentration, and purification steps. Solid-phase synthesis is thus particularly advantageous for multi-step iterative synthesis. Various solid-phase automated synthesizers have been developed and are now commercially available. Our research focus on automated synthesis of bioactive compound and building-up of compound libraries by automatic synthesizer Nautilus 2400.

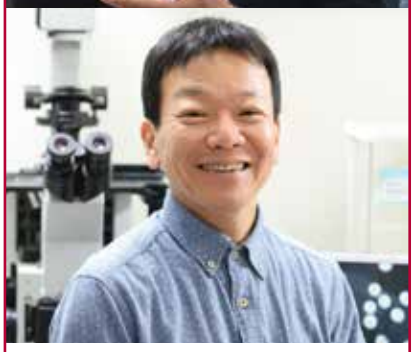
Chemo-Enzymatic Synthesis of glycosides and glycoconjugate.

Galactofuranose is a component of polysaccharides and glycoconjugates. There are few reports about the involvement of galactofuranosyltransferases and galactofuranosidases in the synthesis and degradation of galactofuranose-containing glycans. The cell walls of filamentous fungi in the genus Aspergillus include galactofuranose-containing polysaccharides and glycoconjugates, such as O-glycans, N-glycans, and fungal-type galactomannan, which are important for cell wall integrity. Our research interests focus on many problems that lie at the integrity of cell wall, we are especially investigating the methodology to synthesize glycosides and glycoconjugates by chemo-enzymatic methods including use of some enzyme.



Research Area : Chemistry of Bioactive Compounds



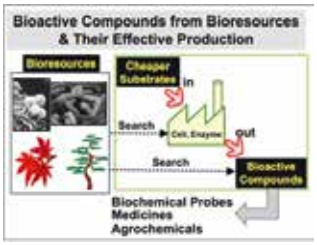


Prof.
KANZAKI Hiroshi
Prof.
NITODA Teruhiko

Aiming for use in medicine and agrochemicals, we are conducting
1: Search for natural bioactive compounds (highly functional compounds)
2: Research on biocatalyst-mediated conversion of low-functional substances.

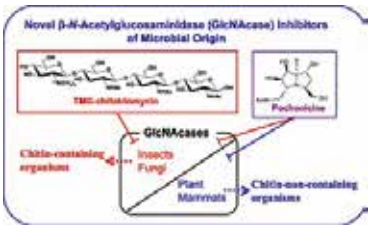
Search and use of new enzymes effective for production of useful substances

(1) We can synthesize various dehydrogenated cyclic dipeptides by using the novel cyclic dipeptide oxidase that we found in actinomycetes. We are investigating various properties of this unique enzyme and conducting applied research on highly sensitive detection of cyclic dipeptide and production of dehydrogenated cyclic dipeptide using this enzyme.
(2) We are preparing new antioxidant active substances by enzymatic conversion from olive secondary metabolites, and are studying their usage.
(3) We are conducting a detailed study of microbial enzymes that show characteristic transglycosylation activity.
(4) We are studying methods for treating woody biomass with



Search for chitinolytic enzyme inhibitors and analysis of their bioactivity

The epidermis of insects and the cell wall of filamentous fungi contain the polysaccharide chitin. Since the metabolism of chitin is essential for the growth of insects and filamentous fungi, the enzymes responsible for the metabolism of chitinase and β-N-acetylglucosaminidase are expected to be applied to pest control agents and antibacterial agents. We have conducted research to find inhibitors of these enzymes in microbial metabolites. We have discovered two novel β-N-acetylglucosaminidase (GlcNAcase) inhibitors with distinct specificity. We are trying to elucidate the molecular basis of their inhibitory specificity and to search further novel GlcNAcase inhibitors.

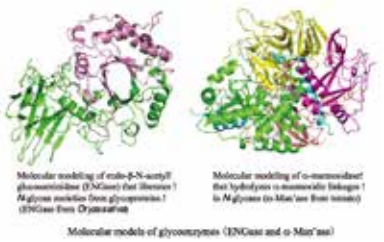


Research Area : Functional Glycobiochemistry

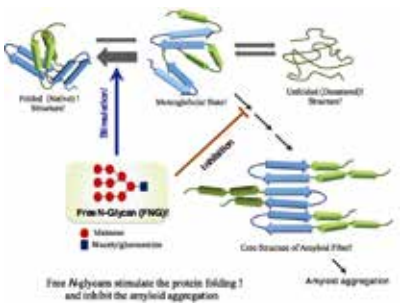
Prof.
KIMURA Yoshinobu

Functional analysis of oligosaccharides involved in plant differentiation, growth, and fruit maturation

In developing hypocotyls, seeds, and fruits at the maturing stage, free N-glycans (FNG) released from glycoproteins or glycopeptides occur at micro molar concentration. We analyze (1) the biofunctions of FNs involved in plant differentiation, growth, and fruit maturation, (2) chaperon-like functions involved in the protein-folding or -refolding mechanism. Based on the unraveled of the biofunctions of FNGs, we aim to establish a new plant biotechnology to control plant differentiation, growth, and fruit-maturation through artificial regulation of the expression of glycogenes (glycosidases, glycosyltrasferases, and glycan-liberating enzymes).



Analysis of in vivo / in vitro functions of free N-glycans (FNGs) responsible for correct protein folding and refolding



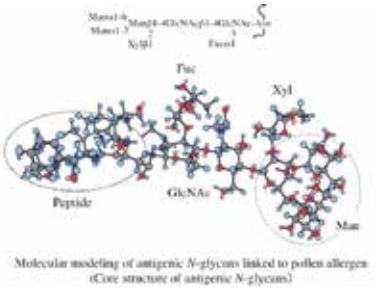
In plant and animal cells or tissues, the liberated asparagine-linked glycans (free N-glycans, FNG) ubiquitously occur. Recently we have found that these FNGs induce the correct protein folding or refolding of denatured or misfolded proteins at millimolar concentration. We analyze the chaperon-like activity of FNGs involved in the protein quality control system working in eukaryotic cells using biochemical and physiochemical strategies. We aim to establish a new concept of glycan function responsible for correct protein folding and apply the chaperon-like function to the development of glycol-reagents stimulating the correct construction of protein 3D structures.

Research Area : Functional Glycobiochemistry

Assoc. Prof.
MAEDA Megumi

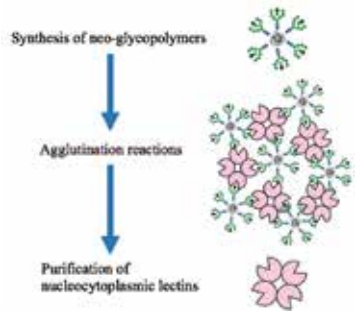
Analysis of the immunological activities of antigenic glycans of plant or insect origin

In many case, allergens of plant or insect origin are glycoproteins to which antigenic glycans are linked and these allergens are often referred as glycoallergens. We analyze the chemical structures and immunological activities of these plant glycoallergens. Recently, we have found that plant antigenic glycans suppress the production of Th2 type cytokine, IL-4, from Th2 immune cells. For the application of immunological activity of these plant glycans to the development of glycodrugs, we analyze their cellular immunological activities and synthesize neo-glycopolymers carrying the immunoactive glycans.



Molecular modeling of antigenic *N*-glycans linked to pollen allergen (Core structure of antigenic *N*-glycans)

Application of a neo-glycopolymer carrying multivalent N-glycopeptides for identification of nucleocytoplasmic lectins



Recently, several novel plant lectins localized in the nucleus and/or cytoplasm of plant cells have been reported, and some of them have induced the gene expression under biotic and/or abiotic stress condition. The endogenous ligands and the physiological role of these carbohydrate-binding proteins have not been identified to date. We have synthesized glycopolymers carrying multivalent *N*-glycopeptides to identify and characterize the nucleocytoplasmic lectins.

Research Area : Applied Enzyme Chemistry

Asst. Prof.
NEMOTO Michiko

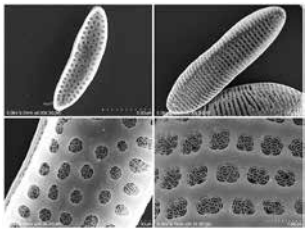
Understanding of molecular mechanisms of biomineralization

Biominerals are minerals formed by organisms. They possess various superior material properties derived from their structure and composition. Understanding biomineralization could contribute to the development of material science and nanotechnology. We are studying biomineralization using omics technologies.

Magnetite biomineralization in chitons

The denticle caps of chiton radular teeth consist of magnetite. The elucidation of magnetite biomineralization mechanisms in chitons could pave the way for developing novel environmentally benign processes for the production of iron oxide materials. To clarify the molecular mechanisms of magnetite biomineralization, we constructed de novo assembled transcriptome data from radular tissue of chitons for the first time. Furthermore, we identified the proteins that were specifically expressed in the mineralized teeth. Characterization of these proteins using genetic engineering techniques are ongoing.

Silica biomineralization in diatoms



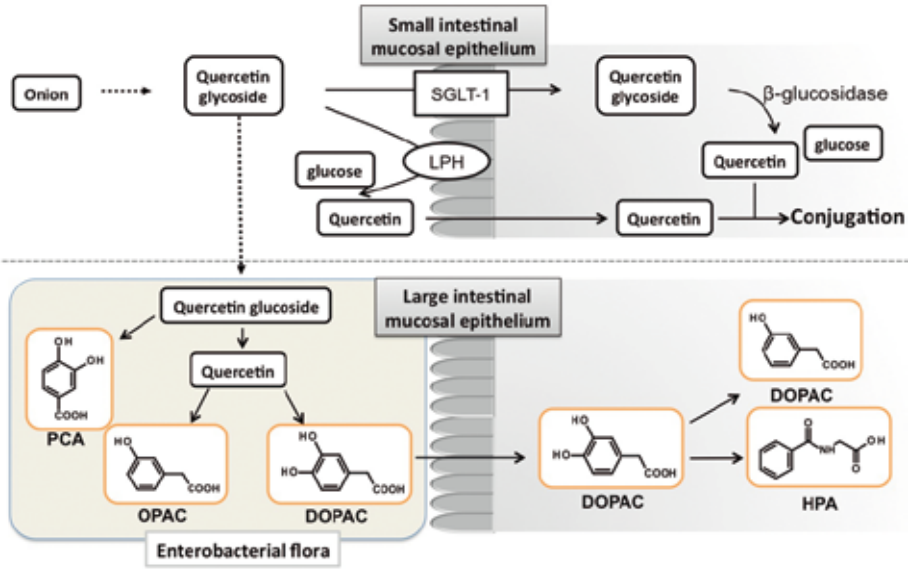
The beautiful geometric design of diatom silica cell walls have attracted many people over the years. Recently, it has been shown that diatom silica cell walls are not only beautiful but also useful in the nanotechnology field because of their many exceptional material properties. We are studying silica biomineralization in consideration of future nanotechnological applications.

Research Area : Food Biochemistry

Prof.
NAKAMURA Yoshimasa

Activation of endogenous defense mechanisms by food constituents and their metabolites by gut microbiota

Electrophilic substances in foods possess potential to exhibit various biological activities through transcriptional regulation of cytoprotective genes involved in cellular defense against biotic stresses induced by xenobiotics, reactive oxygen species, and alcohol. We have been focusing on food-derived electrophiles such as isothiocyanates, flavonoids, and phenolic acid metabolites of quercetin 4′-glucoside, the major polyphenol in onion. Modulating effects of these compounds on cytoprotective gene expression and the underlying molecular mechanisms are investigated by the forward chemical genetics approach to elucidate their physiological significance.



Research Area : Chemistry of Bio-signaling

Prof.
MURATA Yoshiyuki

Study on the molecular mechanisms that regulate environmental stress responses in plants

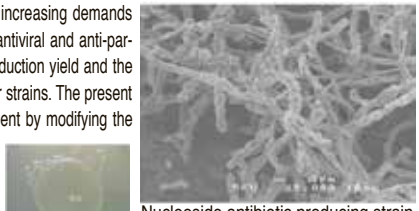
In nature, plants are exposed to a combination of a wide variety of environmental stresses. To sustain their growth, plants have developed robust mechanisms that integrate the stress signals and then output the optimal adaptation response. The long-term goal of our research is to uncover the molecular mechanisms of how plants achieve the signal integration and its conversion to the downstream response. In particular, our research focuses on stress signaling regulating stomatal movement. Stomatal pores, which are formed by pairs of guard cells in the epidermis especially of leaves, regulate gas exchange for photosynthesis and transpirational water loss. Guard cells can perceive various stimuli such as light, CO_2, pathogen infection, and various phytohormones such as abscisic acid, jasmonate, and salicylic acid, then transducing the inputs to a change in stomatal aperture. Using multidisciplinary approaches, we aim to reveal the detailed mechanisms of signaling cascading from stress sensing to stomatal aperture regulation in guard cells. We also study the basic mechanisms of heavy metal and salt stress responses in plants using model plants as well as cultured cells. Our research advance will contribute to develop new technologies that improve crop productivity and safety.

Research Area : Microbial Function

Prof.
TAMURA Takashi

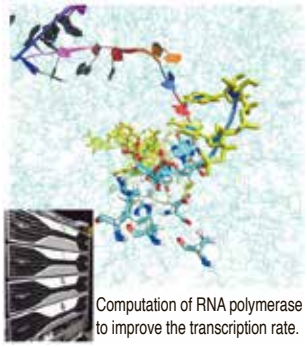
Frontiers of Nucleoside Antibiotics with Antifungal, Antiviral, and Antitrypanose Activities.

Nucleoside antibiotics comprise a group of microbial products, which has antifungal, antiviral and anti-protozoan activities. These antibiotics, mostly produced by *Streptomycetes* species as their secondary metabolites, can inhibit parasite-specific processes such as viral proliferation and protozoan-specific metabolism. Despite the potential utility and yet increasing demands for such powerful antibiotics, there are few successful utilization case of antiviral and anti-parasitic activity of the nucleoside antibiotics, due exclusively to the poor production yield and the difficulty in identifying the biosynthetic genes in the genome of the producer strains. The present research aims to develop an alternative strategy for production improvement by modifying the cellular machineries for transcription and translation to increase and maintain the biosynthetic enzymes without the need of cloning the biosynthetic genes. RNA polymerase genes and ribosomal genes are altered on the genome to increase and maintain the biosynthetic genes.



Nucleoside antibiotic producing strain *Streptomyces incarnatus* NRRL8087.

Engineering RNA polymerase based on Molecular Dynamics Simulation and Density Function Theory Calculation - QM/MM Estimation and Experimental Proof.



Computation of RNA polymerase to improve the transcription rate.

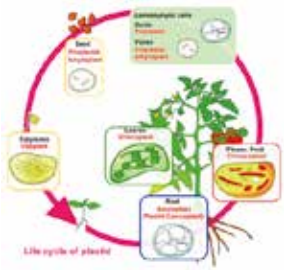
RNA polymerase (RNAP) has four conserved residues, which are collectively termed as *rif-1* cluster residues, in the β-subunit. Alteration of the *rif-1* residues by site-directed mutation very often results in production enhancement of the secondary metabolites. The residues are positioned to interact with the newly synthesized mRNA, and they can regulate the polymerization rate. Multiple combination of mutation can alter the interaction between the β-subunit and RNA chain, which is also computed by MD-modeling and Density Function Theory calculation. Computation gives the theoretical consequence of residue change in terms of interaction energy at the electronic levels, and experimental data gives clues on the most appropriate interaction for the highly enhanced production of the secondary metabolite .

Research Area : Plant Genetics and Physiology

Prof.
SAKAMOTO Wataru
Asst. Prof.
OKEGAWA Yuki

Photosynthesis and chloroplast biogenesis: Understanding to innovation

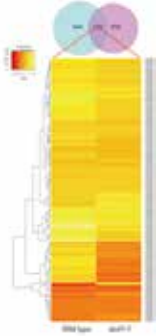
Plants perform photosynthesis in chloroplasts, where light energy is converted into chemical energy by a series of electrochemical reactions. In contrast, sessile land plants are exposed incessantly to excess light energy or harsh atmospheric environments that engender 'photodamage'. How do plants cope with such photosynthetic inactivation? What are the key elements to maintaining or even maximizing chloroplast functions?



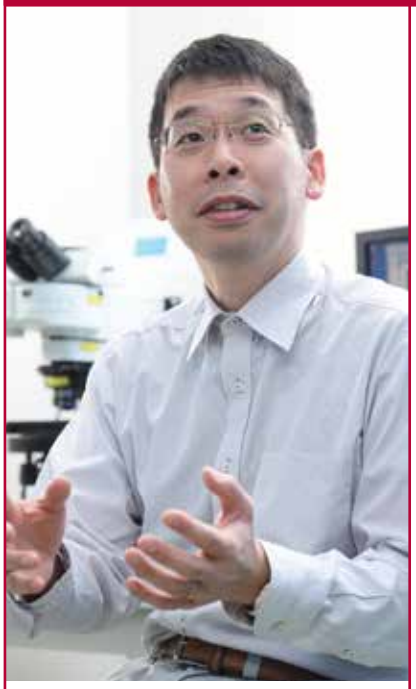
Our group studies various aspects of chloroplast development and photosynthesis. Through understanding of the factors involved in photoprotection and chloroplast function, we aim at improving crop productivity against atmospheric stress over the long term.

Ongoing projects in Plant Light Acclimation Research Group

1. Proteolytic machineries in chloroplasts
2. Photooxidative stress and quality control of photosynthetic proteins
3. Maintenance of chloroplast envelope through protection mechanism through VIPP1
4. Behavior of chloroplast DNAs during leaf maturation and senescence
5. Quantitative trait locus (QTL) controlling stay green in sorghum



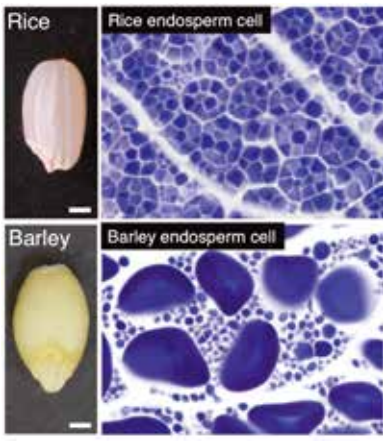
Research Area : Plant Genetics and Physiology



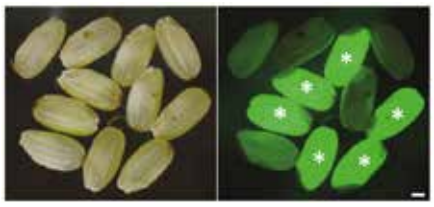
Assoc. Prof.
MATSUSHIMA Ryo

Dissection of the mechanism to determine starch grain morphology and Breeding new varieties with novel starch properties

Starch is a glucose polymer which plants synthesize as a photosynthetic product and is human energy source as a staple food. In addition, starch is used as food additives and industrial products (adhesives, printing improvers). Starch is synthesized as particles, so called “starch grains (SGs)” in plant cells.
The shape of SGs shows variations depending on plants species and limits the production efficiency and functionality of starch. However, details of the shape determination mechanism of SGs are not known. To understand the mechanism and to create new SGs with novel properties, I am now screening and analyzing rice and barley mutants defective in SG shapes.



Comparison of SGs of rice and barley. Endosperm sections are stained with iodine to visualize SGs.



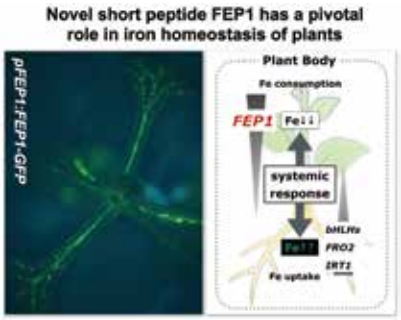
In addition to the genetic analysis, I also conduct live imaging analysis of SGs. In the left figure, transgenic rice seeds in which amyloplasts (organelle synthesizing SGs) are visualized with green fluorescent protein.

Research Area : Signaling Mechanisms

Prof.
HIRAYAMA Takashi

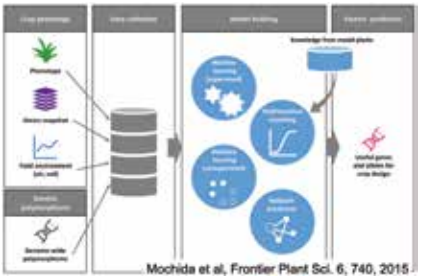
Molecular genetic studies on the mechanisms for stress sensing and response in plants.

As autotrophic sessile organism, plants have developed unique systems to regulate biological phenomena such as development, environmental stress responses, and reproduction process. To understand and manipulate the plant behavior, we have been trying to describe the regulatory system for these molecules, deciphering the information possessed by these plant signaling molecules by molecular genetic approaches using model plants such as Arabidopsis. In these years, we are investigating novel short-peptide factors involved in the regulation of iron homeostasis responding to environmental changes.



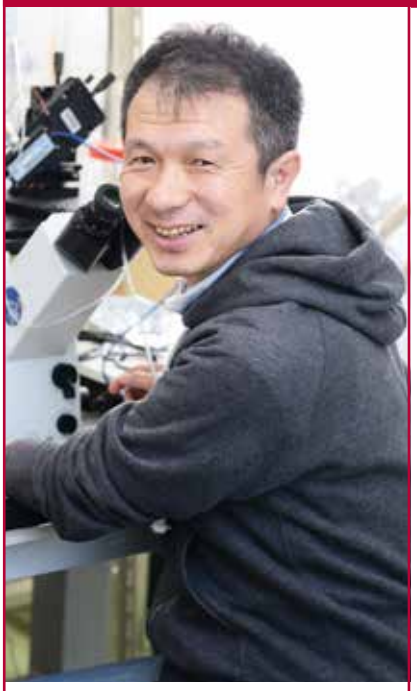
Establishment of data driven crop design technology.

It has been known that useful agronomical traits of crops are dependent on both the genetic factors the crop possesses and environmental factors the crop lives. Importantly, these two factors are not independent and affect each other in a complex manner.



We have been trying to identify the genetic factors and environmental factors critical to useful traits by describing the life-course dynamics in physiological status of field crops associated with the environment data. Using these isolated determinants, we successfully built models that can predict the agronomical traits at high accuracy. Such the models enable us to design the crops with suitable genetic factors to a given filed condition including the forecasted climates in the near future.

Research Area : Signaling Mechanisms



Assoc. Prof.
MORI Izumi

Study on Molecular Physiology of Stomatal Movement against Air Pollutants

Yield loss of crops due to airborne pollutants is estimated as 30-40% near future in Japan. Plants equip the mechanism to withstand such pollutants. One of the major mechanisms is elucidated as closing stomata to prevent the entry of gaseous toxicants. To gain insight into the molecular basis of plant response to airborne pollutant, I employ molecular genetic and physiological approaches to comprehend stress signaling mechanism of stomata.

Ion Dynamics Study of Stomata, Roots and Inside of Leaves.

Although plants seems calm, silent and static, it is not real. Plants are always active and dynamic. For example, stomata move every day, every minute; tendrils move spiral around and root architecture keeps changing. These movement of plants are more or less associated with the mobilization of ions. I am an expert in ion dynamics study through electrophysiological techniques. My main research focuses are Ca^{2+} ion transport in guard cells and CO_2 transport in mesophyll cells, which play crucial roles in photosynthesis under biotic and abiotic stresses.

Plant Hormone Quantification.

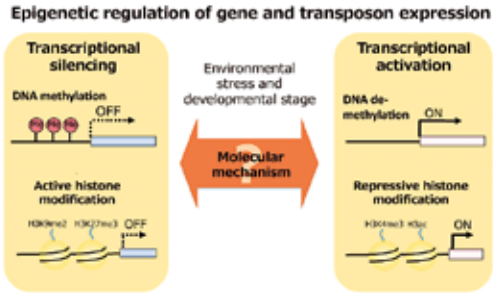
In addition to physiological analysis, chemical analysis using LC-MS is one of my missions as a stuff of Institute of Plant Science and Resources, Okayama University. I am taking a part of the comprehensive plant hormone quantification analysis group. Our group is having a large number of collaborators from all around the world.

Research Area : Signaling Mechanisms

Assoc. Prof.
IKEDA Yoko

Epigenetic regulation mechanisms of gene and transposon expression in plants

Genetic information is encoded in DNA base sequences. However, epigenetic information outside of the DNA sequence also has been found to play an important role in gene and transposon expression. Such epigenetic information including DNA methylation and histone modification is known to be affected by the stage of growth and changes in the environment. My research interests are: i) the molecular mechanism that controls epigenetic status in plants; ii) the ways in which epigenetic information is transmitted to the next generation; and iii) the study on the variety and the change of epigenetic regulation systems in plant evolution.



Analysis of transcriptional gene silencing mechanism in Arabidopsis

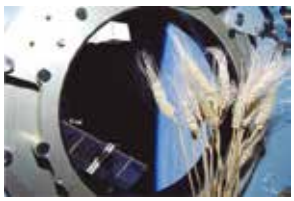
To reveal the mechanism of epigenetic gene silencing, we did mutant screening affecting transcriptional gene silencing in *Arabidopsis thaliana*, and recently identified new factors for transcriptional gene silencing. *Arabidopsis thaliana* is useful material for genetic analysis, but we also utilize several plant species for research e.g. barley, seaweed, and liverwort *Marchantia polymorpha* to analyze the function of epigenetic regulation in plant evolution.

Research Area : Plant Cytomolecular Biochemistry

Assoc. Prof.
SUGIMOTO Manabu

Genome-wide expression analysis of reactive oxygen species gene network in plants grown in long-term spaceflight

Spaceflight environment have been shown to generate reactive oxygen species (ROS) and induce oxidative stress in plants, but little is known about the gene expression of the ROS gene network in plants grown in long-term spaceflight. The molecular response and adaptation to the spaceflight environment of plants harvested after 27 days of cultivation onboard the International Space Station (ISS) have been measured using genome-wide mRNA expression analysis.

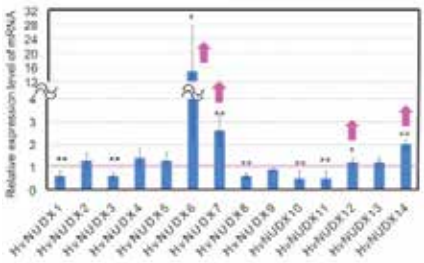


Crop grown in International Space Station (©NASA)

ROS network induced in plants grown in space (red arrows)

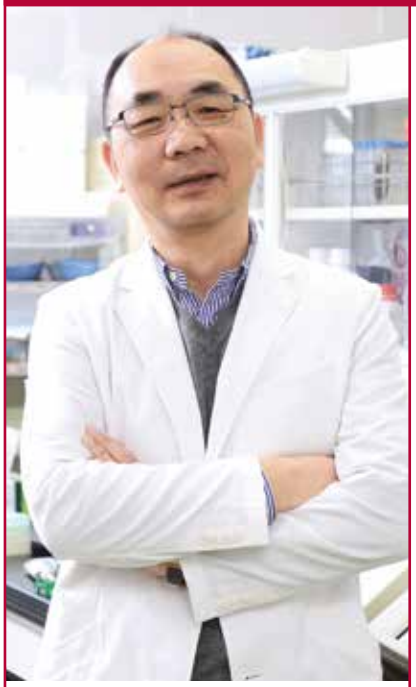
Gene expression analysis in plants exposed to UV irradiation

Plants should be necessary to self-supply foods when astronauts would stay during long-term space travel and habitation on the Moon and Mars. Thought the sunlight is the most importance to plants, UV presenting the sunlight can damage many aspects of plant processes at the physiological and DNA level. Especially UV-C, which is eliminated by the stratospheric ozone layer, is suspected to be extremely harmful and give a deadly injury to plants in space. The molecular response to UV irradiation of plants have been analyzed.



Expression level of genes in plants exposed to UV-C irradiation

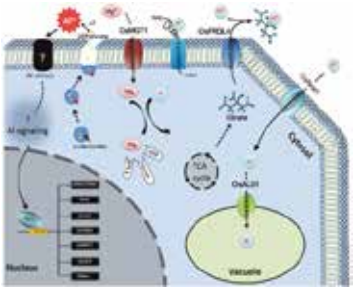
Research Area : Plant Stress Responses



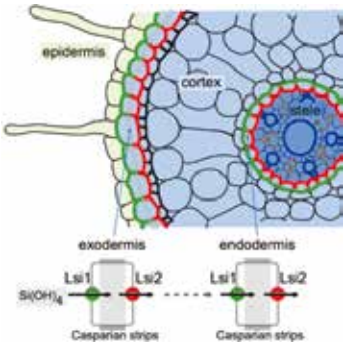
Prof.
MA Jian Feng

Molecular mechanisms of aluminum tolerance in plants

Aluminum (Al) toxicity is a major factor limiting crop production on acid soils. However, some plant species or accessions have evolved strategies to cope with Al. Rice is the most Al-tolerant species among small grain cereal crops. We identified a transcription factor for Al tolerance (ART1) and found that it regulates at least 32 genes implicated in Al tolerance. On the other hand, barley is the most sensitive cereal to Al toxicity, but there is a large genotypic difference in Al tolerance. We identified a major Al-tolerance gene in barley, HvAACT1. Furthermore, we found that high expression of this gene is acquired by a transposon insertion in its promoter.



Transport system of mineral elements in plants

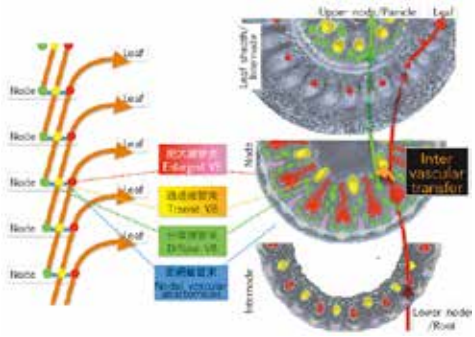


Mineral elements including essential, beneficial and toxic elements in soil affect both plant growth and human health. We are working on identification of transporters involved in uptake, root-to-shoot translocation and distribution/redistribution of these elements in plants. We have identified a number of transporters for Si, P, Mg, Mn, Zn, Cu, Fe, B, Cd and As. Especially, we found that rice has developed an efficient uptake system for mineral elements, which is mediated by both influx and efflux transporters polarily localized at the exodermis and endodermis of the roots. We also identified several transporter genes for accumulation of Cd and As in rice.

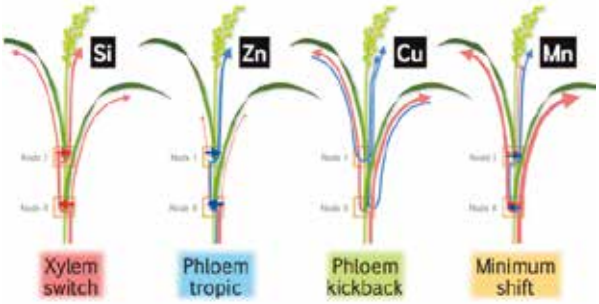
Research Area : Plant Stress Responses

Assoc. Prof.
YAMAJI Naoki

Mineral nutrients required for plant growth and development are taken up by the roots from soil solution, and then delivered to different organs and tissues depending on their requirements. In Poaceae, this selective distribution is mainly mediated in the nodes, which have highly developed and fully organized vascular systems. We found that “Inter-vascular transfer” of mineral elements from enlarged vascular bundles to diffuse vascular bundles is required for their preferential distribution to developing tissues and reproductive organs.



Studies on mineral distribution control systems in plants

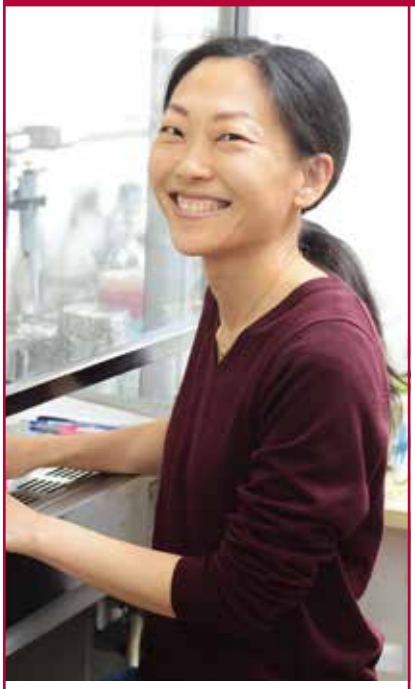


A number of transporters involved in this inter-vascular transfer processes have been identified mainly in rice. They are localized at the different cell layers and form an efficient machinery in the node. These findings will be applicable to improve productivity, nutritional value and safety of cereal crops.

Representative references

Yamaji N. et al. Reducing phosphorus accumulation in rice grains with an impaired transporter in the node. *Nature* 541:92-95. (2017)
Yamaji N. and Ma J.F. Node-controlled allocation of mineral elements in Poaceae. *Current opinion in plant biology* 39:18-24. (2017)

Research Area : Plant Stress Responses



Assoc. Prof.
MITANI-UENO Namiki

Studies on mineral transporter and its regulation mechanisms in plants

Plants are important for us, having been utilized as indispensable materials for, food, clothing and housing since ancient times. Therefore we couldn’t live without plants. I’m focusing on mineral transporters for healthy and high nutrient-efficient crop production.

>Molecular mechanisms of Si transport

Silicon (Si) is a beneficial element for plant growth, which can alleviate many stresses by accumulation in their shoots. However, Si content of the plants varies greatly with species, and only those plants that are capable of accumulating the element can receive benefit from it. Rice is one of major Si accumulating plants. I am focusing on the study about molecular mechanisms of Si uptake and accumulation in rice for applying the beneficial effects of this element in many other plants.

Wild-type rice and a low silicon accumulation mutant. Growth and yields in the mutant are extremely poor

>Identification of mineral redistribution transporters

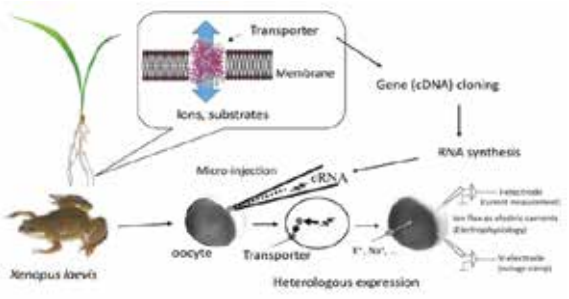
Plants require 14 mineral elements for their growth. These elements are taken up by the roots, translocated from the roots to shoots, followed by distribution/redistribution to different organs A number of transporters for uptake and translocation of mineral elements have been identified, however, most transporters involved in mineral distribution/redistribution remain to be identified. I am working on mineral redistribution systems in rice for efficient use of mineral elements.

Research Area : Plant Molecular Physiology

Prof.
KATSUHARA Maki

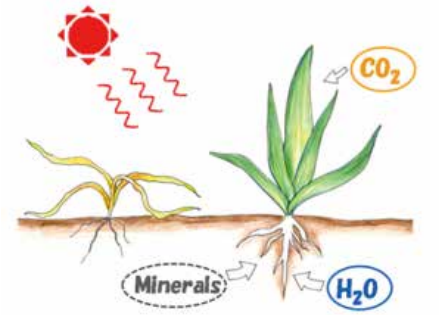
Water and ion transport in plants under salinity stress

Salinity stress is one of major abiotic stress that limit plant productivity in global agriculture. Salinity, usually high concentration of Na^+, reduces water and mineral uptake in plant. I study root hydraulic conductivity (Lp_r) using the root pressure chamber method, because regulation of Lp_r is important to prevent dehydration and to cope with osmotic imbalance in initial phase of salinity stress. As for plant ion transporters, cRNAs are injected into a frog *Xenopus* oocytes and their properties (ion selectivity and activation mechanism) are investigated electrophysiologicaly to reveal what and how transporters regulate ion flux under salinity stress.

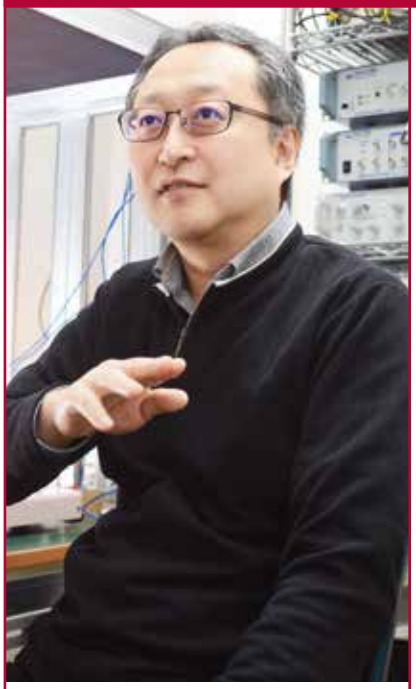


Aquaporins transporting water and low-molecular weight compounds

Aquaporins was first identified as a membrane protein exhibiting permeability for water when faced with an osmotic gradient. Now it is reported that several aquaporins facilitate the transport of not only water but also other low-molecular weight substrates such as glycerol, ammonia, silicic acid, arsenite, boric acid, and carbon dioxide. I study rice and barely aquaporins to improve plant growth and stress tolerance via aquaporin functions.



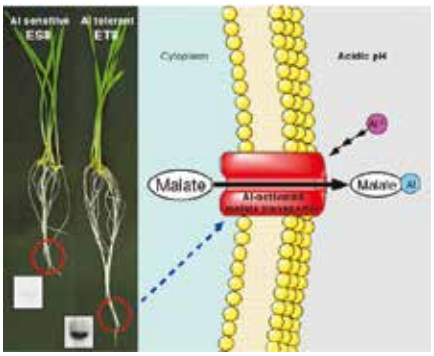
Research Area : Plant Molecular Physiology



Assoc. Prof.
SASAKI Takayuki

Research on function and structure of plant-specific malate transporters

Aluminum (Al) ion is a major inhibitory factor of plant growth in acidic soils which comprise almost 40% of the world arable land. Toxic Al cations (Al^{3+}) rapidly inhibit root growth and prevent subsequent uptake of water and nutrients. The mechanisms of Al toxicity and tolerance are analyzing using a cultured cell system and whole plants. Especially Al-tolerance mechanism, wheat *ALMT1* gene encoding Al-activated malate transporter was found by our group, and demonstrated as Al-tolerant as well as acidic-soil tolerant gene, for the first time in crops. In addition, since the *ALMT* gene and its homologues have been found only in plants, the diversity of physiological functions for individual *ALMT* genes was elucidated as recent studies. The molecular details of the structure and functions and the expression mechanisms of these transporters are now studied.



A gene encoding aluminum (Al)-activated malate transporter (*ALMT1*) regulates Al tolerance of wheat.
It was previously shown that Al tolerance in wheat (*Triticum aestivum* L.) is correlated with the Al-activated efflux of malate which chelates and detoxifies Al cations around root apices. To isolate the gene involved in this mechanism, Sasaki et al. (2004, Plant J.) examined a pair of near-isogenic wheat lines that differed in Al tolerance at a single genetic locus, and found a gene which shows greater expression in the root apices of ET8 (the Al-tolerant line) than that of ES8 (the sensitive line), as depicted in the photograph. The gene is named *ALMT1* which encodes a novel transporter protein facilitating the Al-activated efflux of malate and is a major Al-tolerant gene of wheat.

Research Area : Plant Molecular Physiology

Asst. Prof.
UTSUGI Shigeko

Study of factors related to seed dormancy and germination

Pre-harvest sprouting (PHS) is one of the most serious issues affecting cereal cultivation because it reduces the quality of crops. In some countries including Japan, high humidity and low temperature during the late ripening and harvesting of wheat seeds damages grains due to PHS. Therefore, the mechanisms underlying seed dormancy and germination need to be elucidated in more detail. I am analyzing some genes and proteins, MOTHER OF FT AND TFL1 (MFT) and bZIP transcription factors, which were upregulated after physiological maturity in dormant seeds.

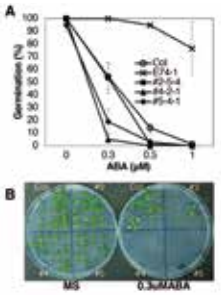
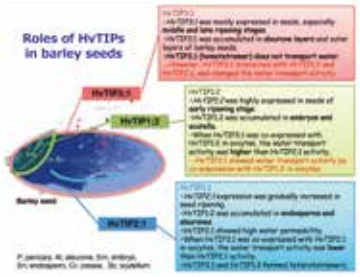


Figure 4. ABA sensitivity of WT and T4 seeds of TaABF over-expressed transformants in Arabidopsis.

Mechanisms of the water control by plant aquaporins



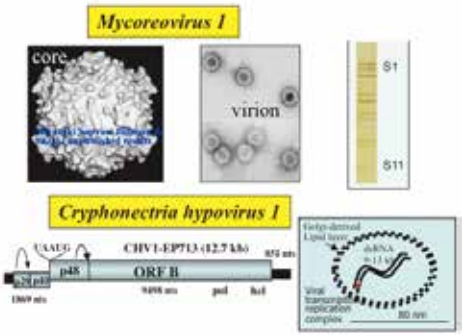
Most seeds form an embryo and store starch and nutrients, which are necessary for germination and development at the early stage, and are then desiccated and maintained under desiccated conditions until germination. This suggests the existence of some mechanisms to control the inner water condition of cells during the development and subsequent desiccation of seeds. I focus on water channels, especially tonoplast intrinsic proteins 3 (TIP3s), which highly accumulate in seeds during seed development and desiccation, and analyze its expression patterns and the regulation mechanisms of water transport activity.

Research Area : Molecular Virology

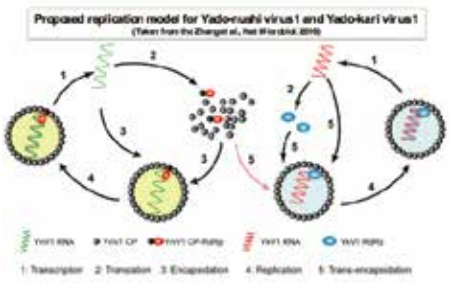
Prof.
SUZUKI Nobuhiro

Study on the interaction among plant/fungus/virus toward virocontrol of phytopathogenic fungi

Using two combinations, Chestnut/chestnut blight fungus/mycoviruses and fruit trees/root rot fungi/mycoviruses, viral replication and symptom expression were investigated at the molecular and cellular levels. Obtained knowledge and achieved technical advance will be integrated into into virocontrol (a form of biological control using viruses) of the plant pathogenic fungi.



Research on neo-lifestyle of fungal viruses



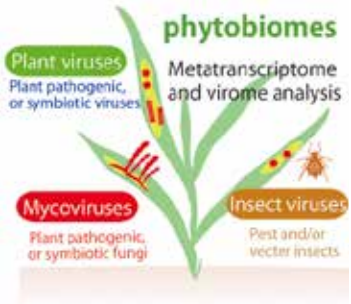
Several viruses, challenging the concept or rules of viruses, have been discovered from lower eukaryotes. The objective of this project is to reveal the unique neo-lifestyle of Yado-nushi virus 1 (YnV1) and Yado-nushi virus 1 (YnV1) newly discovered from an important pathogen of perennial fruit trees, *Rosellinia necatrix*. We show that YkV1 highjacks the capsid of YnV1 to heteroencapsidate YkV1 genomic RNA and replicase and use it as the replication site. Furthermore, viruses with similar mutualistic virus/virus interactions will be found in other eukaryotic organisms to show the generality of the neo-lifestyle.

Research Area : Molecular Virology

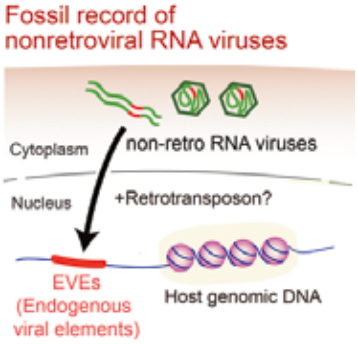
Assoc. Prof.
KONDO Hideki

Study on viromes in crop phytobiomes

Phytobiomes refer to the complex networks between plants and their associated communities of organisms including bacteria, fungi, viruses and invertebrates. Phytobiomes are becoming increasingly recognized as important factors in plant health and productivity, but in particular, little is known about the diversities of virus communities in agricultural cropping system. Taking advances of the next generation sequencing and metagenomics, our group studies on viromes in fungi and insects that are associated with crop plants. We aim to find out whether these viral communities influence their hosts and promote the health and growth of crop plants.



Study of non-retroviral RNA virus-like elements in the genome of the plants, insects and fungi



The availability of genome sequences of a large number of eukaryotes has led to the discovery of endogenous non-retroviral RNA virus-like elements, also known as endogenous viral elements (EVEs). These elements are considered as fossil of RNA virus integrated into host genomes by as-yet-unknown mechanisms. To gain deeper insight into the long-term viral evolution and host-virus coevolution, our research is focused on identification and analysis of the EVEs in the genome of the plants, insects and fungi.

Research Area : Molecular Virology

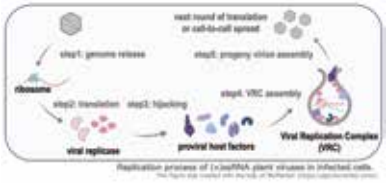
Assoc. Prof.
HYODO Kiwamu

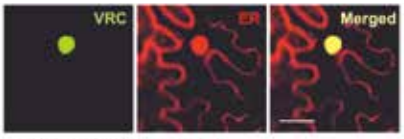
Plant-Virus interactions

Plants are constantly attacked by various kinds of pathogens and pests, resulting in 40% yield losses annually. Among plant pathogens that pose a major threat to sustainable agriculture and global food security, viruses account for nearly half of the plant endemics and cause estimated economic losses more than US$30 billion annually. Positive-sense single-stranded (+ss)RNA viruses are the most abundant in plant viruses and cause the economically important diseases in major vegetable and field crops worldwide. The vast majority of plant (+)ssRNA viruses are very simple entities comprising a nucleic acid genome encoding from 4 to 11 viral proteins needed for genome replication, local and systemic spread within the host plant, and transmission to a new host. Despite the simple nature of these pathogens, there is still much to be learned about how they interact with their hosts and cause disease. Understanding the molecular mechanisms underlying pathogenicity of (+)ssRNA viruses is a crucial step towards the design of effective strategies for crop protection.

In general, virally encoded proteins have a multifunctional property with the potential to interact with several virus- and host-derived molecules, thus creating a complex web of molecular interactions in infected cells. Because of the limited number of viral-encoded proteins, (+)ssRNA viruses need to subvert the host cell machinery for their own vital functions, ultimately creating a cellular environment favorable to the infection. For this purpose, (+)ssRNA plant viruses co-opt an array of host-derived factors (referred to as proviral host factors) to establish viral infection, in which viruses remodel their functions to facilitate every step of the viral life cycle. The identification of the global landscape of plant-virus interactions at the molecular level is key to understand how the virus hijacks the host cell to facilitate infection.

Our research aims at deciphering the molecular network of plant-virus interactions using (+)ssRNA plant viruses as models. Discoveries in this area will provide insight into host-virus interactions as well as identify new breeding targets for the development of virus-resistant crops.

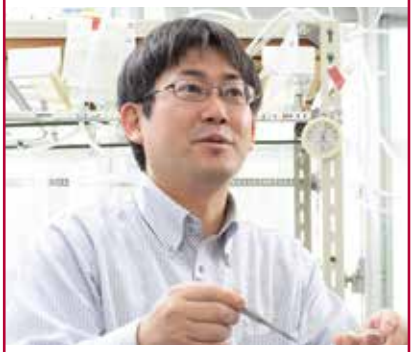




VRC: viral replication complex
ER: endoplasmic reticulum

Research Area : Plant-Insect Interactions

Prof.
GALIS Ivan

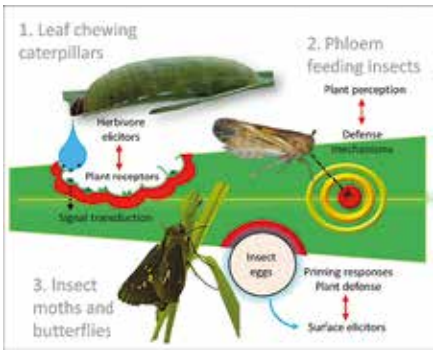


Assoc. Prof.
SHINYA Tomonori

Understanding of metabolic defense against herbivores in plants

Plants activate powerful protective shield against feeding herbivores that involves biosynthesis of various toxic phytoalexins. While spectrum of phytoalexins in plants is vast, their biosynthesis and regulation during herbivory are less known. We use monocot plant models, including rice and sorghum, to identify novel metabolic patterns associated with herbivory. We look for transcriptional regulators involved in the regulation of biosynthetic genes for these compounds, in particular those induced in response to herbivore attack. We also study the role of plant hormones as secondary messengers in defense signaling pathways against herbivores.

Research on perception of herbivory in plants



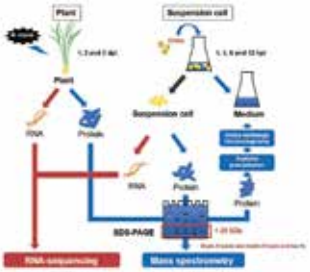
The strength of plant defense largely depends on early detection of elicitor molecules from herbivores which are deposited in plant wounds during feeding. As the number of identified elicitors is still limited, we aim identification of novel elicitors using rice plants and their herbivores as our model systems. We develop efficient bioassays for rapid detection and isolation of novel compounds, use biochemical techniques for their characterization, and intact plants for functional analyses of these novel herbivory-associated molecular patterns (HAMPs).

Research Area : Plant-Pathogen Interactions

Prof.
KAWANO Yoji

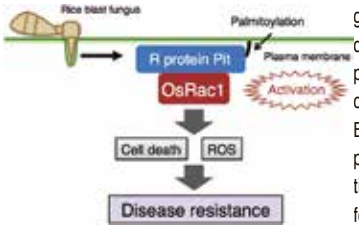
Involvement of phytocytokines in rice immunity

Plants cleverly regulate their immunity by secreting endogenous peptides called plant cytokines (phytocytokines). We believe that understanding and optimizing phytocytokine signaling and their networks will improve plant immunity, and we are conducting this research. Recently, we have established a multi-omics pipeline to isolate potential phytocytokines in rice and identified 236 endogenous secreted peptides that were induced during the disease resistance response (Plant Biotech J 2020). These included cytokine-like peptides such as the cysteine-rich RALF7, the post-translationally modified PSK4, and a novel family of IRPs that do not contain any known domains. Further analysis revealed that IRPs do indeed have cytokine activity and act as positive regulators of resistance to blast fungus, the most important pathogen of rice (bioRxiv 2021).



Effector-triggered immunity through small GTPase OsRac1

Resistance (R) proteins are crucial intracellular receptors that detect attacks by insects and invasion by various pathogens, including fungi, bacteria and viruses. However, the signaling molecules which mediate R protein-induced immune responses are not yet fully understood. We have previously shown that an intracellular switch, the small GTPase OsRac1, is a master regulator controlling immunity in rice (Plant Cell 2016, Curr Genomic 2016, FPS 2014, COPB 2013, Rice 2010). However, the mechanism by which OsRac1 receives signals from the immune receptors and becomes activated has remained unclear. Thus, we explored OsRac1-binding proteins and identified the R protein Pit, which is an immune receptor for rice blast fungus, a prominent microbial disease of rice. Through various analyses, we demonstrated that OsRac1 functions as a molecular switch, controlling ROS production and hypersensitive cell death (CHM 2010) and a GDP/GTP exchanger OsSPK1 mediates the activation of OsRac1 by Pit1 (PNAS 2018). Besides, we have found that anchoring Pit to the plasma membrane through palmitoylation, a type of lipid modification, is required for Pit-induced activation of OsRac1 on the plasma membrane (JBC 2014). Our work has therefore revealed the signaling pathway of the R protein Pit through OsRac1.



Research Area : Plant-Environmental Microbiology

Assoc. Prof.
TANI Akio

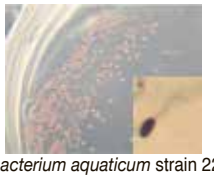
Lanthanide-dependent enzyme and motility in plant-associating methylotrophic bacteria

Plant emit large quantities of methanol through stomata as a result of their growth and pectin degradation. Methanol can be a good nutrient for bacteria and methanol-utilizing (methylotrophic) bacteria predominate on the aerial plant surface (phyllosphere). We focus on their methanol metabolism and symbiosis with plants.

Methylobacterium species are commonly found in phyllosphere, and they can promote plant growth. They have methanol dehydrogenase (MDH) to oxidize methanol. Not only calcium-dependent MDH encoded by *mxaF*, recently it was found that lanthanide-dependent MDH is also encoded by *xoxF* in the genomes of *Methylobacterium* species. This is the first enzyme described to date, to contain lanthanide. We investigate the mechanism of expression switching between these MDHs, depending on the availability of lanthanide.

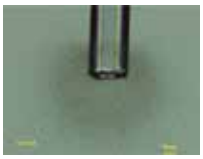
We also study molecular mechanism of the motility and chemotaxis in methylotrophs, which is important for the bacteria to find and colonize plants. The chemotaxis is also affected by the carbon source and lanthanide.

We have found new methylotrophic bacteria belonging to novel genera. They have been isolated from rice rhizosphere using lanthanide as an essential cofactor. They are named as *Oharaeibacter diazotrophicus* SM30 and *Novimethylophilus kurashikiensis* La2-4. Thus, lanthanide can be used for isolation of bacteria that contain *xoxF*, which can be found in many so-believed non-methylotrophic bacteria and novel bacteria.



Methylobacterium aquaticum strain 22A

Strain 22A adhering plant root hair



Strain 22A chemotaxis toward methanol

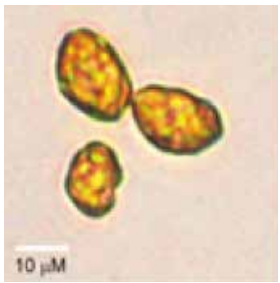
Novimethylophilus kurashikiensis La2-4

Research Area : Plant-Environmental Microbiology

Assoc. Prof.
UEKI Shoko

Study on dynamics of Phytoplankon in environment

Our group focuses on the study of *Heterosigma akashiwo*, a unicellular alga that forms harmful algal bloom (commonly termed 'red tide') . Algal bloom is typically caused by aberrant propagation of a single species, resulting in its predomination in the local population. While environmental factors including temperature and eutrophication are linked to bloom, the precise mechanism of its formation process is still obscure. We isolated a bacterial strain, *Altererythrobacter ishigakiensis*, a member of the class *Alphaproteobacteria*, that promotes growth of *Heterosigma akashiwo*.This is the first example of selective growth promotion of *H. akashiwo* by a marine bacterium, and may exemplify importance of symbiotic bacterium on algal bloom forming process in general.



A bloom causative phytoplankton, *Heterosigma akashiwo*

Study on interaction between a giant doube-stranded DNA virus and its host

HaV infect and lyse its host, *Heterosigma akashiwo*. The virus was identified as a bloom terminating factor.

H. akashiwo bloom is known to be terminated by algicidal bacteria and viruses. *Heterosigma akashiwo virus* (*HaV*) was identified as one of such bloom-terminating factors. We completed the sequencing of its genomes. The virual genome was characterized to be a linear double stranded DNA (dsDNA), with an estimated size of ˜290 kbp. It is a member of *Phycodnaviridae*, one of the viral families regarded as "giant dsDNA viruses" that possess genomes larger than several hundred-kbp in size.

We are particularly interested in studying about the infection mechanism of *HaV* at cellular and molecular level. The study will provide insights into infection strategies of a giant dsDNA virus, and the molecular mechanism of a major environmental phenomenon, bloom termination.

Research Area : Plant Diversity Analysis

Prof.
SATO Kazuhiro

Preservation and application of genetic and genomic resources in barley

Ca. 15,000 accessions of wild and cultivated barleys and a wide range of experimental strains are preserved with a support from the National Bioresrouce Project. Genomic libraries and extensive cDNA resources have been developed for genomic analysis of barley which contributed to estimate gene regions on the draft barley genome sequence published in 2012. These genetic and genomic resources are used to identify agriculturally important genes on barley genome. We also found that barley and diploid wheat shared the same genomic structure and barley can be used as a diploid model of the Triticeae species, including wheat, barley and rye.

Gene isolation in barley

The study focuses on isolation and characterization of genes controlling industrially important traits using the genome diversity of barley. A recent example is a gene corresponding for barley seed dormancy (*Qsd1*), which is associated with pre-harvest sprouting and malting for brewing beer. Our analysis using a wild barley accession harboring a strong grain dormancy revealed novel insight into the genetic mechanism regulation grain dormancy in barley (Sato et al. 2016 Nat. Commun.).
The orthologous genes are also existed in wheat genomes which will be important to control seed dormancy in wheat.

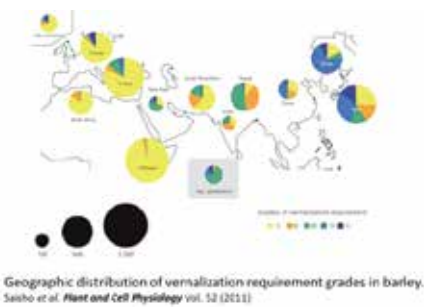
Research Area : Plant Diversity Analysis

Assoc. Prof.
SAISHO Daisuke

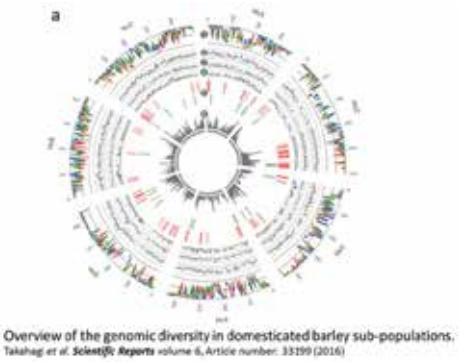
Study on genetic diversity of crop species toward achieving sustainable crop productivity

Genetic diversity of target species is indispensable sources to breed new crop varieties to overcome food shortages under global environmental changes and population explosions. IPSR preserves more than 10,000 barley germplasm as not only for the research materials for plant science but also future resources to improve this crop species. The aims of our seed-bank activity as well as our research projects are to grasp the degree of the variation of traits associated with stress tolerance and 'high-yield' productivity and to understand genetic structure of the trait for mining the phenotypic diversity.

Deciphering the genetic diversity of domesticated barley spreading the entire world, we are evaluating agronomic traits such as vernalization requirement and salt tolerance at the germination stage. Genomic variation of the barley materials is explored using the next generation sequencing (NGS) technologies to make advances in our barley domestication history research. To uncover the genetic structure of the agronomic traits, multiple mapping populations such as recombinant inbred lines (RIL), chromosome segment substitution lines (CSSL) and nested association mapping population (NAM) are also developing, and the quantitative trait loci (QTL) corresponding to the agronomic traits are identifying.

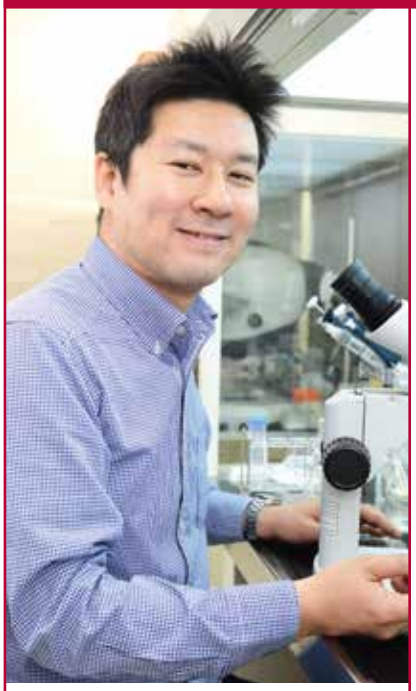


Geographic distribution of vernalization requirement grades in barley.
Saisho et al. *Plant and Cell Physiology* vol. 52 (2011)



Overview of the genomic diversity in domesticated barley sub-populations.
Takahagi et al. *Scientific Reports* volume 6, Article number: 33199 (2016)

Research Area : Plant Diversity Analysis



Assoc. Prof.
HISANO Hiroshi

Identification of the genes responsible for transformation amenability in barley

Different plant cultivars of the same genus and species can exhibit vastly different genetic transformation efficiencies. However, the genetic factors underlying these differences in transformation rate remain largely unknown. In barley (*Hordeum vulgare*), 'Golden Promise' is the most useful and well-studied cultivar for genetic transformation. By contrast, cultivar 'Haruna Nijo' is recalcitrant to genetic manipulation, although numerous genomic resources have been developed for this haplotype. Recently, we identified three major genomic regions on chromosomes 2H and 3H in barley important for successful transformation with *Agrobacterium*, utilizing the 'Haruna Nijo' × 'Golden Promise' F_2 generation. We termed these loci as *Transformation Amenability* (*TFA*) responsible for *Agrobacterium*-mediated transformation.

Fig. Green shoots regenerating from callus of barley

The genomic regions identified herein likely include necessary factors (i.e. regeneration from callus) for *Agrobacterium*-mediated transformation in barley. The potential to introduce these loci into any haplotype of barley opens the door to increasing the efficiency of transformation for target alleles into any haplotype of barley by the *TFA*-based selection method. Now we are trying to isolate the genes responsible for *TFAs*.

Genome editing in barley

Genome editing is a new technology of genetic engineering in which DNA is inserted, replaced, or removed from a target genome sequence using artificial restriction enzymes (nucleases). We are now developing a method of mutagenesis by the Clustered Regularly Interspaced Short Palindromic Repeats /CRISPR-associated proteins 9 (CRISPR/Cas9) or other techniques for future breeding and functional genomics in barley.

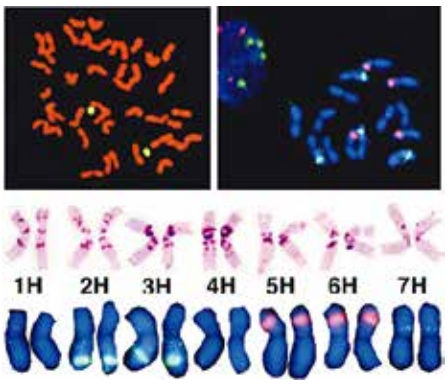
Research Area : Plant Functional Genomics

Prof.
TAKETA Shin

Molecular dissection of beneficial genes in barley

Barley is typically characterized by grains with inseparable chaffs. A single mutation event produced a free-threshing variant, called naked barley, about 8,000 years ago somewhere in the Near East. We clarified the genes controlling naked caryopsis (*nud*), which is suitable for food rich in soluble dietary fiber (*wax.b*). We are also interested in photosynthesis of non-foliar tissues, such as awns and spikes for improved productivity and quality. Using short awn (*lks2*) mutants and white spike (*albino lemma 1*) mutants, we are clarifying their contribution to photosynthesis and grain yield in barley.

Chromosome manipulation of wheat with introduced barley segments

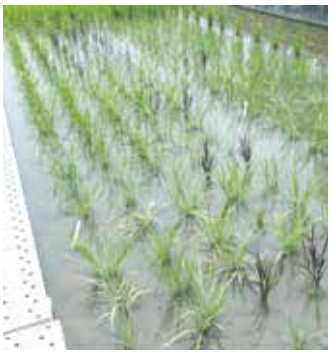


Through intergeneric hybridization between wheat and barley, we aim to produce unique wheat lines with introduced tiny barley chromosome segments with useful genes. These target genes are expected to confer higher dietary fiber content in seeds and improved disease resistance.

Research Area : Integrated Genomic Breeding

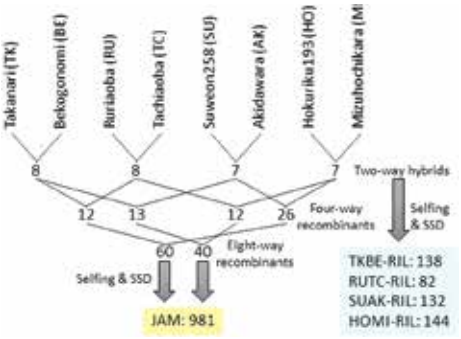
Prof.
YAMAMOTO Toshio

Development of remote cross breeding in rice via polyploidization



For breeding of super rice varieties with useful new genes, it is important to promote allelic exchange in existing cultivars by crossing them with wild or genetically remote cultivars. However, hybrids are rarely obtained from such distant crosses due to multitude of reproductive barriers. Interestingly, we found a fertile tetraploid progeny derived from anther culture of Asian rice cultivar, *O. sativa*, and African rice cultivar, *O. glaberrima*. Using genomic and phenotypic analyses, we now aim to clarify mechanisms involved in recovery of seed set in these plants. Furthermore, we hope to establish a novel remote cross breeding strategy in rice that overcomes reproductive barriers by introduction of polyploidization and haploidization.

Genetic dynamics in rice multiparent cross population

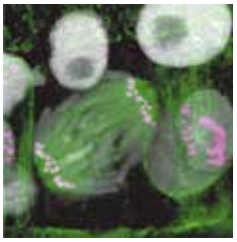


The expansion of genetic diversity in crossed populations is essential for faster and more efficient crop improvements. To overcome a limiting factor of biallelic gene combinations in rice breeding that depends on classical 2-way crosses, we developed a new multiparent population using 8-way cross strategy. By comparing genomic and phenotypic dynamics of this population, with those found in usual 2-way populations or parents, we aim to demonstrate the usefulness of multiparent populations for genetic improvement and development of novel breeding approaches in rice.

Research Area : Integrated Genomic Breeding

Assoc. Prof.
NAGAKI Kiyotaka

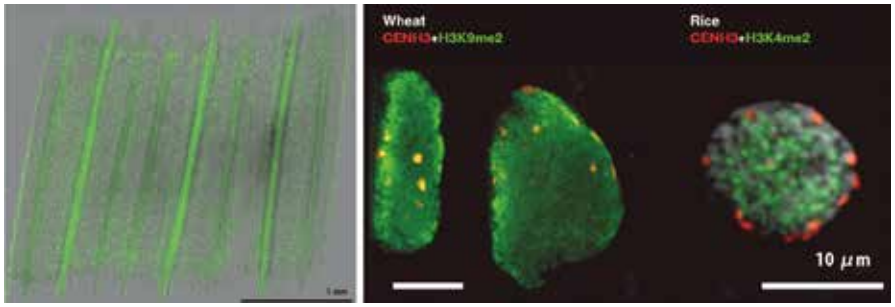
Analyses of kinetochore components of plant and its applications



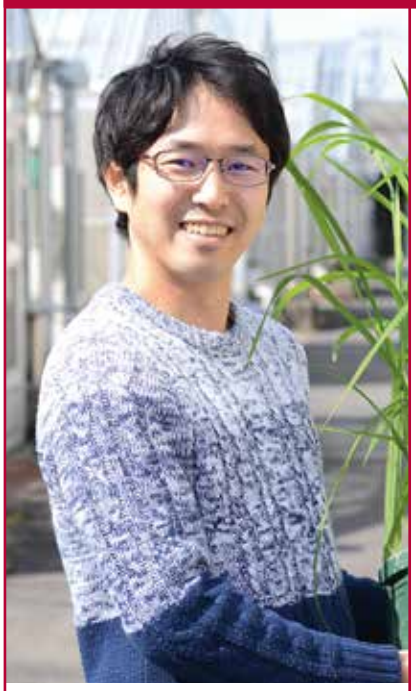
We have been conducting molecular cytogenetic studies on the structure and function of nuclei and chromosomes using plant species. Kinetochores have been our main research subjects among functional chromosomal elements. We have been conducting basic research on the kinetochores, and have identified kinetochore components from various plant species including many crops. Additionally, we have conducting applied research including “construction of plant artificial chromosome (chromosome vector)” and “haploid production” using knowledge of the basic researches.

Analyses of epigenetic status in plants

Epigenetic regulation plays important roles in all aspects of plant life activities including development and stress responses. Epigenetic modifications of individual cells in plant organs/tissues are considered to be individually controlled, but it is difficult to know how each cell is modified by current methods. In order to solve this problem and to obtain epigenetic modification information of individual cells, we are developing epigenetic modification analysis methods using immunohistochemical staining, which provides a bird's-eye view and single cell-level resolution keeping positional information of individual cells in organs/tissues.



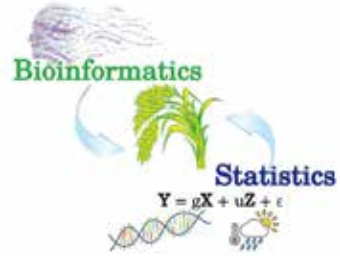
Research Area : Integrated Genomic Breeding



Asst. Prof.
FURUTA Tomoyuki

Boosting up crop breeding by integrated bioinformatics and statistical genetics

Along with drastically changing our lives, computers have also brought a paradigm shift in plant breeding. “Genomic breeding” is a state-of-the-art method which integrates genome-wide genotype information to model and predict phenotypic variation in populations. Although modern computer-based methods have strong potential for accelerating the development of new varieties, statistical models used in the method still need improvements to capture in detail events happening in real nature. At present, we try to integrate all useful environmental and biological data into new statistical models for genomic breeding that will allow accurate phenotype prediction within relatively small datasets. We apply a large variety of modeling methods that also include machine learning strategies. We hope that our work will boost up breeding in the future, helping to overcome the global shortage in food production experienced worldwide.



Exploring genetic diversity for discovery of novel beneficial genes and improved crop productivity

In addition to methodological approaches, we also use real plants to discover novel genes leading to practical improvements of rice. Currently, African cultivated rice *Oryza glaberrima* is our main genetic target and source for variety of stress tolerance-related genes. In particular, we hope that *O. glaberrima* will provide us with beneficial genes to promote rice yield even under harsh environments that spread as a result of global warming in the current era.

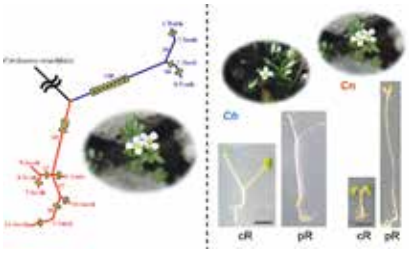
Research Area : Plant Diversity and Evolution

Assoc. Prof.
IKEDA Hajime

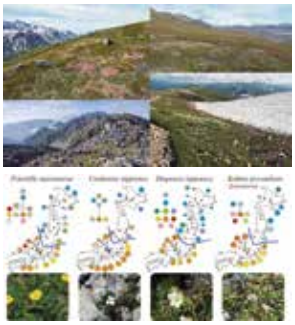
Evolution of photoreceptors

Modifying sensitivities to environmental signals is one of fundamental mechanisms for plants to optimize adaptive responses to environmental differences and lead to their diversification on the earth. Since photoreceptors play pivotal roles for plants to sense environmental signals and adjust their physiological responses such as germination and flowering, natural variations on photoreceptors are possibly responsible for such adaptive evolution in plants.

By focusing on phytochromes, we performed multiple approaches including molecular evolution, plant physiology, and genetics and attempt to (1) explore natural variation on phytochrome genes, (2) investigate physiological as well as phenotypic changes that were conferred by amino-acid changes on phytochromes, (3) unravel molecular mechanisms underlying phenotypic variations.



Phylogeography of alpine plants and molecular basis of adaptation to regional environments



Alpine as well as arctic-alpine plants have specifically extensive ranges in the northern hemisphere and plausibly encounter various environments at some parts of their ranges. We are interested how alpine plants adapt to such various environments.

By conducting phylogeographic studies, (1) we attempt to examine whether adaptation is responsible for genetic changes or phenotypic plasticity. If genetic changes are responsible for adaptive divergences, we have two further questions: (2) what kind of genes are important for adaptive divergence and (3) is there any mechanisms (genes) that are shared across various species.

In addition to these evolutionary interests, we are interested in how alpine communities have been established following the past climate changes, especially glacial and interglacial cycles during the late Pleistocene.

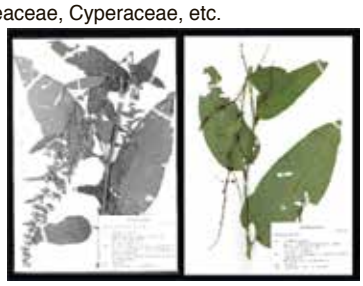
Research Area : Plant Diversity and Evolution

Asst. Prof.
YAMASHITA Jun

Study on taxonomic reevaluation and conservation of wild plants

Previous plant taxonomic systems based on morphology had often disagreed with the molecular phylogenetic trees. I have advanced taxonomical reevaluation based on morphology and molecular phylogeny on family Asparagaceae, Tofieldiaceae, Dioscoreaceae, Cyperaceae, etc.

For conserving local populations of endangered plant species, I am investigating their fluctuation, and studying on hybridization and genetic disturbance of the species. For ex-situ conservation, frozen seeds from the local populations of endangered plants have been preserved. For example, I have surveyed a lot of wild populations of Rumex nepalensis subsp. andreaeanus in Okayama and adjacent area, and found new hybrids of the subspecies.



Genetic resources of wild plants

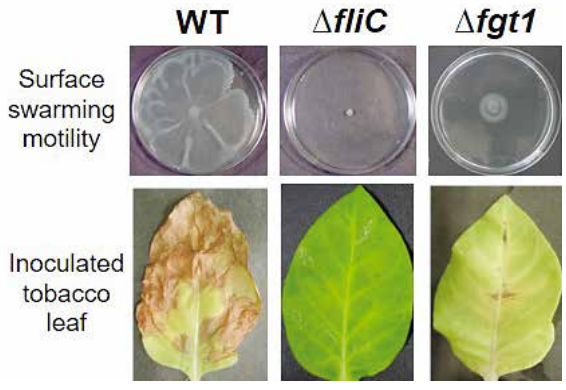
About 17,000 frozen seed accessions of 3,500 wild plant species from wild populations are available for scientific studies. Those are not guaranteed for survival rate. Exchanging MTA is needed before using the seeds. An herbarium is also available for studies on weekdays. About 80,000 specimens of 6,000 wild plant species from Japan and other countries have been preserved under APG system. They include various weeds from the world, naturalized plants in Japan, endangered species, plants of Ryukyu, and so on. About 30,000 dried seed specimens are also available. Please contact me (junyama@okayama-u.ac.jp) to access the genetic resources and herbarium.

Research Area : Genetic Engineering

Prof.
ICHINOSE Yuki

Role of flagella, flagellin glycosyation and flagella-mediated chemotaxis in virulence of *Pseudomonas syringae* pv. *tabaci* 6605 (*Pta*6605)

Understanding the mechanisms by which phytopathogens express their virulence is crucial for controlling plant diseases. Using Gram-negative phytopathogen *Pseudomonas syringae* pv. *tabaci* 6605 (*Pta*6605) as a model pathogen, we revealed that flagella-defective mutant (Δ*fliC*) lost surface motility and reduced virulence. Furthermore, flagellin-glycosylation-defective mutant (Δ*fgt1*) remarkably reduced surface motility and virulence. These results indicate that flagella and flagellin glycosylation are important for surface motility and virulence. To examine whether motility with directionality is required in virulence we generated several mutants for chemotaxis. Although there are two sets of chemotaxis gene cluster (*cheⅠ* and *cheⅡ*), we found that *cheⅡ* is required for virulence in *Pta*6605. In general, compared with animal pathogenic bacteria, plant pathogenic bacteria have a large number of chemotactic receptor genes, *mcp*. *Pta*6605 also has 53 *mcp* genes and among them we revealed that one *mcp* encoding the chemoreceptor for gamma-aminobutyric acid and two *mcp* encoding the chemorecepotrs for amino acids are important for bacterial infection. Analysis of role of other Mcp proteins in plant infection is now under investigation.

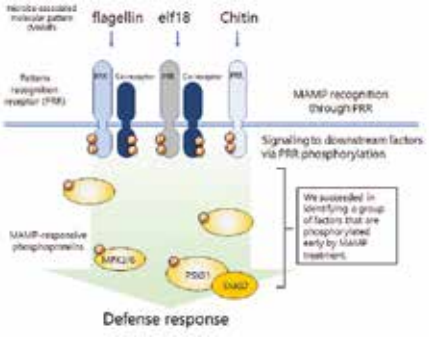


Research Area : Genetic Engineering

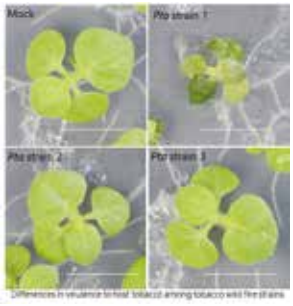
Assoc. Prof.
MATSUI Hidenori

Elucidation of the regulatory mechanism of plant immune responses by focusing on MAMP-responsive phosphoproteins

Plants have a defense mechanism to protect themselves from infection by various pathogens. An understanding of the defense mechanisms of plants is essential for efficient plant breeding. Pattern recognition receptors (PRRs) on the cell membrane recognize the basic structure (Microbe-associated molecular pattern: MAMP) of the microorganism and exert resistance. Many PRRs contain protein kinase domains and, after MAMP recognition, transmit signals downstream via protein phosphorylation. In other words, if we can elucidate the function of proteins whose phosphorylation changes with MAMP recognition, it will help us to understand the molecular mechanism of disease resistance. We have identified several MAMP-responsive phosphoproteins and are investigating the role of their resistance mechanisms.

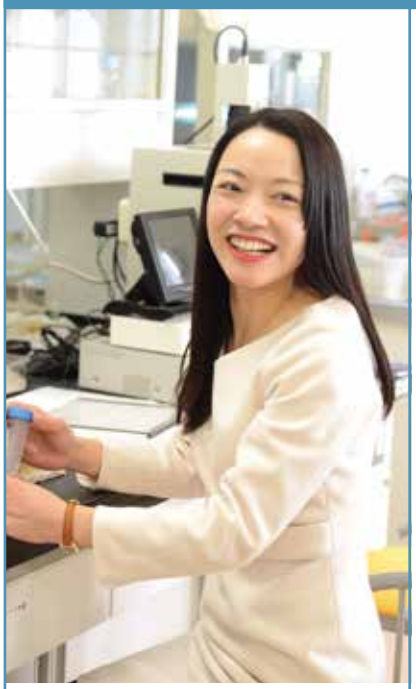


Elucidation of the virulence regulatory mechanism of phytopathogenic bacteria



Plant pathogens have evolved various molecular mechanisms to establish infection in the host plant. On the other hand, even plant pathogenic bacteria that can establish infections in plants have different pathogenicity to host plant. The clarification of the molecular mechanisms involved in the exertion of pathogenicity is expected to lead to the development of more efficient drugs and the establishment of infection prevention methods. Currently, we are clarifying the differences in pathogenicity between multiple strains and searching for gene regions important for pathogenicity through comparative genomic analysis.

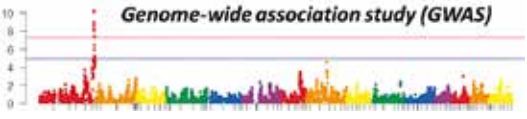
Research Area : Plant Genome Dynamics Analysis



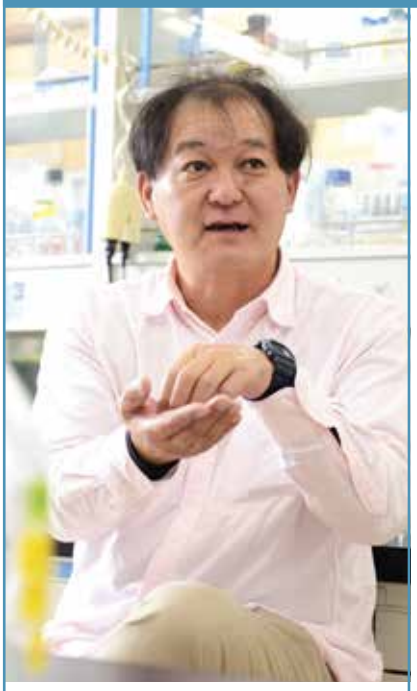
Assoc. Prof.
MONDEN Yuki

Study on genetic and genomic analyses for plant breeding

We are engaged in genetic and breeding research by using next-generation sequencing technology (NGS) for various crop species. Our research has been mainly conducted on the hexaploid crop species called sweetpotato (*Ipomoea batatas* (L.) Lam.). Sweetpotato is one of the most important crop species in the world, and the annual production in the world exceeds 100 million tons (FAO). There is a need to develop high value-added varieties to which excellent traits such as pest resistance, yield and taste have been imparted. However, sweetpotato is genetically complicated, and its genetic analysis has been considered extremely difficult. In such a situation, our groups succeeded in genome-wide genetic analysis by using NGS in sweetpotato. We identified genetic regions related to agricultural traits such as disease and pest resistance by performing QTL analysis and GWAS (Genome-wide association study). Using these research results, we developed selective DNA markers useful for breeding.



Research Area : Plant Pathology



Prof.
TOYODA Kazuhiro

Unrabeling plant disease susceptibility to fungal pathogens

Multi-layered defense barriers ensure that a plant is the host to only a few adapted pathogens. Thus, the host range of a particular plant pathogen relies on its ability to fully suppress plant defense responses such as the pattern-triggered immunity (PTI). One of the common pathogen strategies to overcome PTI is the production of a plant defense suppressor. In the case of *Mycosphaerella pinodes*, a causal agent of Mycosphaerella blight on pea, this fungus can avoid host defense responses by secreting at least two suppressors named supprescins A and B (Fig. 1), which manipulate the physiology of the host cells, including JA biosynthesis through targeting the host's ATPase. In parallel, a constituent(s) similar to the fungal suppressins has been discovered in healthy leaves of pea. Such a constituent was also found in the healthy leaves of barley and Arabidopsis plants, and collectively referred to as an endogenous suppressor (ES). Actually, the purified ES can suppress or delay PTI, enabling the non-adapted pathogen to cause disease symptom on corresponding plants. Interestingly, the action of the pea ES is quite similar to that of the suppressins A and B secreted by *M. pinodes*. Consistently, the ES can severely inhibit host's ATPase, temporarily reducing the ability of the host cell to defend itself. The putative role of the ES is assumed to be involved in the trade-offs between plant growth and defense by preventing excessive defense responses against pathogen attack. Alternatively, it is likely used by a pathogen to promote disease susceptibility. We are now focusing on the host cell physiology altered by a pathogen- and/or plant-derived suppressors in relation to the convergent evolution between pathogen and host.

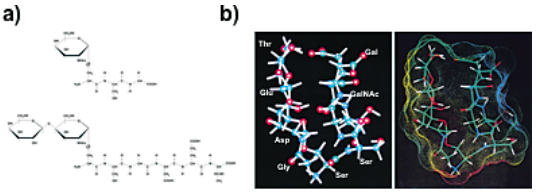


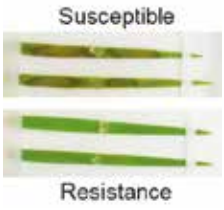
Fig. 1. Chemical structures of Suppressins A and B from *Mycosophaerella pinodes*. (a) Chemical structures of Suppressin A (*upper*) and B (*lower*). The common moiety consisting of O-glycosyl portion attached to the serine (GalNAc-Ser-Ser-Gly) is proposed to be essential for suppressor activity. (b) A predicted structure (*left*) of the Suppressin B, a major suppressor of M. pinodes and its distribution of charge around this molecule (*right*).

Research Area : Plant Pathology

Assoc. Prof.
NOUTOSHI Yoshiteru

For the control of crop diseases caused by a fungal pathogen *Rhizoctonia solani*

Rhizoctonia solani is a soil-borne fungal phytopathogen causing rice sheath blight as well as seedling damping-off or root rot in various crops. Management of this pest is difficult and it gives rise to serious damage in agriculture and economies. An experimental pathosystem using *Brachypodium distachyon*, an emerging model plant, revealed plant immunity mechanism against this pathogen leading to a novel insight into the fungal infection strategy. Fungal proteinaceous weapons called effectors are now being investigated.



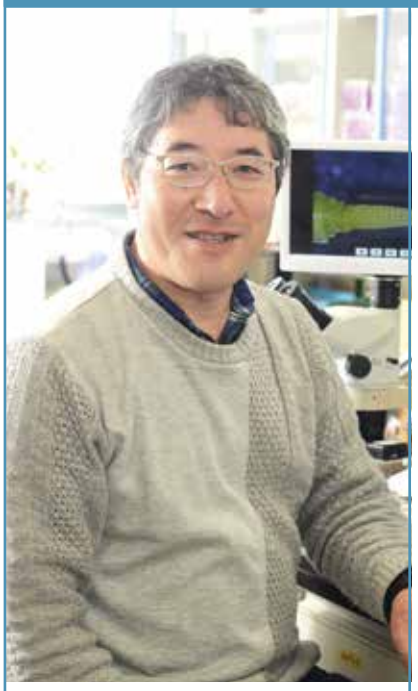
Molecular basis of a biological control agent for crown gall disease in grapevine

Grape is one of the major fruits produced in Okayama. It suffers serious damage from grown gall disease which is caused by *Rhizobium vitis* Ti strain. A non-pathogenic strains of *R. vitis* have been isolated as biological control of this pest. The molecular mechanism underlying this suppression activity is investigating and we found a potential causal substance produced by this biocontrol agent.

Isolation and characterization of plant defense activators for sustainable agriculture

Plant defense activators exhibit cop protection activity by priming or inducing plant immune response. We established a quantitative assay method for plant defense response and identified potential compounds through a high-throughput screening of several commercial libraries of organic small molecules as well as a laboratory-made small cyclic peptides. They can be used for not only lead compounds to develop agrochemicals but also molecular probe to understand plant immunity.

Research Area : Plant Genetics and Breeding



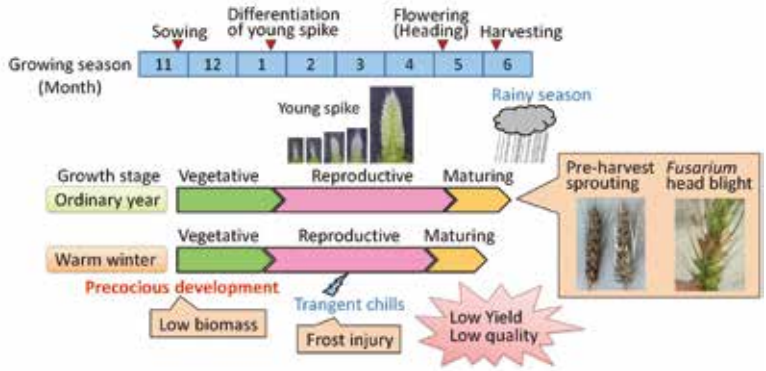
Assoc. Prof.
NISHIDA Hidetaka

Genetic study on instability of flowering time in wheat and barley under global warming conditions

Global climate change has a huge impact on crop production. For wheat and barley production in Japan, warm winter has been arising as a serious problem which would cause yield decrease and low quality.

So far, early-flowering (heading) varieties of wheat and barley have been developed to avoid pre-harvest sprouting and Fusarium head blight, which could often be caused by monsoonal rain during maturing and harvesting stages. However, most of early-flowering varieties show “instability of flowering time” in response to ambient temperature. They differentiate young spike primordium extremely earlier in warmer winter than in ordinary years. Unexpectedly precocious spike development will result in yield decrease due to less biomass production and frost injury caused by transient chills in early spring.

To solve the problem, it is necessary to disclose genetic mechanism underlying the instability of flowering time. For this goal, we are working on (1) identification of novel flowering-time genes and their interaction with other flowering-time genes, (2) finding genes which do not promote flowering very much even under warm winter condition, and (3) disclosing the genetic mechanism underlying the instability of flowering through molecular genetic study.



Research Area : Postharvest Horticulture

Assoc. Prof.
AKAGI Takashi

Prediction of qualities and disorders of fruits and vegetables, by “DEEP LEARNING”

Deep learning system enables us to reproduce professional eyes on the qualities & disorders of fruits and vegetables, potentially acting as prompt prediction. This technique also might be applicable to prediction of the preferences in marketing or of patterns of DNA sequences, etc. Furthermore, recent progress in back propagation of neural network enabled visualization of “what is a deep learning model looking”, developing further utilization of this technology.

FIG. Diagnosis of “fruit crop species” by ResNet50, and backpropagation of the contributors to the original picture

Research on fruit “shapes” and “ripening”

FIG. Representative variations in persimmon fruit shape

As major characters affecting fruit quality, shape and ripening are our research targets, with genome-wide transcriptomic or genetic approaches. Persimmon (柿) shows a wide diversity in their fruit shape and ripening. Utilizing their genetic diversities, with GWAS and/or transcriptomic network analyses, we are attempting to identify genetic factors conferring various shapes and ripening characters. Also, planning to launch onto tomato ripening system, focusing on evolutionally conserved ethylene receptors and chemical compounds accessible to them.

Study on sex determination in horticultural crops

Sexuality is one of the most important strategies to maintain the genetic diversity within a species. In horticultural crops, the sexuality also involves breeding, cultivation, and fruit qualities. Harnessing various sexual systems (or sex expressions) would derive many applications. We have been researching on the sex determination systems of persimmon, in which the first finding of plant sex determining gene was made, kiwifruit, and white campion. Their independent but convergent evolution of the sexualities tells us potentially various ways to artificially modify sex expressions in crop.

FIG. Production of synthetic hermaphrodite in kiwifruit

Research Area : Pomology

Assoc. Prof.
HIRANO Ken

Studies on relationship between fruit constituents and its taste

A fruit contains various taste active compounds, such as sugars, organic acids, amino acids, polyphenols, and aromas. We have been studying to clarify the effects of juice constituents on the fruit taste and developing quantitative evaluation system for fruit taste.

Studies on the mechanism of gibberellic acid induced seedlessness in grapes

Gibberellic acid (GA3) is widely used in the production seedless grape in Japan. We have been studying to clarify the mechanism involved in seedlessness of gibberellic acid treated grapes.

Research Area : Pomology

Assoc. Prof.
FUKUDA Fumio

Effects of timing of flowering on fruit quality and incidence of physiological disorders in peach

We are trying to clarify physiological aspects and mechanisms of various problems or improved points in high quality fruit production and to develop their solution.
Stability of fruit size and Soluble solid content (SSC) level is important in high quality peach fruit production. Also, severe flesh disorder causes economic loss. We found that “the fruit from early timing of flowering” shows worst qualities and the severe flesh disorder symptom within a tree awe to inferior accumulation of mineral nutrition and assimilates during the latter half of fruit development. These results are utilized to improve the skill thinned flowers or fruit.

Difference in timing of flowering within a group of bearing shoots


Reddish pulp disorder (Right)

Researches on detection of incidence of internal fruit physiological disorder and estimation of fruit maturity on the tree using an acoustic vibration method


“split-pit” in peach


Ripeness mesurement over fruit bag

To accomplish the stable fruit production, removal of abnormal fruit in orchard during immature stage and information of optimal harvesting was needed. Therefore, it is important to develop nondestructive method which can be utilized on the tree. By using an acoustic vibration measurement, split-pit occurrence could be detected from the ratio of resonant frequencies (f_3 / f_2), and progress of fruit maturity (decrease in flesh firmness) could be associated with the decline of f_3 value measured without removal of fruit bag.

Research Area : Vegetable Crop Science

Prof.
YASUBA Ken-ichiro

Research on the environmental control for greenhouse production using ICT

Greenhouse production is important for supplying vegetable and ornamental plants. In our country, the environmental control in greenhouse using microcomputer has not been spread until recently. A controller for environmental control was too expensive for small scale greenhouse, which was popular in Japan. So, the low cost controller named "Yoshi Max" was developed by our laboratory. This controller is conforms to the Ubiquitous Environment Control System (UECS) communication protocol (https://uecs.jp/index-e.html). UECS is beginning to spread in Japan as an environmental control system using ICT.

Research Area : Control of Flowering

Prof.
GOTO Tanjuro

Development of compacted medium using heat fusion fiber

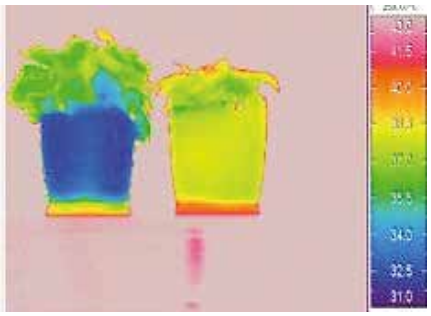


Fig. Medium and leaf temperature in potless culture.
Medium temperature decreased about 7°C.
Leaf temperature decreased about 2°C.

We found that medium could be hardened using heat fusion fiber. We demonstrated that use of hardened medium could enable cell transplants production and bedding plant production without polyethylene pots. Pansy and garden-type cyclamen plants grown in compacted medium without polyethylene pots in the summer season were bigger than those grown in compacted medium with polyethylene pots. The temperature of the medium without polyethylene pots was lower than that with polyethylene pots. This could be due to the evaporative cooling effect from the surface of compacted medium without polyethylene pots.

Improvement of growth and flowering of *Eustoma grandiflorum* by low temperature treatment

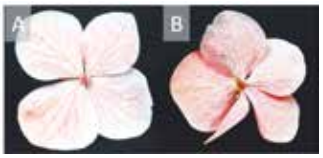
It is important to establish a suitable method for rosette avoidance and cost reduction in *Eustoma* seedlings production in summer. We found that intermittent low temperature storage treatment could be available as a supplemental method to prevent rosette of *Eustoma* seedlings after application of low temperature treatment to imbibed seed. However, suitable temperature and cycle have not been clarified. We confirmed that the cycle of 15-15 day stored at 10˚C was a suitable treatment to avoid rosette, promote growth and decrease labor for *Eustoma* growing.

Research Area : Control of Flowering

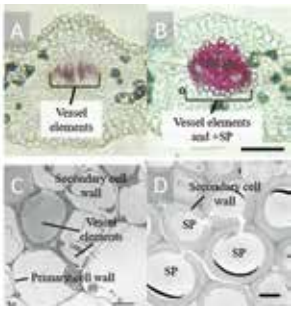
Assoc. Prof.
KITAMURA Yoshikuni

Study on the vein structures that increase water transportation in plant decorative organs

Some plant species show characteristic vein structure in decorative floral organs, development of sclerified parenchyma cells.
The sclerified parenchyma cells increase water transport in decorative organs and flowering longevity on plant or vase life.
We are studying the mechanisms underlying sclerified parenchyma cell differentiation and trying to use them for increasing the flower longevity.



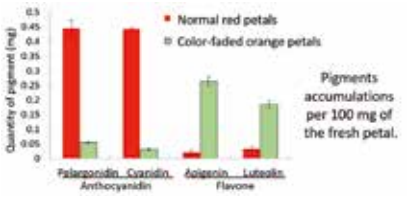
A: Flower before the sclerified parenchyma cell differentiation.
B: Flower after the the sclerified parenchyma cell differentiation.



A, C: Vein cells before the sclerified parenchyma cell differentiation.
B, D: Vein cells after the sclerified parenchyma cell (SP) differentiation.

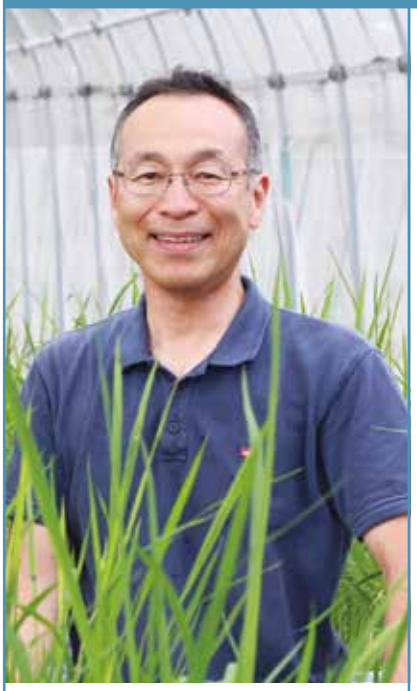
Research on flavone synthesis regulation in flower

Flower color of a dahlia cultivar, 'Nessho'.
A: Normal red-colored flower.
B: Orange colored flower of 'Nessho'.



Plants of a dahlia cultivar 'Nessho' produces solid red colored flower from spring to autumn. However, they produce orange colored flower in winter. The color change is owing to the increase in the flavone accumulation and decrease in the anthocyanidin accumulation.
We are studying the underlying mechanisms of seasonal change of the pigment accumulation.

Research Area : Crop Science



Prof.
HIRAI Yoshihiko

Studies on Salinity Tolerance Relating Grain Productivity in Cereals

An adequate food supply from agricultural crops is essential to the quality of human life. Salinity is one of the most serious environmental stresses severely limiting crop growth and grain productivity. Salt-affected land occupies about 19.5% of irrigated agricultural land. Rice, a major staple food for the ever-increasing world population, is one of the most salinity-sensitive crops. As such, improving the salinity tolerance of rice is desired to increase productivity on salt-affected soil. However, genetic and physiological knowledge of salinity tolerance relating grain productivity in rice is still limited. We study salinity tolerance in rice at both physiological and molecular levels. We found several quantitative trait loci (QTLs) for salinity tolerance relating high plant dry weight and grain yield under long-term saline conditions by using chromosome segment substitution lines carrying segments from a salinity-tolerant variety in the genetic background of a salinity-sensitive variety. Our research advance will contribute to developing rice varieties with high yield under salinity stress conditions.

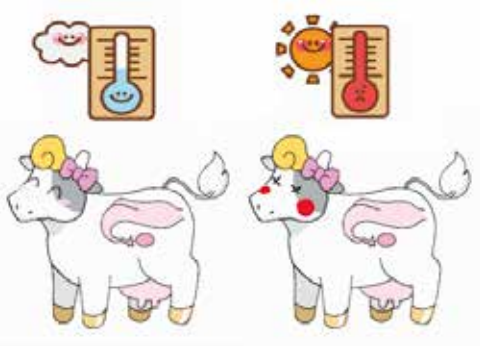
Varietal difference in salinity tolerance

Salinity-induced white head

Research Area : Reproductive Physiology

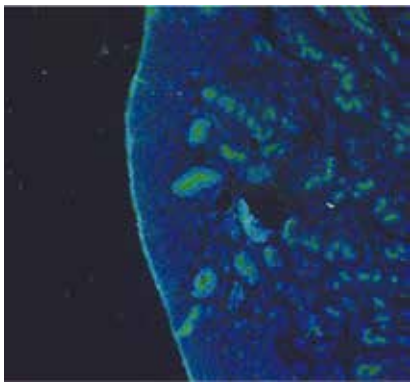
Prof.
KIMURA Koji

Study on uterine function of cattle under heat stress condition



Global warming affects agriculture and food supply. In livestock industry, extraordinarily high temperature in summer season gives stress to livestock species and reduces their productivity, such as daily gain of body weight and milk production.
Recently, it is becoming a big issue that the heat stress decrease pregnancy rate of dairy cows in summer not only in Japan but also all over the world.

To solve this problem, we are investigating the effect of heat stress on uterine functions of cattle.
In our current study, it is shown that the heat stress disrupts endocrine function of bovine uterus such as prostaglandins secretion and influences the mechanism for the recognition of pregnancy in cattle, resulting in low pregnancy rate.
Now we study how the heat stress affect uterine function of cattle.

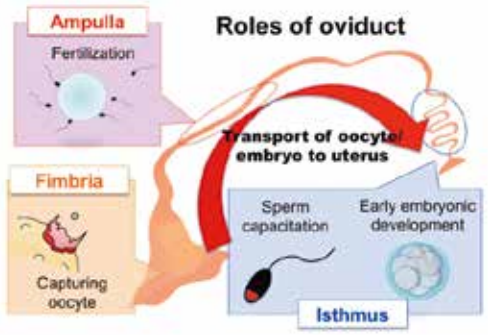


Immunohistochemistry of bovine endometrium. Green signals indicate the localization of heat sensor proteins.

Research Area : Reproductive Physiology

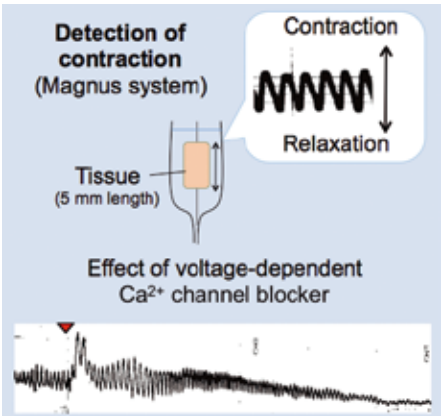
Assoc. Prof.
YAMAMOTO Yuki

Transport systems of gametes and embryo in mammalian oviducts



Oviduct is an important organ as a site for sperm capacitation, fertilization and early embryonic development. It is also the pathway of gametes and embryo connecting the ovary to the uterus. In spite of the essential organ for establishment of pregnancy, regulating mechanisms of oviductal function are unclear.
Our aim is to clarify the physiological mechanisms which control the oviductal functions.

Spontaneous contraction of oviduct is necessary for transport of gametes and embryos, since it produces peristaltic movement. Oviduct contains endogeneous pulse generator for contraction called as “pacemaker”. Pacemaker cells generate rhythmic spontaneous deporalization leading to the contraction of smooth muscle cells. In our project, the factors involved in spontaneous contraction are investigated using bovine oviductal tissues. In additon, we also try to identify the pacemaker cell in mammalian oviducts.



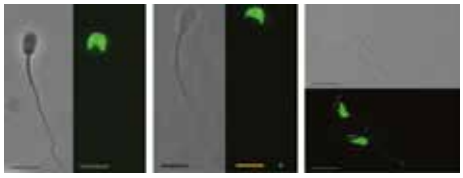
Research Area : Animal Development and Reproductive Biotechnology

Prof.
FUNAHASHI Hiroaki

Basic and applied research on mammalian gametes (maturation, fertilization and early development)

We are studying on gametes in mammals including humans during gametogenesis, maturation, fertilization and early development, to develop efficient systems for embryo production in vitro. We are also undertaking basic and applied studies to improve the efficiency in the production of more value-added useful animals.

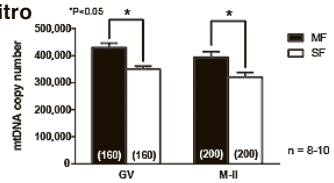
Intracytoplasmic sperm injection



Distribution of phosphodiesterase-5 (green) in different mammalian sperm (right, boar; center, bull; right, mouse)

Development of new systems to produce embryos in vitro from oocytes collected from small diameter follicles

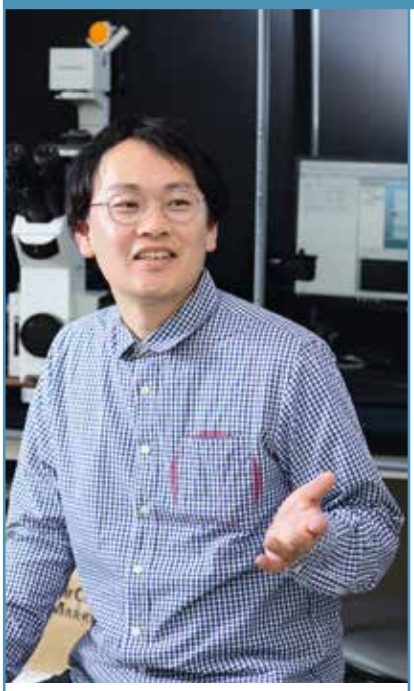
For in vitro embryo production in mammals, especially domestic animals, usually oocyte-cumulus complexes derived from middle follicles with a diameter of 3-6 mm have been used. However, a large number of small follicles with less than 3 mm in diameter, rather than middle follicles, dominantly exist on the surface of ovaries. On the other hand, the developmental competence of the oocytes from small follicles (in meiosis and early development following fertilization) has been known to be much lower than those from middle follicles. We're trying to make clear the molecular reasons about differences in the developmental competence and to make effort to improve the ability by various modifications.



mtDNA copy number in porcine oocytes

Microinjection of mitochondria

Research Area : Animal Development and Reproductive Biotechnology

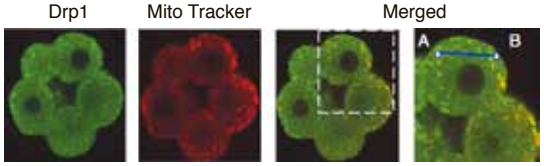


Assoc. Prof.
WAKAI Takuya

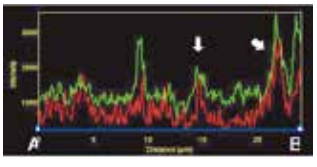
Basic and applied research on organelles in mammalian oocytes and embryos

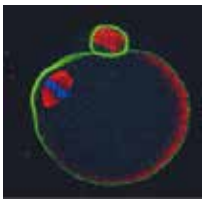
Gametes (oocytes and spermatozoa) are highly specialized cells for the transmission of genes to the progeny. Our laboratory is interested in understanding the mechanisms of oocyte development, maturation and fertilization in mammals. Problems in oocyte quality cause the infertility, and the development of organelles, such as mitochondria and endoplasmic reticulum, is a key determinant for the successful fertilization and subsequent embryonic development. We are using several techniques to address the roles of organelles in oocytes including in vitro maturation, fertilization, genetic manipulation and live cell imaging.

Normal (right) and sex-reversed mice (left) by genome editing of Sry. Both animals had morphologically normal uterus and ovaries.



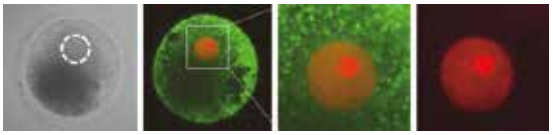
Expression of Drp1 protein, which is a critical factor associated with the division of mitochondria, in mouse embryos and the co-distribution with mitochondria





Actin cap in mouse oocyte

Expression of H2B-mCherry RNA injected into porcine immature oocyte

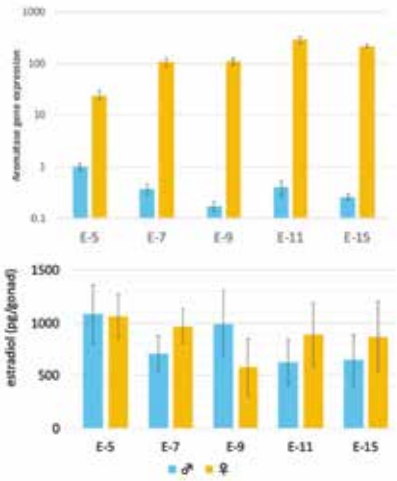


Research Area : Animal Physiology

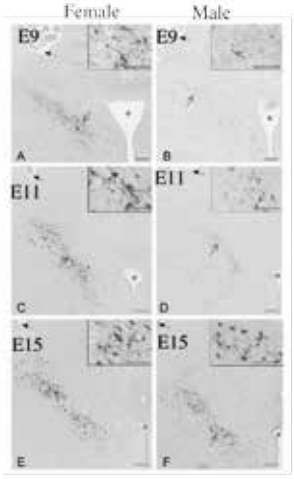
Prof.
SAITO Noboru

Study on sexual differentiation of birds

The sex of animals, including birds, is determined by genes. However, gonads and sexual differentiation of the brain are influenced by hormones and are determined. The mechanism of sex differentiation in birds differs in many respects because the sex chromosomes are ZW, unlike the XY type in mammals, and the details are still unknown in many respects. In the gonads, the gene expression of the enzyme that synthesizes estradiol (aromatase) is overwhelmingly higher in females than in males, but there is almost no difference in estradiol content between males and females. In addition, especially for sexual differentiation in the brain, aromatase gene expression may be higher in females than in males, and it is possible that sexual differentiation is self-sustaining.



Gonadal aromatase gene expression in quail embryos (left) and gonad estradiol content (right).



Expression of aromatase gene in the cerebral hypothalamus of quail embryos.

Research Area : Animal Physiology

Assoc. Prof.
HATABU Toshimitsu

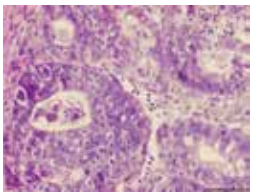
1. Study on host-pathogen relationship and pathophysiology in parasite infection

We are exposed to the infectious diseases. We need to develop a cheaper, effective, and safety ways to control the infectious diseases because these incur a heavy economic loss. One of the problems is that we have a little information to the infectious diseases. Hence, our mission is to understand the pathophysiological and immunological mechanisms of infectious diseases. In near future, we hope that the results of our research are applied to vaccine development and new strategies for disease control.

Our targets are parasites as follows:

1. Avian coccidia: Our research is to understand 1) the molecular mechanisms of parasite invasion, 2) the pathological mechanisms in the intestine, and 3) immunological mechanisms.

2. Leishmaniasis: We are studying to understand 1) the molecular mechanisms of disease development, 2) analysis of virulence factors of the parasites, and 3) the parasitic mechanism.



Eimeria tenella in Cecum

2. Food Science: physiological analysis of food ingredients

Food ingredients have important roles to our health. However, we have a little knowledge of them scientifically. Our mission in this research area is to understand the physiological effects of food ingredients, especially polyphenols and carotenoids, and to develop the innovative and useful way for human and animal health.

Research Area : Animal Breeding and Genetics

Assoc. Prof.
IBI Takayuki

Genetic parameters for calf mortality in Japanese Black cattle

The Japanese Black cattle is the predominant beef breed in Japan. In Japan, calves are sold at action, so, the death of calves is an economic loss for the reproductive farm. In spite of the economic importance of calf mortality, studies of the genetic parameters of calf mortality are few. Because, calf mortality is not a continuous trait such as body weight, but a threshold trait, classified only as live or dead. However, in recent years, the genetic parameters of threshold traits can be analyzed. Therefore, we investigate the genetic parameters of calf mortality in Japanese Black cattle.

Genetic parameters for reproduction traits in Japanese Black cattle

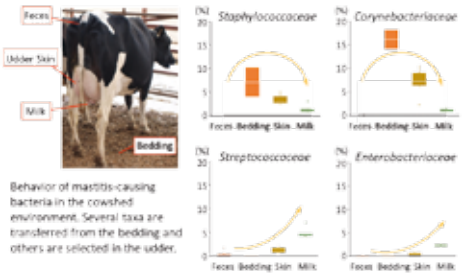
In recent years, Japanese Black cattle have been selected mainly for their meat quality, especially the degree of (intramuscular) marbling. In practice, genetic improvement for meat quality is very high. On the other hand, fertility performance is falling. Therefore, it is very important for genetic improvement of fertility performance to investigate the genetic parameters for reproduction traits and the genetic correlation between reproduction traits and carcass traits in Japanese Black cattle. Moreover, we investigate the genes responsible for reproduction traits with another institute.

Research Area : Animal Nutrition and Feed Science

Prof.
NISHINO Naoki

Health promotion and disease prevention of animals

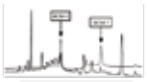
Mastitis, an inflammation of the mammary gland regarded as the most important disease affecting dairy herds, is triggered by pathogens derived from infectious and environmental bacteria. Milk microbiota is shown to be influenced by the microbiota present on teat skin, bedding, feed, and in the surrounding air. Region, season, and hygiene of the milking practices also influence the microbiota. We characterize the microbiota of the gut, milk, and cowshed environment to gain insights into improved cow management and mastitis prevention.

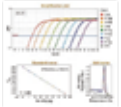


Behavior of mastitis-causing bacteria in the cowshed environment. Several taxa are transferred from the bedding and others are selected in the udder.

Integrating genomic approaches to upgrade the value of dairy products

Various projects have been progressed to improve the productivity of dairy cows and the value of dairy products using genomic approaches. Hiruzen, a northern region of Okayama Prefecture, is a well-known area where dairy farming performs with Jersey cows. Jersey milk has a rich taste and high-fat content, making it suitable for the production of dairy products such as butter, cheese, and yogurt. β-casein is one of six milk proteins produced by the CSN2 gene, and the variants can be classified into A1 and A2. We identify the CSN2 gene variants and evaluate the quality and function of A1 and A2 milk products using rodent models.





Research Area : Animal Nutrition and Feed Science

Assoc. Prof.
TSURUTA Takeshi

Research of the mechanism by which food microorganisms and dietary fiber intake prevent and improve obesity-related disorders

Excess energy intake and lack of exercise not only cause obesity, but various lifestyle-related diseases caused by obesity. Although correction of lifestyle is the most important to prevent and improve them, intake of food microorganisms and dietary fiber is effective as an additional preventive measure. In our laboratory, we are searching for new food microorganisms and dietary fibers that prevent and improve obesity-related disorders, and we are also studying how these food materials act on gut microbiota and gut immune system to exert their effects.

Effect of fat and oil intake on gut microbiota and immune system

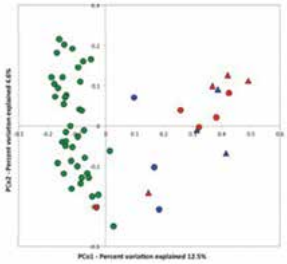
We daily consume a variety of fats and oils such as lard, beef fat, and vegetable oil. The fatty acid composition of these fats and oils differs greatly, which affects the physiological effects of each fat and oil. In our laboratory, we evaluate the effect of type of fats and oils and their intake amount on gut microbiota composition, secretion of immunoglobulin A (IgA), a major molecule responsible for gut immune system, and the IgA reactivity to gut microbiota.

Research Area : Animal Applied Microbiology

Prof.
MORITA Hidetoshi

Study on human gut microbiota to contribute for health

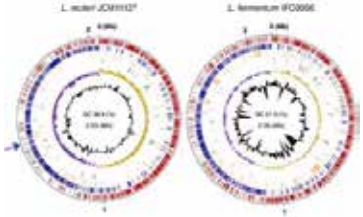
1. Research history and analytical methods of gut microbiota
2. Gut microbiota and the bacterial composition and diversity of human gut microbiota
3. Symbiosis with the host of the gut microbiota
4. Effect of food ingredients on the human gut microbiota
5. Gut microbiota and disease (effect of gut microbiota to host)
6. Metagenome analysis and gene function of gut microbiota



Research on probiotics/prebiotics effects and complete genome analysis of lactic acid bacteria and bifidobacteria

A scanning electron microscope (SEM) photograph of this lactic acid bacterium whose complete genome was analyzed by me.

1. Complete genome analysis of lactic acid bacteria and bifodobacteria
2. Functional bacterial genome analysis
3. Research on probiotics/prebiotics effects by using gnotobiotic mice
4. Effect of dietary fiber as prebiotics



Research Area : Animal Applied Microbiology

Assoc. Prof.
ARAKAWA Kensuke

Studies on protein metabolism of lactic acid bacteria

Lactic acid bacteria (LAB) are known as fastidious microorganisms that require a wide variety of exogenous free amino acids or peptides as nitrogen sources for growth. Most of Food stuffs such as milk generally contain proteins but very low amount of free amino acids and peptides. Therefore, LAB first hydrolyze the proteins to get nutritious oligopeptides using their own cell-envelope proteinases (CEP). The oligopeptides released are subsequently taken up by the LAB cells via specific transport systems for further degradation into shorter peptides and free amino acids using various intracellular peptidases. The CEP, transporters and peptidases are species- or strain-specific, and their functional and enzymatic differences are an important factor to produce the diversity on taste, flavor and health-promoting effect of fermented food products. In our laboratory, we are studying the protein metabolism of LAB; particularly focusing on characterization of CEP and function of the oligopeptides released by CEP on fermented foods.

Studies on antimicrobial substances produced by lactic acid bacteria

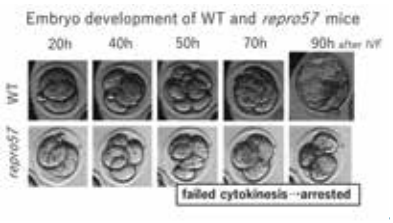
Lactic acid bacteria (LAB) are known as safe producers of antimicrobial substances such as lactic acid and bacteriocins. Bacteriocins, ribosomally biosynthesized antibacterial peptides, have strong activity with a very small quantity and are easily degraded by digestive enzymes in the animal gut. Food-derived antimicrobial peptides are also produced by LAB. Food proteins such as milk caseins are good origins of functional peptides, including with antimicrobial activity, released by hydrolysis using cell-envelope proteinases (CEP) of LAB. These antimicrobial peptides are expected to be used as a safe natural preservative (biopreservative) for foods and feeds. In our laboratory, we isolated some LAB strains with bacteriocin productivity and high CEP activity for production of food-derived antimicrobial peptides, and characterized the bacteriocins and the food-derived antimicrobial peptides for application to foods and feeds.

Research Area : Assisted Reproductive Medicine

Assoc. Prof.
OTSUKI Junko

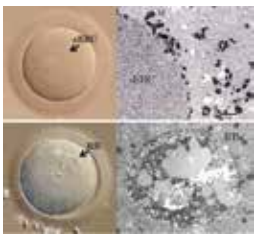
The meiotic abnormalities in mouse and human oocytes and their mechanisms

During the maturation process of human oocytes, numerous genes are responsible for meiosis. Recent studies have begun to reveal that defects in some interrelated genes are the cause of female infertility. We aim to perform functional analyses of the process of oogenesis, during the first and second meiosis using oocytes from mutant mice, which present with a mutation, leading to genetically developed abnormalities on chromosomal crossing-over during meiosis. In this way, we hope to contribute to the existing body of therapeutic strategies and preventive measures which can be taken against human infertility. As ten to twenty percent of cases of infertility are considered to be idiopathic, we also aim to perform a comprehensive analysis of meiotic DNA mutations and thereby elucidate the causes of infertility derived from those mutations.



The elucidation of the mechanism of dysmorphic phenotypes in human oocytes and preventive measures against those dysmorphisms

The dysmorphic phenotypes to be found in human oocytes are unlike any other species, with the exception of chimpanzee oocytes. Among these dysmorphisms, we have been focusing on two phenotypes: smooth endoplasmic reticulum clusters (sERCs) and refractile/lipofuscin bodies. We have found that the incidence of mitotic and meiotic cleavage failure during the second polar body extrusion is significantly higher in oocytes with sERCs than that in oocytes without sERCs. Regarding the refractile body (RB), we have reported that it presents with autofluorescence. Viewed by means of transmitted electron microscopy, the refractile bodies display the conventional morphology of lipofuscin inclusions and consist of a mixture of lipids and dense granule materials. We aim to elucidate the mechanisms of these dysmorphic phenotypes in human oocytes and work towards preventive measures against them.

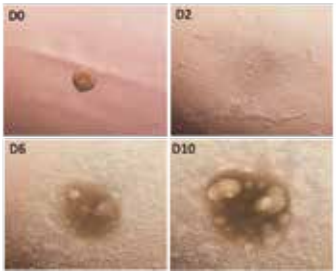


Research Area : Assisted Reproductive Medicine

Asst. Prof.
TASAKI Hidetaka

Research on the Mechanism of Oocyte Development

The mammalian ovary contains follicles in many development stages, which can be grown in vitro to provide an additional source of mature oocytes. These processes have long periods and the development and differentiation of female germ cells require a unique microenvironment created by surrounding somatic cells. Our research theme is focused on the mechanism of oogenesis/folliculogenesis by somatic cells in human and animal ovaries. Furthermore, we are developing in vitro culture systems compatible with all stages of oocytes present in ovarian tissue. These systems contributed to assisted reproductive medicine, animal reproduction, and the conservation of endangered species.



Cryopreservation System of Reproductive Tissue and Germ Cell

Embryo cryopreservation has become routine procedures in assisted reproductive medicine worldwide. Recently, there has been a growing interest in cryopreservation of ovaries or oocytes for women's career development and to protect germ cells from cancer treatment. A few reports successful in births by obtaining mature oocytes from the frozen ovarian tissue or immature oocytes. However, the success rates are limited, the optimization of these freezing methods is urgently needed. To solve this problem, we investigated the effects of cryopreservation on ovarian tissue and oocytes. We focused on cryoprotective substances, osmotic stress, and antioxidants during the freeze-thaw process. Our research goal is to establish safe cryopreservation methods, which technology will also preserve livestock and wildlife in the event of unprecedented epidemiological problems.