Graduate School of Life and Environmental Sciences
Master’s and Doctoral Programs in Biological Sciences
Our research focus is basically in two areas, namely functional analysis of mouse genomes, and epigenetic dynamics during early embryogenesis and germline development. During early mammalian development, a cell lineage maintains its developmental pluripotency. Pluripotent cells in this lineage undergo large-scale changes in epigenetic status by a process called “genomic reprogramming.” This process is involved in phenomena such as X-chromosome inactivation or reactivation and genomic imprinting. Extensive genomic reprogramming also occurs during germ cell development.

To study these complex processes we use various approaches, including genetics, epigenomics, transgenic technology, and bioimaging. The knowledge obtained from these studies can be used to define vital transition points in this lineage and contribute to our understanding of the genes and factors that play important roles in these processes.

Select Publications

Hermatypic corals are on the forefront of climate change. Rising temperature has resulted in increased mass bleaching and disease occurrence in the tropics, but it has also favor a poleward shift/expansion of corals in Japan and other parts of the world. In order to understand the future extent of this expansion and the possibility that high latitudes provides a future refuge for corals, a better understanding of the effect of environmental parameters on coral ecology and physiology is required. Monitoring and diverse surveys including citizen surveys of coral communities around Izu and the Izu Islands were established to study the competition with macroalgae, the bleaching occurrence and the growth and diversity of high latitude corals under different pH conditions. The effects of pH on natural coral communities is studied at the recently discovered CO₂ seep in Shikine Island. Laboratory experiments complement the investigation of the stress response of corals. The physiological mechanisms of the effects of high and low temperature stresses and of ocean acidification are studied under controlled conditions in the laboratory.

Porites heronensis is a dominant species of hermatypic corals in high latitude of Japan. It forms dense patchy communities around Shimoda and Izu. It cohabit and compete with a diverse community of macroalgae. Low temperature often cause important bleaching and mortality during winter.

Publications

In our body, proteins are in a dynamic state, and the speed of protein synthesis and degradation is tightly regulated. The degradation of protein is individually regulated by the “Ubiquitin and the Proteasome System” which plays critical roles in many biological aspects such as embryogenesis, immune system, and memory.

The major goal of our laboratory is to understand:
(1) The component and regulation of intracellular protein degradation at molecular level.
(2) The physiological roles of selective protein degradation in our body.

The Ubiquitin System.
Ubiquitin acts as a degradation signal and its attachment to the substrate is tightly catalyzed by a cascade reaction composed of E1, E2s and E3s enzymes.
(Keywords; Cullin, NEDD8, signalosome)

Proteasome Activators
Proteasome is a barrel-shaped multisubunit protease complex that captures and degrades ubiquitinated proteins. The activity of the proteasome is regulated by multiple proteasome activators.
(Keywords; Proteasome, PA28, PA200, Ecm29)

My lab is focusing on;
(1) The regulation and function of Cullin-RING-type Ubiquitin ligases.
(2) The regulation and function of proteasome activators using multiple knockout mice.

Publications
My research aim is to apply the strategy used by newts to regenerate their body parts to medical treatments that will save the lives of people who have suffered traumatic injury. I am currently trying to uncover the cellular and molecular mechanisms of newt body-part regeneration, which has been a biological mystery for more than two centuries. I intend to compare these mechanisms with those of mammalian wound healing and tissue repair, as well as with the pathogenic or oncogenic processes that occur after traumatic injury.

Among vertebrates, the newt is the master of regeneration. No other animal can match its ability to regenerate body parts such as the limbs, the tail and spinal cord, parts of the eye (such as the retina and the lens), and the brain, heart, and jaw. This regeneration is mediated by dedifferentiation or transdifferentiation of somatic cells at the site of injury.

Our current focus is on the retina, lens, and limbs. Recently, we established a highly efficient transgenic system using the newt Cynops pyrrhogaster. This is an undoubted breakthrough in our research field and will accelerate the accumulation of knowledge on regeneration of the newt’s body parts (Nature Protocols 6, 600-608, 2011).

Select Publications
The Kingdom Fungi is one of the most important on Earth. At present there are 100,000 known species, but the total number is estimated to be over 5 million. Our Laboratory of Mycology is situated in the Japan Alps in the Sugadaira Highland, at an elevation of about 1300 m. It has 30 ha of well-preserved natural fields, including grasslands and Pinus–Quercus forests. The lab has been managed by the late Emer. Prof. H. Indoh (1908–2003), the late Emer. Prof. K. Tubaki (1924–2005), and Emer. Prof. S Tokumasu (1945–).

The Kingdom Fungi is regarded a sister group of the Kingdom Animalia in the supergroup Opisthokonta. But how did fungi originate and diversify? In our laboratory, we are studying the natural history (taxonomy, phylogeny, and ecology) of a wide range of fungal taxa, by using living natural materials, with the aid of molecular biological approaches. Our focus is 1) the biodiversity of the Chytridiomycota and basal lineages of fungi, in order to elucidate the origin of fungi; 2) the biodiversity of the Zygomycota, to examine the interactions between fungi and other organisms; 3) the biodiversity and life histories (teleomorph–anamorph connections) of the Ascomycota and Basidiomycota.

Select Publications
Plant growth and functions are controlled by the dynamic regulation of gene expression by transcription factors. We work on functional analyses and utilization of such transcription factors that are promising to solve many problems we are facing, such as food shortage, energy issues, and global warming. Our current projects include: 1) basic studies of transcriptional regulation mechanisms, 2) identifications and analyses of transcription factors that can be utilized for the development of useful plants, and 3) research and development of useful plants by modifications of transcription factors.

Select Publications
My group is interested in elucidating the neuronal mechanisms of brain development and plasticity, using the fruit fly (Drosophila melanogaster) as a model organism. We are particularly interested in analyzing the brain networks involved in higher brain functions such as memory and cognition. Past studies have disclosed surprising similarities in the genetic programs of brain development in flies and vertebrates. We have demonstrated that the Drosophila Pax6 genes eyeless and twin-of-eyeless play significant roles in the development of mushroom bodies, which are centers for higher brain functions such as memory in the fly brain. In light of these commonalities, we are also studying the molecular and genetic bases of human cognitive disorders such as bipolar disorder and schizophrenia by using the genetic tools available in this fascinating model.

Confocal image of the Drosophila brain
Green: olfactory projection neurons labeled with GH146-GAL4.
Red: Homothorax protein expression.
Blue: Neuropiles stained with anti-NC82.

Select Publications
Since the 1950s, coastal ecosystems have been profoundly changed by human activity. Our use of finite natural resources is accelerating and our planet is at high risk of entering a phase of extinction of marine species unprecedented in human history. Fisheries have removed large amounts of fish from ecosystems and homogenised continental shelf habitats, with extensive damage now occurring all along shelf-break regions and even on remote seamounts. Moreover, marine ecosystems will also have to also contend with climate change, including ocean acidification, over the coming years which will have a myriad of ramifications for our oceans. My research focusses on applied research that can provide policy makers with the necessary scientific information required to best manage the marine environment. I specialise in temperate reefs, with my research ranging from deep-sea benthos, fisheries, aquaculture, marine protected areas, biogenic reefs and seamounts. Most recently, my research seeks to investigate the effects of ocean acidification, using natural shallow water volcanic CO$_2$ seeps in Japan (Shikine Island) and the Mediterranean, and deep-water coral reefs in the Arctic Ocean. My research uses a combination of field surveys and in situ experiments to provide important knowledge for the predictions of the effects that ocean acidification will have on marine organisms and ecosystems.

"I have a job that gets me out to sea, where I can find out first hand what is happening to life, both on and in it. That's the most enjoyable part, but it's also rewarding to be able to communicate these findings to help improve the ways in which we look after our oceans."

Selected Publications
Ocean acidification (OA), the change in seawater carbonate conditions associated with increasing levels of atmospheric CO₂, has been identified as one of the 21st century’s greatest challenges for marine biodiversity. There is now quite an impressive body of scientific literature on how individual species are likely to respond to OA. The variety of responses within and between taxa suggest that OA is likely to drive substantial change in marine ecosystems, and potentially generate novel communities composed of new combinations of species. Hence, the next significant knowledge gap is to understand how OA will affect the structure and functioning of whole communities, with the aim of informing on the implications for the ecosystem services that these communities provide (e.g. food, habitat provisioning, coastal defence, nutrient cycling). My research seeks to address this knowledge gap by using natural in situ CO₂ seeps.

Volcanic vents releasing CO₂ gas were recently discovered in the shallow bay of Mikama on Shikine Island. This release of gas causes a local acidification of the waters around the vent resulting in similar chemical conditions to the future conditions under OA. My research uses a combination of field surveys at the CO₂ seep in Mikama and in situ experiments to investigate the effects of OA on the marine organisms and the ecosystem. From species interaction to alteration in the organism’s physiology, my research provides important knowledge for the predictions of the effects that OA will have on marine ecosystems.

**Publications**

1. Harvey, B.P. *et al.* (2016) Linking individual and population-level responses to climate change. *Scientific Reports*, 6, 20194
2. Harvey, B.P. *et al.* (2014) Evolution of marine organisms under climate change at different levels of biological organisation, *Water*, 6 (11), 3545-3574
Tetsuo Hashimoto

Molecular Evolution of Microbes

hashi@biol.tsukuba.ac.jp

https://sites.google.com/site/memicrobes/

The central focus of our research is to gain insight into the origin and early evolution of eukaryotes. This is currently the most important open problem in evolutionary biology. We are using molecular and cellular biological methods, including comparative ‘omics’ analyses and molecular phylogeny, to approach the evolutionarily interesting issues presented by diverse eukaryotic microorganisms.

One of the goals of our research is to reconstruct a reliable eukaryotic tree. We are continuing to perform phylogenomic analyses using high-performance computing to elucidate the early phase of eukaryotic evolution. By using a refined tree of the organisms of interest, we compare genomic, transcriptomic, and proteomic data so as to trace the evolutionary history of the divergence of cellular functions and molecular mechanisms. Our recent focus is elucidation of the reductive evolution of mitochondria in a diverse anaerobic organismal group, the Fornicata, all of which contain no typical mitochondria but have mitochrondri-on-related, reduced organelles.

Select Publications


My main research interest is to understand how plastids (chloroplasts) have evolved in diverse organisms. Many species of plants and algae possess plastids as photosynthetic organelles, which were originated by endosymbiotic uptakes that a photosynthetic organism was fully integrated into a phagotrophic eukaryote. Plastids of plants and several algae (red and green algae) were derived from a cyanobacterial endosymbiont. In contrast, many other algal groups acquired complex plastids through secondary endosymbioses of red and green algae. These multiple endosymbiotic events are a significant driving force in evolution of diverse photosynthetic eukaryotes on the earth.

How was an endosymbiont integrated into a host cell as a plastid? To answer the question, I’m currently studying on several topics using a marine unicellular algae, chlorarachniophytes. Research topics: 1) Reductive genome evolution of integrated endosymbionts 2) Endosymbiotic gene transfer 3) Protein targeting into complex plastids 4) Plastid division mechanism 5) Organelle DNA replication.

Publications
Akira Hirao

Molecular Ecology of Plants

akihirao@sugadaira.tsukuba.ac.jp

http://www.sugadaira.tsukuba.ac.jp/

The study of micro-evolutionary processes in wild plants, underlying the variety of morphological, reproductive and genetic traits associated with diversification, provides the conceptual basis for my research. I mainly focus on plants inhabiting alpine environments that provide a steep environmental gradient and a large variety of habitat types on small spatial scales. Alpine ecosystems are ideal fields for examining the effect of environmental factors on micro-evolutionary processes in plants. Research approaches involve field surveys and genetic analysis. My past research includes landscape effects on fitness, population genetic structure, and ecotype differentiation in alpine plants. More recently, I have also focused on microbial organisms inhabiting floral nectar, which have potential consequences for interactions among a complex assemblage of plants, pollinators, and microbes.

Mountain landscapes are ideal for examining micro-evolutionary processes in organisms. They provide steep ecological gradients (e.g. altitude, precipitation or snowmelt timing) and a large diversity of different habitats (e.g. fellfield, snowbed or rocks).

Publications
The oscillatory movement of cilia and flagella is produced by highly regulated force production of axonemal dynein molecules. Dynein molecules in axonemes are regularly arranged between neighboring microtubules, which are linked together by a structure called nexin. In order to understand the mechanism of dynein’s regulated force production, we are developing a system that mimics an axoneme: axonemal dynein molecules were bound between two microtubules that were cross-linked with DNA-origami structures (Fig. A). The cross-linking structures are expected to prevent the dynein-microtubule complex from disassembly and enable us to observe dynein molecules that are producing force under load.

The advantage of using DNA-origami structures is that we can observe the cross-linking structures under electron microscopy (Fig. B). We are analyzing the movement of the complex by optical trapping nanometry (Fig. C) and studying the high-resolution structures of dynein during force production by electron microscopy.

Publications
We are seeking to improve process-based understanding of carbon dynamics in terrestrial ecosystems by investigating carbon fluxes and pools. By demonstrating such parameters and their relationships with various environmental factors, we will be able not only to estimate carbon sink capacity with high accuracy, but also to demonstrate the features of individual ecosystems. Current projects include

- Responses of alpine grassland carbon dynamics to recent environmental changes
- Relationship between biodiversity and ecosystem functioning in a highly diverse Tibetan grassland ecosystem
- Island ecosystem restoration focused on decomposition processes after the 2000 eruption on Miyake Island, Japan
- Reevaluation of the carbon sink capacity of old-growth forest ecosystems.

Select publications
Takeo Horie

Neural Circuits and Behavior in Ascidian Larvae

horie@kurofune.shimoda.tsukuba.ac.jp


Animal behavior results fundamentally from the coordinated activity of neural circuits. Our laboratory is studying the relationships among neurons, neural circuits, and behavior in ascidian larvae. These larvae have a very simple central nervous system (CNS) consisting of only about 100 neurons. Despite its simplicity, the CNS of ascidian larvae shares several properties with those of vertebrates. The small number of neurons in these larvae enables us to describe neural circuits at the single-cell level. Our ability to manipulate the activity of individual neurons makes it possible to elucidate how neural circuits function. We are using a combination of optogenetics, in vivo Ca$^{2+}$ imaging, proteomics, and behavioral genetics in the ascidian Ciona intestinalis to gain an understanding of the operating principles of the neural circuits underlying animal behavior.

Cilia are microtubule-based organelles that extend from basal bodies and form on the apical surfaces of cells. We are also studying the developmental role and physiological functions of the cilia present in the nervous system of ascidian larvae.

Select Publications

My research is focused on the biodiversity of the order Helotiales, phylum Ascomycota, Kingdom of Fungi. Fungi is one of the largest group of organisms in the world, estimated to consist of more than 1.5 millions of species. Ascomycota is the largest group of fungi, and Helotiales is one of the most diverse group in Ascomycota. The members of Helotiales produces small saucer to nail-shaped mushroom, called apothecia. The majority of the members of Helotiales were thought to be weak saprophytes occurring on decaying plant substrates. Recently, however, the majority of plant root endophytes (fungi that live in plant symbiotically or without showing any symptoms) turned out to be Helotiales. Helotiales were more versatile than we imagined! Then which species are there? Actually, we cannot tell which species by names, because the taxonomy of Helotiales is so poor, and we are not sure how many species exactly are there in Japan, either.

We use molecular barcoding technique and conventional taxonomic technique (morphology and isolation) to evaluate the biodiversity of species. Enumeration of all the Helotiales in Japan is one of the goal. Another issue is the comparisons with previously known European species. Our predecessors have identified Japanese species based on European literature. However, the present knowledge suggests that Japanese species may be different from that in Europe. We have to critically examine the identity using molecular technique. Finally, we also use isolates to help understanding the lifecycles.

[Selected Publications]

Our research goal is to explore the biological significance of sperm and eukaryotic cilia and flagella by using several marine organisms, including tunicates, sea urchins, sea snails, comb jellies, spiny lobsters, flounder and marine algae. The main projects in my lab are as follows:

**Biology of sperm:** Molecular characterization of sperm flagella; molecular mechanism and regulation of flagellar motility; sperm activation and chemotaxis by egg-derived substances; genomics and proteomics analyses of testis-expressed genes and proteins; ocean acidification and sperm function; molecular mechanisms of spermatogenesis; the structure and function of gastropod parasperm; and the molecular diversity of sperm protein.

**Biology of cilia and flagella:** Structure and function of dynein motors; regulation of flagellar motility by protein kinases and protein phosphatases; molecular architecture of the axoneme and comb plate; cDNA and proteomics analysis of axonemal proteins; novel Ca²⁺-binding protein and photoreceptor protein; in vitro assembly of the axoneme; phylogenetic analysis of ciliary and flagellar proteins; and eukaryotic evolution and diversity of cilia and flagella.

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**Select Publications**

Ken-ichiro Ishida

Plant taxonomy and phylogeny

ken@biol.tsukuba.ac.jp

http://www.biol.tsukuba.ac.jp/~ken/

Research interest in my lab is to elucidate the diversity and evolution of photosynthetic protists (algae) and their non-photosynthetic relatives. Following three major subjects are the current focuses in my research.

1. **Cellular evolution in the endosymbiotic acquisition of plastids**: Plastids were born by a primary endosymbiosis and transferred to the different eukaryotic lineages by several secondary endosymbises. We are interested in how a photosynthetic endosymbiont was integrated into a host cell as an organelle. This mystery is being uncovered by various approaches, such as genomics, cell biology, electron microscopy and molecular phylogenetics.

2. **Taxonomy and phylogeny of protists**: We look for new protist species, especially the ones that can connect missing links in the tree of life. We collect protists from the nature, establish clonal cultures if possible, observe them under light and electron microscopes and perform molecular phylogenetic analyses. We are the protist hunters.

3. **Search for useful protists for bio-fuel production**: We are studying how to look for oil-producing algae and protists in the nature and establish cultures of high-performance strains.

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**Publications**


Mitochondria are dynamic organelles which fuse and divide continuously, and they have evolved with eukaryotic cells, developing a symbiotic relationship and complementing each other. Understanding "normal" and "abnormal" mitochondrial functions is very important to uncover the mechanisms of human diseases.

We are studying the impact of mitochondrial DNA (mtDNA) mutations on cellular or tissue functions using in vitro and in vivo models.

Mitochondria in human cells are visualized by green dye. Blue dye indicates nuclei. Mitochondria construct dynamic networks in cytosols.

Publications

Human pluripotent stem cells (ES/iPS cells) and mesenchymal stem cell are expected as powerful tool for regenerative medicine in the world. However, those cells are likely to lose the useful ability for cell therapy during preparation (establishment, culture, cryopreservation etc.) Moreover, method for preparation of some organ cells is insufficient so safe and effective method of treatment isn’t realized yet.

To establish the facile, economical and safe regenerative medicine, we should develop several supporting technology for quality control, safety administration and so on. We will promote the development of technology for supporting regenerative medicine.

Fluoresceinated rBC2LCN directly stains human iPS cell colonies. This new probe that we developed can detect good iPS/ES cells accurately, nondestructively and quickly. We can use this probe as “high-sensitive” and “low-toxic” technology for human ES/iPS cells to facilitate of quality control.

Publications
Stress tolerance in higher plants is an interesting phenomenon. Plants are immobile and must evolve defense systems that are uniquely suited to their ambient environmental stresses. Several genes associated with these defense systems have been identified. Our aim here is to generate genetic lines conferring abiotic stress tolerance and to verify their performance. We are also studying the impacts of transgenic plants on biological diversity so as to establish an environmental biosafety risk-assessment system for transgenic plants. In addition, we are trying to elucidate the mechanisms of abiotic stress tolerance in higher plants by using GM (genetically modified) techniques, and we are studying the induction of somatic embryogenesis by abiotic stress. In this way, while elucidating the mechanism of abiotic stress in higher plants, we are also working on the development of abiotic stress–tolerant GM plants that can be used for crop production.

Somatic embryogenesis induced in carrots by abiotic stress
In carrots, somatic embryo production can be induced from apical tip segments by application and removal of stress treatment. The somatic cells are converted to embryogenic cells by the stress treatment. After removal of the stress, the embryogenic cell begins to develop into a somatic embryo.

Select Publications
Germ cells are specialized cells that can transmit genetic materials from one generation to the next through sexual reproduction. All other cells of the body are somatic cells. This separation of germ and somatic cells is one of the oldest problems in developmental biology. In many animal groups, a specialized portion of egg cytoplasm, or germ plasm, is inherited by the cell lineage which gives rise to germ cells. This cell lineage is called germline. The germline progenitors eventually migrate into the gonads, where they differentiate as germline stem cells (GSC) to form eggs and sperm when the organisms are physically matured. Our laboratory aims to find the molecular mechanisms regulating germline segregation, germline sex determination, and GSC niche function in *Drosophila*.

**Publications**


Organisms in nature exist not in isolation, but in association with other organisms of different species. One-on-one interactions among species rarely occur in natural communities; instead, the organization of such communities is characterized by complex interactions. Therefore, the understanding of complex sets of species interactions is an important focus of today’s ecological studies.

There are six categories of species interaction: competition, predation, herbivory, parasitism, disease, and mutualism. To date, these interactions have been treated separately, although unified interactions need to be understood to elucidate community-organizing mechanisms. We are trying to elucidate such community-organizing mechanisms by using an interaction-web approach that integrates all aspects of species interaction.

Various organisms inhabit marine coastal areas. Complex interactions are involved in the organization of such marine biological communities.

Select Publications
We are interested in the fusion of archaeal and bacterial genomes, which is thought to have produced the origin of early eukaryotes. Phylogenetic studies give some information on which archaeon and bacterium were involved in the combination. The archaeon is thought to have been Crenarchaea, but ambiguities remain about the bacterium. In order to construct an experimental system that enables the genome fusion, we isolated *Thermosipho globiformans*, as a model microorganism for the bacterial counterpart of the fusion, by deploying an in-situ cultivation device of original construction at a hydrothermal vent. We have shown that *T. globiformans* transforms to spheroids, which enlarge from 2 μm to more than 10 μm in diameter, and produces toga-less progeny in the periplasm. The toga-less nature is consistent with the known high susceptibility of Thermotogales to lateral gene transfer, and the progeny production represents a model for the generation of endoplasmic reticulum membrane from nuclear membrane.

Other topics from our laboratory include (1) the isolation of *Thermococcus* species that perform cell fusion, which is possible only with a nucleic acid-staining dye, (2) development of an anaerobic thermophile observation chamber (ATOC) for high-temperature microscopy, which enables live observation of the growth of anaerobic thermophiles, (3) syntrophy between *T. globiformans* and *Methanocaldococcus jannaschii*, which produces methane and is involved in the production of oil components from algae, and (4) effects of hematite (α-Fe₂O₃) on the cocultivation of syntrophic partners in the presence of elemental sulfur, which interferes with the syntrophy.

Select Publications
Self-reproduction or Self-organization is a characteristic which is observed in all biological organisms. In My Lab, we research the self-organization using a cellular slime mold, Dictyostelium discoideum, as a model system, by the combination of experimental and theoretical methods. is to clarify the molecular system that regulates cell orientation and to simulate its dynamics.

Dictyostelium discoideum is the solitary amoeboid microorganism grows as a single cell, but in starvation it initiates chemotaxis towards cAMP, which is secreted by neighboring cells, and constructs a multicellular organism. This feature is simple but very useful for investigating how cells construct the multi-cellular organisms. At present, we are focusing on biological soliton phenomenon which was firstly discovered in my Lab, chemotaxis which involves questions how cells recognize their environment with the molecular techniques. We are also interested in disease-causing genes which are related to the biological self-organization.

Biological soliton phenomena in multi-cellular movement observed in Dictyostelium mutant.

Selected Publications

Ryuichiro Machida

Hexapod Comparative Embryology and Phylogeny

machida@sugadaira.tsukuba.ac.jp

http://www.sugadaira.tsukuba.ac.jp/machida/mushi.html

Our team has been reconstructing the phylogeny and groundplan of the Hexapoda (Insecta s. lat.) by using a comparative embryology approach. So far we have tackled about 20 hexapod orders. Our present focus is on two subjects. The first is the early splitting of hexapods; the figure summarizes our recent advances. The other is the reconstruction of the phylogeny and groundplan of the Polyneoptera, which are composed of 11 orders; the Polyneoptera are difficult to reconstruct in terms of not only the interrelationships between each order but also their groundplan. So far we have studied the following aspects of nine polyneopteran orders: 1) the sister-group relationship between the Grylloblattodea and Mantophasmatodea; 2) the phylogenetic assemblage of the Phasmatodea, Embioptera, and Zoraptera; 3) the inter-group phylogeny of the Dictyoptera, formulated as “Mantodea + [Blaberoidea + (Blattoidea + Isoptera)]”; and 4) the affiliation of the Dermaptera with the Polyneoptera.

A large international project has started with the aim of establishing a robust phylogeny of hexapods based on the results of expressed sequence tag analyses. This 1KITE (1000-species Insect Transcriptome Evolution) project has brought together internationally recognized experts in molecular biology, morphology, embryology, and bioinformatics from 19 global institutes of eight countries. The 1KITE project is coordinated through eight core institutes; our laboratory is the only core institute in Japan.

Comparative embryological synthesis of the early splitting of the Hexapoda. The Entognatha, which were previously well supported, are discounted, and the Diplura, which were previously regarded as being an entognathan constituent, are affiliated with the Ectognatha.

Select Publications
Stem cells and regeneration are currently hot research subjects in the life sciences and provide many possibilities for future treatments for major diseases, including organ damage and degenerative conditions. We are studying the mechanisms regulating stem cell maintenance, proliferation, and differentiation. Our experimental system uses the germline stem cells in *Drosophila* oogenesis. We also use neuronal stem cells in the regenerating newt retina and undifferentiated germline cells in developing newt gonads. Our approaches involve genetic, immunological, and molecular biological techniques.

Keywords on our research are “cell differentiation”, “regeneration”, “*Drosophila*”, “newt”, “germ cell”, and “stem cell”.

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**Select Publications**


Over 27 year experience in pharmaceutical company, I have been contributing to drug discovery by introducing latest life science and technologies. World-class studies on identification and characterization of ligands for “orphan GPCRs” and chemical-based preparation of “iPS cell-derived insulin producing cells” are my original and representative accomplishments. Based on my strong scientific background and problem solving abilities, I have also fostered translational research in the past 3 years through study planning, especially for biomarker strategy and technology, at pre-clinical stage. Recently, I have back again to stem cell research field as Senior Research Scientist in FUJIFILM Co.

If you are interested in joining my laboratory as a graduate student, please contact me before application of admissions.

Publications


Functional analysis of orphan GPCR was my first research area as a biologist in drug discovery research. Kisspeptin was one of the most impactful research topics for me, starting from the discovery of its physiological functions in relation to reproductive neuroendocrinology and its therapeutic application for prostate cancer. Through this program I gained experience and knowledge ranging from the drug target discovery to drug development as clinical studies. I then changed my research field from oncology to drug repurposing, expanded my research therapeutic areas and strengthened translational science. I am now leading External Neuroscience Research to deliver breakthrough medicine through innovative partnership. My experience of therapeutic area includes oncology, reproductive neuroendocrinology, inflammation, and neuroscience.

Drug discovery and development is a teamwork-oriented process where very diverse multi-functional professionals are working together. In addition, drug discovery and development cannot be achieved without external professional partners as well. I really like this multidisciplinary research approach because we can overcome hurdle after hurdle to eventually achieve our goals. Let's work together to make innovation happen.

**Selected Publications**


(1) Elucidation of molecular mechanisms for cold signaling and tolerance
(Figure)
ICE is a transcription factor to control cold-regulated genes and cold tolerance. However, how
ICE1 is regulated and cold sensor(s) have not been elucidated. To elucidate molecular
mechanism, we isolated several interacting proteins of ICE1, including MYC transcription
factors, kinases, and calcium-binding proteins. Characterization of these proteins for cold
signaling and how these proteins regulate ICE1 are studied.

Cold stress should be perceived by cold sensor (unidentified). Then, ICE1-interacting kinase may
activate ICE1 by phosphorylation. Other ICE1-interacting proteins, MYC transcription factors, act like a
competitors of ICE1. These molecular factors control expression of cold-regulated genes and cold
tolerance. Precise molecular mechanisms for cold signaling and identification of cold sensor(s) are
to be studied.

(2) Production of allergens from plant tissues (collaboration with medical doctors)
As a definitive therapy of pollen allergy, sublingual desensitization therapy attracts attention.
However, under the present circumstances, an extraordinary labor is required for extraction of
allergen to use for this purpose. The aim of this study is production of allergen and extraction
of large quantities by using other plants.

Publications
2. Miura et al. (2012) SlICE1 encoding a MYC-type transcription factor controls cold tolerance in
3. Miura et al. (2012) Accumulation of antioxidants and antioxidant activity are enhanced by
4. Miura et al. (2011). ICE1 Ser403 is necessary for protein stabilization and regulation of cold
signaling and tolerance. Plant J 234, 1191-1199.
regulates abscisic acid signaling. Proc Natl Acad Sci USA 106, 5418-5423.
7. Miura et al. (2007). SIZ1-mediated sumoylation of ICE1 controls CBF3/DREB1A expression and
My lab is working on two projects: 1) the cellular and molecular mechanisms of sexual dimorphism of gametes in isogamous, anisogamous, and oogamous green algae; and 2) sexual reproduction in green algae, mosses, ferns, and gymnosperms. Marine green algae belonging to the Ulvophyceae, as well as the unicellular green alga *Chlamydomonas* and land plant sperm, are used mainly as our experimental systems.

**Sexual dimorphism of green algal gametes**

We have been focusing on asymmetric placement of the mating structure (cell-fusion apparatus) in gametes as a feature of sexual dimorphism in green algae. The gamete of green algae belonging to the Chlorophyta has two flagella elongated from the cell apex and a mating structure that is a specialized plasma membrane near the flagellar apparatus. The spatial position of the mating structure differs between the sexes. In the male gamete, the mating structure is located on the opposite side to the eyespot (E), whereas it is located on the same side as the eyespot in the female gamete. As a result of this difference, the two eyespots align on the same side of the planozygote after fertilization. Our lab is trying to elucidate the cellular and molecular mechanisms of mating structure development and placement in green algal gametes. We also aim to elucidate the mechanisms of gamete-type differentiation according to mating-type locus by using *Chlamydomonas* and ulvophycean green algae.

**Select Publications**

Apicomplexan parasites, including *Toxoplasma gondii* and malarial parasites, have an organelle called the apicoplast, which is a kind of plastid and developed from a secondary symbiont of the ancestor of red algae. Apicomplexan parasites have lost their photosynthetic activity because they gained a new, parasitic ability during evolution. However, they still possess the apicoplast, which is essential for their survival. The biology of *T. gondii* and malarial parasites is therefore similar in some ways to that of plant systems because they still have a plant inside the cell. We are investigating the plant-like nature of apicomplexan parasites as a target for the development of anti-parasitic drugs. We are also focusing on the parasitic ability that replaced their photosynthetic ability, and studying how they highjack host functions for their survival.

**Select Publications**

Mitochondrial genome (mtDNA) mutations and the resultant mitochondrial respiratory abnormalities are associated with a wide variety of disorders, such as mitochondrial diseases, neurodegenerative diseases, diabetes, and cancer, as well as aging. By using model cells and mice carrying mutant mtDNAs, we are studying the pathophysiological mechanisms of mtDNA-based disorders; our goal is to develop effective treatment strategies for these conditions.

Select Publications
Until recently, gene expression was thought to be controlled mainly at the level of transcription initiation by repressor or activator proteins. It has now been revealed that other mechanisms can regulate gene expression and involve RNAs that might act as antisense RNAs, sequestering molecules, or thermosensors. Bacterial pathogens sense their environments, and in response, virulence genes are induced or repressed through spatial and temporal regulation. These pathogens are also subjected to stress conditions, which require appropriate responses. Recent research has revealed that RNAs are key regulators in pathogens. Small RNAs regulate the translation or stability of mRNAs that encode virulence proteins, namely proteins that are triggered by environmental cues and stresses. In most cases, these small RNAs act directly on target RNAs by an antisense mechanism.

Select Publications
We are studying the development of less studied, non-model animal groups, currently focusing on placozoans, *Xenoturbella*, and sea lilies. Despite their phylogenetic importance, development of these groups are largely unknown, with that of placozoans still remaining a mystery. By revealing their developmental patterns, we aim to gain new information on the evolution of metazoans and deuterostomes.

Placozoans are amoebae-like marine flat animals about 1mm in diameter, lacking tissues or organs, and even neurons or muscle cells. *Xenoturbella* is a marine animal belonging to the Xenacoelomorpha, a phylum suggested to be a sister group to all other bilaterian animals. Sea lilies are regarded as the most basal living echinoderm, and we have uncovered its development in 2003 for the first time since it was discovered in 1864.

**Selected Publications**

Kentaro Nakano

Molecular Dynamics and Cellular Function of the Cytoskeleton

knakano@biol.tsukuba.ac.jp

http://www.biol.tsukuba.ac.jp/organelle/nakano.html

My goal is to understand the molecular mechanisms regulating cell behavior, including cell division, cell morphogenesis, and intracellular transport, from the perspective of the cytoskeleton. These processes are fundamental to life. In my lab, unicellular organisms are used as a model to this purpose. We are using a combination of several methodologies, including genetics, cell biology and biochemical approaches, to achieve our aims.

Publications
My research interests are in the areas of developmental biology, cell biology, neuroendocrinology, and molecular genetics in insects, particularly the fruit fly Drosophila melanogaster. Currently I am interested in understanding how molecular and neuro-endocrine mechanisms are adaptively involved in regulations of nutrient-dependent developmental plasticity, mating-induced female germline stem cell proliferation, and the host-parasitoid wasp interactions.

Selected Publications


Our major research interests include unique virulence mechanisms and metabolism of protozoa, particularly the enteric anaerobic parasite *Entamoeba histolytica*. We mainly focus on vesicular trafficking, phagocytosis, autophagy, proteases, amino acid metabolisms, drug development, and organellogenesis. Our research approaches are very robust, and include biochemistry, cell biology, live imaging, multi-omics including metabolomics, and reverse genetics. We always have several foreign students and guest researchers. We welcome you to our laboratory, full of international atmosphere. Our official language is English.

Select Publications
We are interested in how simple organisms sense the external stimuli and how movements of such simple animals are regulated. We are using electrophysiological and behavioral approaches to explore these mechanisms. Our current projects include chemosensory transduction mechanisms in the protozoan *Paramecium*, the mechanisms regulating behavioral responses in *Paramecium*, and the mechanisms regulating motility in the tentacle of the dinoflagellate *Noctiluca*.

Photographs showing movements of a live tentacle (upper panels) and Triton-extracted tentacle (lower panels) of the marine dinoflagellate *Noctiluca miliaris*. The live tentacle exhibits spontaneous extension-flexion movements associated with membrane potential changes called tentacle regulating potentials. The extracted tentacle flexes when the pH of the reactivation medium is lowered.

**Select publications**

I maintain diverse research interests, with the common theme of plant–animal interactions. My current interest is to understand how plants have evolved their traits to maximize reproductive success, as mediated through interactions with animal pollinators. According to the questions to be addressed, I adopt various approaches in my research: field observations or experiments, mathematical models, computer simulations, and laboratory experiments with bumble bees, which are among the major pollinators in temperate regions.

Some pollinators, such as bees and hummingbirds, learn to visit particular plants in repeatable sequences while collecting nectar or pollen from flowers. My recent studies have focused on the ontogeny and economics of this "traplining" behavior, as well as its possible consequences for floral evolution. I have found that the responses of pollinators to floral traits change significantly as they gain experience, and that this change could have enhanced the evolution of complex combinations of floral traits. Currently I have been looking closely at floral color change as an evolutionary outcome of such dynamic interactions between plants and learning pollinators.

Left: *B. diversus* with flowers of *Salvia nipponica*. The seesaw-like anther filaments discourage bees from staying on the plant and thus reduce self-pollination rates. See [3]. Right: Floral color change (FCC), i.e., the retention of old, non-reproductive, rewardless, but fully turgid flowers in an altered color, has been suggested to enhance pollination by visually oriented floral visitors. Nevertheless, FCC appears rather infrequent in nature. Why? See [1].

**Select Publications**

Our body fights against pathogens by using its immune system, which is a vast, systemic network of specialized cells and diversified molecules. Antibodies play a pivotal role in the immune system by discriminating and attacking infectious “non-self” agents. B-lymphocytes produce antibodies by regulating the rearrangement of antibody genes and maintaining the antigen specificities of antibody molecules. After an infection, subpopulations of antigen-specific B-lymphocytes achieve longevity to form immunological memory, which is reactivated upon infectious challenge a second time with the same pathogen.

My research interests include 1) the molecular mechanisms of antibody repertoire formation by pre-B-cell receptors in the early stages of B-lymphocyte differentiation; 2) the search for immunological niches that sustain memory B cells; 3) new in silico methods for optimizing the antigen-recognition sites of antibody molecules; and 4) establishment of monoclonal antibodies recognizing the universal epitopes of viruses.

In silico representation of IgG1 antibody (lower molecule) and antigen (upper molecule, hemagglutinin of H5N1 avian influenza virus). Infection with the newly emerging H5N1 virus is life-threatening, and a virus pandemic would be a serious problem for human health worldwide. Our immune system has not experienced the newly emerging H5N1 virus, but it is able to see the so-called “universal epitope,” in other words the common molecular structure that is conserved among many influenza viruses. We are searching for new universal epitopes in silico and trying to establish new methods for making effective antibodies against them.

Select Publications


Michiyuki Ono

Plant Physiology, Biotechnology, and Gene Literacy Education

ono.michiyuki.fm@u.tsukuba.ac.jp

http://gm-edu.sakura.ne.jp/english

Ono Lab’s Researches:

We are approaching the universal mechanisms of the photoperiodic regulation of flowering. We are using *Pharbitis nil* (*Ipomoea nil*), an obligate short-day plant, as well as *Arabidopsis thaliana*. We cloned and studied several genes for components of circadian clock, photoreceptors, floral regulators and florigen.

As development researches on genetically modified (GM) plants, we are developing new methods for modifying the shapes and colors of flowers. We are also studying production of edible vaccines etc. using transgenic crops in collaboration with medical doctors.

We are investigating ways to deepen the understanding of secondary students on genes “gene literacy” through practice of hands on laboratory activities. For citizens, we are practicing activities, such as holding “Science Cafe” and “Science & Art”, to promote science communication and facilitate scientists to fulfill their accountability.

Seedling of *Pharbitis nil* is very sensitive to short-day induction of flowering (Left). Therefore, it has long been used as a model plant for studies on photoperiodic induction of flowering. *P. nil* (Japanese Morning glory) is chosen as one of the National BioResource Project (NBRP, http://wwwnbrp.jp). A genetically modified flower shape in *P. nil*: the sympetalous corolla was disrupted to form choripetalous corolla (Right).

Publications


We have developed a new bioassay system to find and evaluate natural bioactive compounds (e.g. phytochemicals, plant extracts, fermented foods, and animal tissues) that influence health and aging; this novel bioassay system uses nematodes to characterize the bioactivity of natural substances. Because of its biological characteristics (easy culture, short lifespan, and availability of mutants), the nematode is a suitable and well-characterized model for investigating the physiology and mechanisms of human aging and disease. We are using this animal to screen for biomaterials with potential benefits for human health.

To promote health (prevention and amelioration of lifestyle-related diseases) and youth (anti-aging and vitality), we are searching for natural bioactive compounds. We are scientifically evaluating the bioactivity of these substances and developing novel bioactive materials. We are also conducting applied studies to develop functional foods, functional feeds, cosmetics, and medicines.

Select Publications
Vertebrate species derive most of ambient information through photoreceptors, where light is absorbed and signaled to the nervous system. Visual perception initiates with the absorption of light by rod and cone photoreceptors in the retina, which mediate dim light vision and bright light vision, respectively. In addition to this classical vision, light reception by inner retinal neurons or extraocular photoreceptors is thought to be of great importance to animal behaviors such as circadian phase shift and magnetoreception. The aim of our research is to elucidate underlying mechanism of the photoperceptions by which absorbed photons are converted into an electrical response and signaled to the brain. To achieve this goal, we mainly use electrophysiological technique, a powerful tool to characterize molecular mechanism in neurons, in combination with genetically manipulated animals.

Selected publications
Our group is studying the mechanisms of development of the ascidian *Ciona intestinalis*. This ascidian is an excellent model, because 1) its genome sequence has been determined; 2) it has quick embryogenesis (~18 h from fertilization to the swimming larval stage); 3) it has a simple body plan, with about 2600 cells making up the body in the tadpole stage; 4) its basic body plan is shared with the vertebrates; and 5) technologies for studying its genetic functions have been established; they include transposon-mediated germline transformation and mutagenesis.

In particular, we are focusing on 1) mutagenesis of *Ciona intestinalis* with transposons to uncover novel gene functions; 2) the molecular and cellular mechanisms of metamorphosis; 3) formation and differentiation of the nervous system; 4) maternal gene functions and egg formation; and 5) the evolution of chordates in terms of genetic function.

**Select Publications**

The general aim of my research is to reveal the mechanisms of ecological diversification at the level of species and populations, as well as speciation mechanisms. Furthermore, I deal with behavioral variations in different individuals of the same population. In particular, I focus on social behavior and mating behavior in spider mites. Spider mites are small arthropod herbivores less than 1 mm in length. They are good model organisms because they complete their development (egg to adult) in a short period (ca. 5 - 20 days under optimal conditions) and they can be mass-reared in small spaces. These advantages allow investigation of the following projects:

- Kin selection and kin competition
- Geographic variation in lethal male-male combat
- Reproductive isolation among populations showing different male-male aggression
- Evolution of alternative male mating tactics
- Reproductive interference between invasive and native spider mites
- Evolution of social behavior in spider mites

Publications

Do you know what an interspecific hybrid is? Mules from mares and donkeys, leopons from lionesses and leopards… Interspecific hybrids are rare in nature; most of them are sterile and therefore cannot produce descendants. If these hybrids were not rare, then biological species would become fused and lost from the world. In other words, species exist because of reproductive isolation: the origin of new species is completed by acquiring reproductive isolation between populations. Therefore, speciation is a major driving force of evolution. The purpose of our research is to elucidate the genetic mechanisms of speciation.

Our model organism is Drosophila. Genomic sequencing has been completed in 12 Drosophila species. The biodiversity of this genus is spectacular: 3950 extant species (and 12 fossil species) have been described in the Drosophilidae. Furthermore, Drosophila has many crossable sibling species pairs and can be used to provide useful experimental systems for investigating the genetic mechanisms of speciation.
Eukaryotic cilia and flagella are projections on eukaryotic cells. The microtubule-based structure in cilia and flagella is called an axoneme and is composed of molecular motor dynein and several regulatory proteins. The structures of the axonemes have been highly conserved through evolution and play important roles in sperm motility, embryonic locomotion, current generation in epidermal tissues such as the oviduct and trachea, and cell signal reception.

We are using the embryos or sperm of marine invertebrates such as tunicates, sea urchins, fishes and snails to study the regulatory mechanism of ciliary and flagellar movement. Research topics are signaling pathway in sperm motility activation and sperm chemotaxis toward egg-derived substances, and regulation of flagellar and ciliary waveforms. To analyze motility and waveforms in cilia and flagella we are using a high-speed camera, a stroboscopic lighting system, auto-tracking software, and a Ca\textsuperscript{2+}-imaging system.

Publications
How do the organisms know their appropriate timing of maturation from the juvenile to the adult? One of the key regulatory mechanisms is steroid hormone biosynthesis in response to various environmental conditions. We have been studying the neuronal regulatory mechanism of steroid hormone biosynthesis in the fruit fly *Drosophila melanogaster*. By using molecular genetics, cell biological analysis, and live-imaging system, we are trying to understand how the genetic program of organisms is flexibly coordinated to accomplish the development from eggs to individuals. Anyone and everyone is welcome to share our scientific interests in the lab!

**Selected Publications:**


Mitochondria play important roles in cell functions such as ATP production and apoptosis. Mammalian mitochondria contain multiple copies of approximately 16-kbp double-stranded DNA with a closed circular conformation. Two genetic characteristics that are major specific phenomena observed during the inheritance of mitochondrial DNA (mtDNA) are maternal inheritance and rapid segregation. We have been investigating the mode of mtDNA transmission in a mouse model.

Our particular focus is the genetic machinery of rapid segregation. Usually, 1000 to 10,000 copies of mtDNA molecules exist in a single somatic cell, and the mutation rate of mtDNA is higher than that of nuclear DNA. Thus, mtDNA is thought to show heteroplasmcy: in other words, more than one type of mtDNA exists in a cell. However, rapid shifts in mtDNA variants between generations have been observed in several species, and mtDNA homoplasmcy is maintained in most individuals. Our group previously proposed models for the mitochondrial bottleneck effect, which is a concept for the genetic machinery of rapid segregation. We are currently investigating mtDNA and mitochondrial segregation by using transgenic mouse strains.

Select Publications
Legumes (Fabaceae) are well-known for their ability to form nodules on their roots through symbiotic interaction with soil bacteria (rhizobia), a relationship termed “root nodule symbiosis”. Within the nodules, the rhizobia fix gaseous nitrogen and make it available to the host plants as a nitrogen source; in turn, the plants provide a carbon source for the rhizobia. During nodulation, signaling initiated by rhizobial infection alters the fate of differentiated cortical cells and causes formation of new organs. Two qualitatively different regulatory events, namely bacterial infection and nodule organogenesis, need to be coordinated in the epidermis and cortical cells to establish proper nodule formation. We aim to elucidate molecular mechanisms underlying these processes using a model leguminous plant, *Lotus japonicus*.

**Select Publications**

Living organisms recognize changes in their environmental conditions and regulate their gene expression to acclimate to such changes. However, the molecular mechanisms of signal perception by cellular sensors are not yet well characterized. We developed a way to construct chimeric sensors, which contain a signal-recognition domain from an unknown uncharacterized sensory kinase and a kinase domain from the well-studied phosphate-deficient sensor, SphS, from the cyanobacterium Synechocystis sp. PCC 6803. This system is a powerful tool for studying the functions of sensory kinases and the molecular mechanisms of signal perception, as well as for developing artificial switches to regulate gene expression in systems biology.

Construction of a chimeric sensory kinase in Synechocystis. A phosphate sensor, SphS, regulates expression of the phoA gene encoding alkaline phosphatase (AP). The chimeric sensory kinase containing the signal-recognition domain of an uncharacterized kinase and the kinase domain of SphS regulate the expression of the phoA gene under the conditions perceived by the uncharacterized sensory kinase.

Select Publications

Tanaka Kenta

Regeneration and Adaptive Evolution of Wild Plants with Environmental Variation

kenta@sugadaira.tsukuba.ac.jp

http://www.sugadaira.tsukuba.ac.jp/kenta/

My goal is the integration of population ecology and population genetics to elucidate (1) the effects of natural selection due to ecological factors on genes and allele dynamics; and (2) the ecological and population consequences of genetic change. One of our recent targets has been wild Arabidopsis, which is ecologically diverse and genetically tractable. Arabidopsis kamchatica ssp. kamchatica and ssp. kawasakiana are allopolyploids originating independently from the same parental species (see Figure below). Although these allopolyploids inherited identical genome components, they show surprising differences in their ecology. Subspecies kamchatica is a perennial herb with a remarkably wide altitudinal distribution—from 30 to 3000 m—even at a single latitude, whereas ssp. kawasakiana is an annual herb limited to low altitudes. We performed a natural demography census, laboratory and field common-garden experiments, and genome-wide microarray and next-generation sequencing. We found that 1) natural selection and population maintenance mechanisms change with altitude; 2) many traits related to life history, defense, and stress tolerance are genetically distinguished with altitude; 3) populations have evolutionarily adapted to their own altitudes; and 4) there is strong diversifying selection of the genes for trichomes and photoreceptors, and the allele frequencies of these genes change with altitude.

Select Publications
I am an associate professor in the Doctoral Program in Biological Sciences at the University of Tsukuba, where I teach ecology, theoretical biology, biometry, and computer programming. I specialize in population biology using a wide range of materials, including natural communities of egrets and herons in the eastern region of the Kanto Plain; laboratory populations of bean weevils collected from all over the world; natural populations of bumble bees in urban and rural regions, and the \textit{in silico} digital bugs that occupy gigabytes on the hard disks attached to my computers. I am using these materials to question, in an evolutionary sense, why some organisms live in groups but others tend to live solitarily. My speciation philosophy was converted to Wrightian from Fisherian when I studied evolution and ecology under Prof. Michael Wade in 1995–1996. I believe that Wright’s shifting balance scheme is realistic. I’m often described as a theoretician, but I consider myself primarily to be an ecological field worker. Somehow I have become good at capturing wild egrets and herons by hand!

The photographs (clockwise from the top left panel) show a larva of \textit{Callosobruchus maculatus}, a notorious bean-weevil pest of legume seeds, constructing a rough wall inside a bean when it happened to break into the cavity of another larva. The larva has used feces and a secreted substance to form the wall. The \textit{C. maculatus} larvae are of the scramble type, so multiple adults can emerge from a bean, but if the wall structure is artificially removed the larva will fight with the other larva in the cavity and one or both of them will die as a result. The rough wall acts as a kind of language that prevents fights between inherently quarrelsome larvae.

Select Publications

Protein degradation regulated by ubiquitin proteasome and autophagy systems in the central nervous system is critically important to the cellular basis of neuronal networks. Perturbation of this cascade causes various disorders, such as neuronal degeneration and mental retardation. The major goal of our project is to understand the mechanisms that underlie the modification of synaptic connections and neuronal inflammation regulated by both neurons and glial cells. We are focusing on how impairment of protein degradation leads to synaptic dysfunction and inflammation in the brain. We are also interested in developing new tools to screen for small compounds and proteins associated with neuronal disorders caused by aberrant protein degradation.

Select Publications

Our interest is in the evolutionary processes of various animal body plans. We are especially interested in the following issues.

1) Establishment and evolution of the chordate body plan. Chordates acquired several novel characters such as notochord, dorsal central nervous system, vertebrae, and pharyngeal arches. We explore how these novel organs evolved by comparing developmental genetics in amphioxus and lampreys.

2) Evolution of echinoderm larval morphology. Echinoderms show two types of larvae, pluteus and auricularia. We asked how these discrete larval morphologies evolved by comparing developmental genetics in sea urchins and starfish.

3) Evolution of bivalve shell plate in bivalve mollusks. Bivalve mollusks acquired bilaterally separated shell plates, and this unique morphology is visible as early as the gastrula stage, showing that the separated shell plates are established by modifying their early embryogenesis.

4) Establishment of the unique body plan of caprellids. The unique body plan of the caprellids was established from a gammarid-like body plan through the loss of some thoracic limbs and abdominal segments. We are seeking the genetic modification response for this loss. We are interested in this phenomenon because some caprellid species re-acquired the limbs.

Expression of pax3/7 and soxE, whose homologues are involved in the differentiation of the dorsal neural tube in vertebrates, mark dorsal part of the acorn worm nerve cord, showing that acorn worms possess similar DV patterning mechanism in their nerve cord. (Miyamoto and Wada, Nature Comm. (2013).

**Publications**


Organisms interact with other organisms and with their ambient environments. Because these processes are components of ecosystems, we need to understand not only biological activities but also environmental factors if we are to understand ecosystem mechanisms.

Although humans receive various ecological services from marine ecosystems, the mechanisms by which this occurs are less well understood than in terrestrial ecosystems. We are trying to figure out the dynamics and flows of organic matter derived from marine organisms (e.g., macroalgae, phytoplankton, and bacteria) by using field investigations and chemical analyses. Recently, we have been focusing on 1) the fate of macroalgal organic matter; 2) ocean acidification and its effect on marine organisms; and 3) biotic and abiotic formation of marine snow particles.

Selected Publications

The research interests at the University of Tsukuba are:
1) Molecular genetic and cytogenetic studies aimed at the conservation and genetic diversity of underutilized species, with an emphasis on crop species in developing countries.
2) Production of transgenic plants and environmental biosafety assessment of transgenic plants, with an emphasis on biological and genetic diversity.
3) Sustainable enhancement of the germplasm of genetic resources by using biotechnology applications, with an emphasis on polyploid species and polyploidy genetics.
4) Multidisciplinary studies as part of biodiplomacy associated with United Nations agendas in various international forums. Such studies include sharing of access to, and the benefits from, genetic resources, biosafety, and bioethics, with an emphasis on legal, socioeconomic, and developmental issues.

Select Publications
Carefully considered public communication of science and related issues is vital for a healthy relationship between science and the society that both depends on and supports it. It is becoming increasingly apparent that this communication is multifaceted, highly complex, and must be better understood to face the challenges of our progressively science-reliant society.

I have broad academic interests in the areas of public perceptions of science and scientists; the portrayal of science in news and the media; risk perception; and the use of visual media to communicate science concepts and issues in informal education settings.

I develop and conduct undergraduate and postgraduate courses in communication skills and introductory science communication. These courses are designed to equip students to effectively communicate their future research. In a previous life I trained in marine biology and environmental chemistry, and worked on projects searching for potential new drugs from marine invertebrates.
Shunsuke Yaguchi

Developmental Biology of the Sea Urchin
(Shimoda Marine Research Center)
yag@kurofune.shimoda.tsukuba.ac.jp

http://www.shimoda.tsukuba.ac.jp/~yaguchi/english.html

The primary research goal of our lab is to understand the molecular mechanisms of embryonic axis specification and formation in the sea urchin. It has been suggested that this embryo has two independent, maternally specified axes, primary (anterior–posterior) and secondary (dorsal–ventral). My previous work [3] showed that specification of these two axes is linked by a single transcription factor, FoxQ2, during early embryogenesis. The linking pathway involves a double repression mechanism in which Wnt/β-catenin signaling, which is essential for primary axis specification, represses FoxQ2, which represses both the nodal expression required for secondary axis specification, and BMP2/4, a factor downstream of Nodal. My goal is to try to understand how FoxQ2 is related to, or interacts with, those signaling pathways like the Wnt/β-catenin, Nodal, and BMP2/4, which are responsible for axis specification and formation.

Another research goal is to understand the molecular mechanisms of neurogenesis, including the specification and patterning of the neurogenic ectoderm that develops at the anterior end of the sea urchin embryo.

Blocking Wnt/β-catenin signaling produces permanent blastulae with an expanded anterior neurogenic ectoderm. Left: Serotonin (green) and synaptotagmin (magenta) in a normal embryo. Right: The number of serotonergic neurons is increased in the Wnt/β-catenin–blocked embryo.

Select Publications