

Prefectural University of Hiroshima Graduate School of Comprehensive Scientific Research Program in Biological System Sciences



Program in Biological System Sciences (Master's Course/ Doctoral Course)

<< Master's Course / Doctoral Course >>

- This program aims to develop highly professional human resources who will engage in solving problems faced by the human race as part of high-level educational research in applied life science, biofunctional science and technology, food resources science, and environmental science.

<< Doctoral Course >>

- The program is based on the following education and research policy:
 1. Emphasis not only on basic research but on applied research
 2. Development of scholars who take an interdisciplinary approach
 3. Offering of cutting-edge knowledge and technology by on-campus instructors and off-campus scholars through courses, seminars, etc.
 4. Development of logical thinking skills and practical abilities in students by guiding them in their dissertation research carefully from various angles

Field	Applied Life Science			
Outline	Performs advanced examination of life on the basis of the life science field, including proteins, sugars, lipids, and genes, and clarifies cellular activities and biological functions with the goal of returning the results achieved to society.			
	Subject(Class)	Position	Name	Page
	Immunology and Cell Biology	Prof.	Kyoko INAGAKI-OHARA	3
	Bioresource chemistry and Extracellular matrix engineering	Prof.	Shinji IHARA	3
	Advanced Plant Cell, Tissue and Organ Culture	Prof.	Shinjiro OGITA	4
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	Bioinformatics and Evolutionary Genomics	Assoc. Prof.	Hiroshi SUGA	7
	Molecular Physiology	Assoc. Prof.	Yasuhisa YAMASHITA	7

Field	Biofunctional Science and Technology			
Outline	Performs advanced examination of and clarifies the function control of organisms at the molecular and cellular levels, thereby helping to develop, fundamentally and applicatively, advanced medical technology, pharmaceuticals, and other aspect of the health science field.			
	Subject(Class)	Position	Name	Page
	Epidemiology of Health Science for Local Residents	Prof.	Tadayuki IIDA	8
	Management of Musculoskeletal Disorder	Prof.	Sadaaki OKI	8
	Science of Disabilities	Prof.	Takeya ONO	9
	Kinesiology and motor control	Prof.	Shusaku KANAI	9
	Molecular Pathology and Oncology	Prof.	Yasuhiko KITADAI	10
	Physiological response analysis	Prof.	Yoshihisa KOIKE	10
	Gerontology of ICF for the Elderly	Prof.	Hiroshi SUMII	11
	Organized Mechanism of Higher Brain Function	Prof.	Toshihide HARADA	11

Field	Food Resources Science			
Outline	Performs advanced examination of organism breeding and production engineering, from manufacturing to logistics, and clarifies biological functions in the field of food resources with the goal of effective utilization.			
	Subject(Class)	Position	Name	Page
	Plant Gene Engineering	Prof.	Kohei IRIFUNE	12
	Molecular Plant Pathology	Prof.	Takashi OKU	12
	Vegetable crop science	Prof.	Hiroyuki KOHMURA	13
	Ecology of Changing Environment	Prof.	Tadashi GOMI	13
	Science of Food Processing and Preservation	Prof.	Shota TANIMOTO	14
	Agricultural management	Prof.	PARK SOO YOUNG	14
	Applied Plant Science	Prof.	Kenji FUKUNAGA	15
	Cell Biochemistry and Function	Assoc. Prof.	Norio NAGAO	15
	Environmental Plant Nutrition and Bio-resources Recycling	Assoc. Prof.	Taizo MASUDA	16
	Food Evaluation	Assoc. Prof.	Ryota MABUCHI	16
	Farming Systems	Assoc. Prof.	Wakayo MURATA	17
	Applied Lipid Chemistry	Assoc. Prof.	Yukihiro YAMAMOTO	17
	Food Process Engineering	Assoc. Prof.	Tomoyuki YOSHINO	18
	Biological rhythm for control plant growth	Lecturer	Yusuke TANIGAKI	18

Field	Environmental Science			
Outline	Pursues the study of scientific techniques to understand, predict, and prevent material cycles in the biosphere and engages in the construction of environmental and resource measurement systems, while also analyzing land and aquatic environments/ecosystems in order to develop remediation and conservation techniques on a global scale.			
	Subject(Class)	Position	Name	Page
	Environmental Material Chemistry	Prof.	Toshihito OHTAKE	19
	Environmental Health Engineering on Sound Material-cycle Society	Prof.	Kazuyuki NISHIMURA	19
	Environmental Systems Engineering	Prof.	Hiroyuki HARADA	20
	Instrumental Analysis of the Environment	Prof.	Yoshiharu MITOMA	20
	Atmospheric Environment	Prof.	Seiichiro YONEMURA	21
	Chemistry of Environmental Macromolecules	Assoc. Prof.	Mitsuru AOYAGI	21
	Environmental Management	Assoc. Prof.	Kensuke KOBAYASHI	22
	Hydrospheric Environmental Chemistry	Assoc. Prof.	Kanako NAITO	22
	Inorganic Analytical Chemistry	Assoc. Prof.	Jun NISHIMOTO	23
	Environmental Risk Assessment and Management	Assoc. Prof.	Atsushi HASHIMOTO	23
	Adaptive and Intelligent Signal Processing for Environmental Systems	Prof.	Yegui XIAO	24
	Intelligent Control of Environmental Systems	Prof.	Hugang HAN	24

Immunology and Cell Biology



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Research topics

Clarify the role of leptin receptor signaling in modulation of the immune system supporting inflammation and tumorigenesis in the gastrointestinal.

Outline of Research

The gastrointestinal tract is a site constitutively exposed by numerous antigens and microbiota. Therefore, the immune system in the gastrointestinal has evolved mechanisms that maintain immunological tolerance to food antigen and commensal bacteria, whereas it recognizes invasive pathogens and induces protective immune responses. The immunological responses are critically regulated by cytokines / hormones. Failure of homeostasis of the immune system causes to the onset of various diseases, such as inflammation, cancers, autoimmune diseases, allergy.

We have constructed mouse models of gastric cancer that is caused by dysregulation of gastric leptin receptor signaling (5). Leptin is a hormone, which is produced in a variety of tissues including adipose tissue and stomach, and exerts a pleiotropic effect on regulation of food intake and energy expenditure, immunity and hematopoiesis, regulating cell differentiation, proliferation and polarity. In a diet-induced obesity murine model, accelerated gastric leptin signaling due to high-fat diet (HFD) feeding leads to onset intestinal metaplasia,

precancerous lesion in the stomach (3, 4). Our laboratory challenges to reveal the molecular and cellular mechanisms that regulate the development of inflammatory diseases and tumorigenesis in the gastrointestinal mediated through leptin receptor signaling. Recently, we discovered gastric microbiota composition and alteration by HFD. In addition, we showed possibility that leptin signaling in the stomach can modulate gastric microbiota, resulting in regulation of pathogenesis of tumors in the stomach (1).

Reference

1. Arita S. and Inagaki-Ohara K. High-fat diet-induced modulations of leptin signaling and gastric microbiota drive precancerous lesions in the stomach. *Nutrition* 67-68: 110556 (2019).
2. Arita S., Ogawa T., Murakami Y., Kinoshita Y., Okazaki M, Inagaki-Ohara K. Dietary Fat-Accelerating Leptin Signaling Promotes Protumorigenic Gastric Environment in Mice. *Nutrients* 11 (9): E2127 (2019).
3. Arita S, et. al., High-fat diet feeding promotes stemness and precancerous changes in murine gastric mucosa mediated by leptin receptor signaling pathway. *Arch Biochem Biophys.* 610:16-24 (2016)
4. Inagaki-Ohara K, et al., Leptin receptor signaling is required for high-fat diet-induced atrophic gastritis in mice. *Nutrition and Metabolism* 13:7 (2016)
5. Inagaki-Ohara K, et al., Enhancement of leptin receptor signaling by SOCS3 deficiency induces development of gastric tumors in mice. *Oncogene* 33:74-84, (2014)

(Review)

Inagaki-Ohara K. Gastric Leptin and Tumorigenesis: Beyond Obesity. *Int J Mol Sci.* 20(11). pii: E2622 (2019)

Extracellular matrix engineering



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Research topics

Our research is directed at elucidating mechanisms underlying remodeling of basement membrane. We primarily use the model system *C. elegans* in our research. Using the visualized basement membrane of the *C. elegans*, we are currently analyzing remodeling of basement membrane, localization patterns, and how biological resources suppress the damage of the basement membrane.

Outline of Research

The extracellular matrix actively controls cellular functions as the extracellular environment by increasing the expression and changing their structures according to time and circumstances. The basement membrane is an extracellular matrix, a sheet-like protein complex composed of evolutionarily conserved proteins in multicellular organism. The basement membrane is known to be involved in cell adhesion, polarity, differentiation and proliferation, and damage to the basement membrane contributes to skin aging. A major focus of our lab is the understanding of basement membrane remodeling, localization patterns and search for biological resources that suppress the damage of the basement membrane. A key resource of this research is the visualized basement membrane in *C. elegans*, which is conducted by genome editing method. Our group also research other

projects of protein folding in ER, size of organ and artificial remodeling of basement membrane.

- Analysis of the remodeling and localization mechanism of basement membrane proteins *in vivo*
- Search for biological resources that suppress UV damage of basement membrane
- Study on the protein folding in endoplasmic reticulum
- Study of organ size control in *C. elegans*

Reference

- 1) Matsuo, K., Koga. A and Ihara, S.* Visualization of endogenous NID-1 and EMB-9 in *C. elegans*. *mPublication Biology*: 10.17912/micropub.biology.000110 (2019)
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- 3) Ihara, S., * Nakayama, S., Murakami, Y., Suzuki, E., Asakawa, M., Kinoshita, T. and Sawa, H. PIGN prevents protein aggregation in the endoplasmic reticulum independently of its function in the GPI synthesis. *J. Cell Sci.* 130, 602-13 (2017).
- 4) Ihara, S., Hagedorn, E. J., Morrissey, M. A., Chi, Q., Motegi, F., Kramer, J. M. and Sherwood, D. R*. Basement Membrane Sliding and Targeted Adhesion Remodels Tissue Boundaries During Uterine-vulval Attachment in *C. elegans*. *Nature Cell Biology* 13, 641-51 (2011)
- 5) Ihara, S. and Nishiwaki, K*. Prodomain-dependent tissue targeting of an ADAMTS protease controls cell migration in *Caenorhabditis elegans*. *The EMBO Journal*, 26: 2607-2620. (2007)

Advanced Plant Cell, Tissue and Organ Culture



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Research topics

We focus on the application of plant cell, tissue and organ culture methodologies to all research and development areas of traditional and modern plant biotechnology.

- Plant cell, tissue and organ culture
- Transformation
- Plant Stem Cell manipulation
- Histochemical analysis
- Metabolic engineering

Outline of Research

One of major interest of our research is the establishment of cell and tissue culture system and its utilization for utilization of plant bioresources.

We established following methods and procedures (#1-#3) to elucidate detailed features and mechanisms of growth in higher plants.

#1; Establishment of a novel **practical plant cell and tissue culture protocols** of target plants.

#2; Establishment of a novel **cell manipulation** model and its utilization.

#3; Establishment of **plant stem cell culture** systems of several bamboo species for functional analysis.

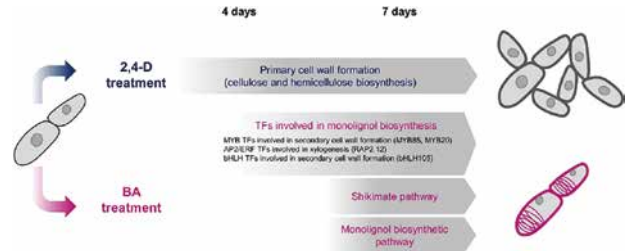


Fig. Xylogenesis suspension culture model ; Pn (rpc00047) cells (ref 2).

Reference

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- 2) S. Ogita et al. (2018) Transcriptional alterations during proliferation and lignification in *Phyllostachys nigra* cells. *Scientific Reports* 8(1) 11347
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Bioscience for Cell Function Control



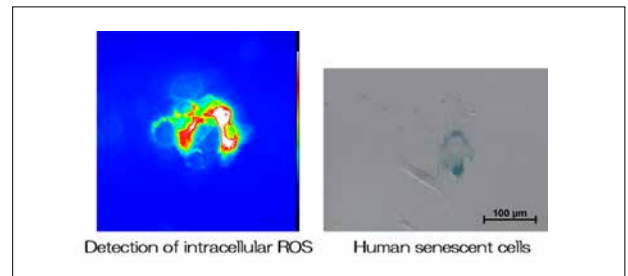
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Research topics

Reactive oxygen species (ROS) play a pivotal role in aging and the pathogenesis of various diseases including cancer. Our research is aiming to develop the controllable methods / biomaterials against ROS-induced deleterious phenomena such as oxidation of biomolecules, cell damage and cell death. Especially, we focus on the ROS-related life phenomena in the fields of dermatology, oncology and anti-aging medicine etc., and we attempt to control the ROS-induced various events in these areas for improvement of quality of life.

Outline of Research

"Cell death" is one of the key phenomena for survival / function control in living organisms, and it is closely related to health / disease / the life-span of the human body. The elucidation of causes of the cell death and its process, and the technical developments to control cell death have great practical values for disease prevention / treatment and aging suppression. Therefore, our study aims to develop biomaterials / bio-techniques for suppression of **aging, cancer** and **life-style related diseases** by controlling the cell injury / cell death (suppression or promotion). Particularly, we have focused on the **oxidative stress (redox) control**, and demonstrated the efficacies of vitamin C / E and its derivatives, fullerene derivatives and the hydrogen / platinum on the ROS-induced cell damage / cell death, on the cellular senescence-induced intracellular ROS increases and on the growth suppression / promotion of cell death / inhibition of invasion of cancer cells using human



cells and 3D-skin models. In addition, we recently investigate the regulatory mechanisms of the **vitamin C transport**.

Reference

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Microbiology



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Research topics

Research theme in SAKAGUCHI Laboratory can be classified into mainly four parts. First, biorecovery and bioconversion of elemental resources by using biomineralization is one of main subject in our research. So far, we have achieved biorecovery of Se, Te and heavy metal ions based on the bioconversion to florescent semiconductor materials. Second subject of our study is development of environment (onsite) monitoring tool and system based on biosensing properties in microbes such as bioluminescence. In the third place, screening of microbes such as wild yeasts and fungi from agricultural and biological products in Bihoku (north Hiroshima) area have been started for the establishment of the regional specific fermented food and beverage for local promotion. Finally, for searching and screening for new species of microbes, we have continuously carried out visits to various extreme environments as hot springs and under grounds below 300 meters, and participations into marine voyage of training ships (Toyoshio-maru and Seisui-maru) in other universities.

Outline of Research

Development and creation of biomaterials and biological functions based on biotechnology and genetic engineering methods with microbes for elemental recovery, bioremediation, environmental monitoring, and manufacturing of nano-spheres,

are main subjects in my laboratory. Furthermore, we have been carried out the fundamental researches on environmental microorganisms, extremophiles and biomineralization toward their technological applications. In addition, recently, we have started to search the new microbe for food and beverages development as our new themes.

Reference

- 1) **Toshifumi Sakaguchi**, Masaki Kato, Naoki Kuriyama, Harutaka Niiyama, Shougo Hamada, Yasutaka Morita and Eiichi Tamiya, Conjugal transformation and transposon and chemical mutagenesis of gram-negative selenate-respiring *Citrobacter* sp. strain JSA, *Current Microbiology*, **59**, 88-94 (2009)
- 2) **Toshifumi Sakaguchi**, Taiki Nakano, Yuko Kimura, Shouhei Nogami, Ikue Kubo, and Yasutaka Morita, Development of a genetic transfer system in selenate-respiring bacterium, *Citrobacter* sp. strain JSA, which was isolated from a freshwater natural sediment, *Journal of Bioscience and Bioengineering*, **111**, 443-447 (2011)
- 3) Hiroyuki Ayano, Masaki Miyake, Kanako Terasawa, Masashi Kuroda, Satoshi Soda, **Toshifumi Sakaguchi**, and Michihiko Ike, Isolation of a selenite-reducing and cadmium-resistant bacterium *Pseudomonas* sp. strain RB for microbial synthesis of CdSe nanoparticles, *Journal of Bioscience and Bioengineering*, **117**, 576-581 (2014)
- 4) Tomoyasu Sugiyama and **Toshifumi Sakaguchi**, Electron microscopy and X-ray analysis of Cr-containing precipitates synthesized by newly isolated actinobacterium, *Flexivirga alba* ST13T *Indian Journal of Microbiology*, **54**, 358-360 (2014)

Radiation Genome Systems Biology



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Research topics

What is the intracellular environment of cancer cells who was exposed to genotoxic stresses that provides an epigenetic landscape permissive for cell survival *in vivo*? How do cancer cells with such genome systems acquire genetic and epigenetic alterations that drive cancer spreading? To address these challenges, we are focusing on the following critical signaling proteins involved in mitotic events, which would become potential targets for the development of new therapeutic agents for cancer.

Outline of Research

A brief overview of our research

Working in the broad areas of cancer cell biology including cell transformation, DNA repair, cell cycle checkpoints, and invasion and metastasis, we have made several seminal discoveries; these include the discovery and characterization of mammalian proteins for driving tumor aneuploidy, such as the **chromosomal passenger protein AIM-1 (Aurora-B) and its related proteins**, and also the discovery and characterization of **RhoGDI β as the cancer metastasis-related gene**. More recently, we characterized a new substrate of AIM-1/Aurora-B, which we named **tRNA (cytosine-5)-methyltransferase SAKI**. This protein is now also known as MISU and NSUN2. SAKI/MISU/NSUN2 is overexpressed in human cancer cells with an

increased gene copy number, and is involved in carcinoma progression and plays a role in chemo-sensitivity.

Our research goal

We are interested in understanding how cancer cells survive and escape the cytotoxic effects of radiations and chemotherapeutic agents, eventually increasing invasive and metastatic properties. To this end, my group is now studying the role of several important proteins that are involved in both of mitotic events and apoptotic signaling. One of their goals is to understand the mechanisms that drive cancer spreading in the tumor microenvironment. Another goal is to provide a novel way to improve conventional radiotherapy and chemotherapy outcomes and/or a novel molecularly targeted therapy for cancer treatment.

Reference

- 1) N. Doi, *et al.*, RhoGDI β affects HeLa cell spindle orientation following UVC irradiation, *J. Cell. Physiol.*, **234**, 15134-15146 (2019).
- 2) Y. Sugihara, *et al.*, Inhibition of DMH-DSS-induced colorectal cancer by liposomal bovine lactoferrin in rats, *Oncol. Lett.*, **14**, 5688-5694 (2017).
- 3) T. Ota, *et al.*, Apoptosis-independent cleavage of RhoGDI β at Asp19 during PMA-stimulated differentiation of THP-1 cells to macrophages, *Mol. Med. Rep.*, **15**, 1722-1726 (2017).
- 4) R. Wiedemuth, *et al.*, Janus face-like effects of Aurora B inhibition: antitumoral mode of action versus induction of aneuploid progeny, *Carcinogenesis*, **37**, 993-1003 (2016).
- 5) G. Qi, *et al.*, PARP6 acts as a tumor suppressor via downregulating Survivin expression in colorectal cancer, *Oncotarget*, **7**, 18812-18824 (2016).
- 6) M. Fujiwara, *et al.*, Radiation-Induced RhoGDI β Cleavage Leads to Perturbation of Cell Polarity: A Possible Link to Cancer Spreading, *J. Cell. Physiol.*, **231**, 2493-2505 (2016).

Structural Biology of Supramolecule



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Research topics

To understand the molecular mechanism of ciliary and flagellar movements, we have analyzed the motility of *Chlamydomonas* mutants lacking specific axonemal components. Our research focus is ciliary motor proteins, dynein.

Outline of Research

We are interested in the **bending movements of cilia and flagella**. Cilia and flagella has an evolutionary conserved "9+2" structure, which is composed of more than 300 protein components. Of these, the motor protein **dynein** is one of the most important proteins in cilia and flagella. The dynein generates **sliding movements** between two **microtubules**, which is the base for the bending movements. How to convert the sliding movements into the bending movements is not understood. To understand the mechanism, we have analyzed flagellar movements of *Chlamydomonas* (a unicellular green alga) mutants. We are also interested in the mechanism to construct the complicated "9+2" structure. After the amputation of flagella, *Chlamydomonas* cells can regenerate them in 1-2 hours using a system to transport flagellar components from cell body to flagella. To reveal

the transporting mechanism, we have investigated several types of mutants deficient in the system by biochemical and biophysical techniques.

Reference

- 1) Yagi T, Nishiyama M. High hydrostatic pressure induces vigorous flagellar beating in *Chlamydomonas* non-motile mutants lacking the central apparatus. *Sci Rep*. 10, 2072 (2020).
- 2) Toda A, Nishikawa Y, Tanaka H, Yagi T, Kurisu G. The complex of outer-arm dynein light chain-1 and the microtubule-binding domain of the γ heavy chain shows how axonemal dynein tunes ciliary beating. *J Biol Chem*. 2020.
- 3) Maeda A, Nishino T, Matsunaga R, Yokoyama A, Suga H, Yagi T, Konishi H. Transglutaminase-mediated cross-linking of WDR54 regulates EGF receptor-signaling. *Biochim Biophys Acta Mol Cell Res*. 1866, 285-295, 2019.
- 4) Shima T, Morikawa M, Kaneshiro J, Kambara T, Kamimura S, Yagi T, Iwamoto H, Uemura S, Shigematsu H, Shirouzu M, Ichimura T, Watanabe TM, Nitta R, Okada Y, Hirokawa N. Kinesin-binding-triggered conformation switching of microtubules contributes to polarized transport. *Journal of Cell Biology*. 217, 4164-4183, 2018.
- 5) Kamimura S., Fujita Y, Wada Y., Yagi T., Iwamoto. H. X-ray fiber diffraction analysis shows dynamic changes in axial tubulin repeats in native microtubules depending on paclitaxel content, temperature and GTP-hydrolysis. *Cytoskeleton* (Hoboken): 73(3):131-44, 2016.
- 6) Ichikawa M, Saito K, Yanagisawa HA, Yagi T, Kamiya R, Yamaguchi S, Yajima J, Kushida Y, Nakano K, Numata O, Toyoshima YY. Axonemal dynein light chain-1 locates at the microtubule-binding domain of the γ heavy chain. *Mol Biol Cell*. 26(23):4236-47. 2015.

Reproductive Biology



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Research topics

- 1) Cryopreservation of oocytes and embryos in mammals
- 2) In vitro culture of non-growing oocytes (follicle) in mammals
- 3) Identification of sperm factor for fertilization and embryo development in bull
- 4) Influence of chronic radiation exposure associated with the Fukushima Daiichi Nuclear Plant on bovine oocytes

Outline of Research

Our research is the establishment of the **assisted reproductive techniques (ARTs)** in mammals (mouse, bovine, canine, etc.). ARTs such as **cryopreservation** and **in vitro culture of eggs** (oocytes and embryos) have contributed not only to human infertility treatment and animal production including domestic and experimental animals, but also to development of biomedical sciences. However, the embryos produced by ARTs are still low in pregnancy rate. The application of cryopreserved embryo transfer to bovine production sites have been interrupted by the decreasing in quality of eggs and pregnancy rates after cryopreservation. Therefore, we elucidate the mechanism of degeneration in cryopreserved oocytes and are developing freezing technology for eggs which can be widely used in general. In canine, we have succeeded in the production of pups derived from cryopreserved embryos that was

the first report in the world. Currently, we focus on the alternation to distribution and function of active mitochondria in cryopreserved oocytes.

In addition, we are doing the following research in order to establish the efficient and reliable techniques for next-generation production.

- **In vitro culture of non-growing oocytes** (follicle) in mammals: Establishment of mass production system for high quality embryos.
- **Characterization in bull spermatozoa**: Search for sperm factor controlling fertilization and embryogenesis
- Analysis of the influence of **chronic radiation exposure** associated with the Fukushima Daiichi Nuclear Plant (FNPP) on germ cells: investigation of the oocytes integrity in domestic animals left within the ex-evacuation zone of FNPP

Reference

- 1) Y. Abe, H. Yamashiro, M. Fukumoto, et al. Analysis of Ovaries and Fertilities in Domestic Animals Affected by the Fukushima Daiichi Nuclear Power Plant Accident. In: Manabu Fukumoto (Ed), *Low-Dose Radiation Effects on Animals and Ecosystems*. Springer Singapore, pp. 113-124 (2019).
- 2) Y. Abe, S. Yokozawa, H. Suzuki, et al. Fertilizing ability of canine spermatozoa cryopreserved with skim milk-based extender in a retrospective study. *Reprod Domest Anim*, 53, 237-242 (2018).
- 3) R. Mihara, R. Umemiya-Shirafuji, Y. Abe, H Suzuki, et al. The development of oocytes in the ovary of a parthenogenetic tick, *Haemaphysalis longicornis*. *Parasitol Int*, 67(4), 465-471 (2018).
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Bioinformatics and Evolutionary Genomics



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Research topics

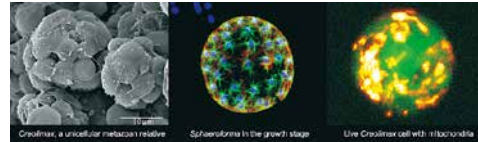
We seek for the molecular mechanisms underlying the evolution of animal multicellularity. Our projects include:

- Comparative genomics and transcriptomics analyses on the unicellular organisms closely-related to animals, namely, unicellular holozoans
- Establishing molecular tools to elucidate the function of "multicellularity-relevant" genes found in unicellular holozoans
- Functional analyses on the genes likely responsible for the evolution of multicellularity using the techniques of transformation and genome editing

Outline of Research

How did multicellular organisms evolve? What were the molecular and genetic mechanisms responsible for? These are the most important, yet unanswered questions in evolutionary biology. The animal multicellularity evolved approx. 700 Mya in the marine environment. It has provided many advantageous features such as large body size, complex behavior, and efficient energy consumption. To acquire multicellularity, on the other hand, cells had to evolve many novel mechanisms including cell adhesion, cell-cell communication, cell differentiation, and organ growth control, which should have been accompanied by a large number of molecular-level innovations. However, the nature of such innovations has remained poorly understood.

We are working on specific protists (unicellular holozoans) that are considered to be the descendants of the closest unicellular ancestor of animals. It is considered that they still retain the cellular and genetic features of animal lineage before the acquisition of multicellularity. We recently sequenced the genomes of several unicellular holozoans, and developed the method of transformation. Using these tools, we are elucidating the mechanisms underlying the transition from unicellularity to multicellularity in the history of life.



Reference

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- 2) Br ate J., ... Suga H. et al., *Curr Biol* 28, 3288 (2018)
- 3) Parra-Acero H., ... Suga H. et al., *Development* 23, 145 (2018).
- 4) Suga H. and Miller W. T. *Sci Rep* 8, 5362 (2018).
- 5) De Mendoza A., Suga H., Permanyer J. Irimia M., and Ruiz-Trillo I. *eLife* 4, e08904 (2015).
- 6) Suga, H., Torruella, G., Burger, G., Brown, M.W., and Ruiz-Trillo, I. (2014) *Mol Biol Evol* 31, 517-528.
- 7) Suga, H. and Ruiz-Trillo, I. (2013) *Dev Biol* 377, 284-292.
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- 10) Suga, H., P. Tschopp, D. F. Graziussi, M. Stierwald, V. Schmid, and W. J. Gehring. (2010) *PNAS* 107:14253-8.

Molecular Physiology



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Research topics

- Analysis of secretory mechanism of EGF-like factor in granulosa/cumulus cells during ovulation.
- Analysis of steroid hormone biosynthesis in granulosa/cumulus cells during follicular development and ovulation.
- Improvement of In Vitro Maturation (IVM) technique in pig.

Outline of Research

In mammals, it is well known that pituitary gland-derived FSH and LH trigger oocyte maturation. Since these receptor do not exit on oocyte, but not somatic cells (granulosa cells and cumulus cells), FSH and LH indirectly induce the process. In our laboratory, to search the oocyte maturation induce factor, we examine the global gene expression in somatic cells using DNA microarray.

Reference

- 1) Y. Yamashita *et al.*, Production of progesterone from de novo-synthesized cholesterol in cumulus cells and its physiological role during meiotic resumption of porcine oocytes. *Biology of*

Reproduction, **68**, 1103-1198 (2003).

- 2) Y. Yamashita *et al.*, Gonadotropin-induced delta 14-reductase and delta 7-reductase gene expression in cumulus cells during meiotic resumption of porcine oocytes. *Endocrinology*, **146**, 186-194 (2005).
- 3) M. Shimada, Y. Yamashita *et al.*, synaprosomal-associated protein 25 gene expression in hormonally regulated during ovulation and is involved in cytokine/chemokine exocytosis from granulosa cells. *Mol Endocrinol*, **21**, 2487-2502 (2006).
- 4) Y. Yamashita *et al.*, Hormone-induced expression tumor necrosis factor alpha-converting enzyme/A disintegrin and metalloprotease-17 impacts porcine cumulus cell oocyte complex expansion and meiotic maturation via ligand activation of the epidermal growth factor receptor. *Endocrinology*, **148**, 6164-6175 (2007).
- 5) Y. Yamashita *et al.*, Positive feed back loop between prostaglandin E2 and EGF-like factors is essential for sustainable activation of MAPK3/1 in cumulus cells during in vitro maturation of porcine cumulus oocyte complexes. *Biology of Reproduction*, **85**, 1073-1082 (2011).
- 6) Y. Yamashita *et al.*, Protein kinase C (PKC) increases TACE/ADAM17 enzyme activity in porcine ovarian somatic cells, which is essential for granulosa cell luteinization and oocyte maturation. *Endocrinology*, **155**, 1080-1090 (2014).

Epidemiology of Health Science for Local Residents

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Research topics

The main purpose of my study is to take preventive measures for health promotion and extension of healthy life expectancy. To practice preventive measures and evaluation of this study, the study subjects are shown below.

- 1) Study on prevention of lifestyle-related diseases and dementia
- 2) Study on health maintenance and promotion by food intervention
- 3) Study on psychological stress and stress response

Outline of Research

People live in various environments, lifestyles (including food), and psychological / social stress. We mainly focus on the epidemiological elucidation of the pathogenic factors of lifestyle-related diseases (arteriosclerosis, osteoporosis, cancer, etc.), the proposal of prevention method of dementia, an early detection by change of physiological function due to psychological stress. We will clarify the cause of health hindrance in the community, study health management, improve health, and extend health life expectancy. Practical preventive measures and evaluations will be conducted with the aim of improving health management and health promotion of the community and healthy life expectancy.

- 1) Epidemiological study on prevention of lifestyle-related diseases and dementia
We inspect the arteriosclerosis related to lifestyle-related diseases in a longitudinal

manner, accurately evaluate the relationship with biochemical indices and motor functions. These studies elucidate the relevance to maintenance and promotion of health in time series.

Meanwhile, previous studies have provided evidence to promote blood pressure improvement through food intervention. This study elucidates the biological response by food and the mechanism of biocompatibility and clarify the role of food in maintaining and promoting health.

- 2) Study on physiological functions by psychological stress

In psychological stress, neural substances are transmitted to the hypothalamus via the cerebral cortex and limbic system. Psychological stress activates the stress defense mechanism (SAM and HPA system). Along with this, the immune system is activated, and homeostasis that maintains balance between mind and body is maintained. At the same time, chronic psychological stress collapses these balances, resulting in autonomic regulation failure, impaired immunity, affective disorders such as anxiety, stress impairment disorders such as sleep disorders. However, there are many unclear points about the mechanism leading to these onset, and we will clarify and discuss it chronologically.

Reference

Iida T, Nishioka R, *et al.*, Effects of Musical Experience on the Autonomic Nervous System Activity of People Listening to Different Types of Sound, *International Medical Journal*, **26**, 43-45 (2019).

Iida T, Inoue K, *et al.*, Comparison of urinary levels of 8-hydroxy-2'-deoxyguanosine between young females with and without depressive symptoms during different menstrual phases, *Acta Med Okayama*, **69**, 45-50 (2015)

Management of Musculoskeletal Disorder



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Research topics

- 1) Study on prevention of musculoskeletal disorder.
- 2) Study on the relationship between musculoskeletal disorder and aging.
- 3) Study on rehabilitation for musculoskeletal disorder.
- 4) Study on orthopedic treatment for musculoskeletal diseases.

Outline of Research

Studies on musculoskeletal disorders in relationship to aging, disuse and overuse.

1. **Prevention** of musculoskeletal disorder.
2. Musculoskeletal disorder and **aging**.
3. **Rehabilitation** for musculoskeletal disorder.
4. **Orthopedic treatment** for musculoskeletal diseases.



Fig. Histological observation of disused soleus muscle following overuse in rat.

Reference

1) S. Oki, T. Ono, *et al.*, Contribution of articular and muscular structures to the limitation of range of motion after joint immobility: An experimental study on the rat ankle, *Biomedical Research*, **19(2)**, 78-81 (2008).

2) W. Tsumiyama, S. Oki, *et al.*, Evaluation of the Lactate Threshold during Downhill Running in Rats. *Journal of physical therapy science*, **24(11)**, 1107-12109 (2012).

3) W. Tsumiyama, S. Oki, *et al.*, Aerobic interval exercise with an eccentric contraction induces muscular hypertrophy and augmentation of muscular strength in rats. *Journal of physical therapy science*, **27(4)**, 1083-1086 (2015).

Science of Disabilities



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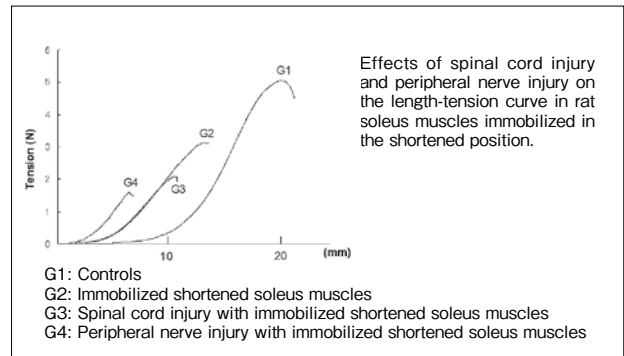
Research topics

We are studying physical disabilities.

- 1) To investigate the prevention and restoration of impairments.
- 2) To investigate the prevention and restoration of muscle elasticity in joint contractures.
- 3) To investigate the influence of the duration of an application of a tourniquet to induce skeletal muscle atrophy.
- 4) To investigate the influence of spinal cord injury, peripheral nerve injury and joint fixation on muscle elasticity in contractures.

Outline of Research

Study of the influence of disease and/or **disuse syndromes** on impairments. Research on the theory and methods of treatment that contribute to the improvement of motor deficits and facilitate health promotion.



Reference

- 1) T. Ono, M. Tsuboi, S. Oki, *et al.*, Preliminary report: Another perspective on the effect of prolonged stretching for joint contractures, *J. Phys. Ther. Sci.*, **19(1)**, 97-101 (2007).
- 2) T. Ono, M. Miyoshi, S. Oki, *et al.*, The effect of ROM exercise on rats with denervation and joint contracture, *J. Phys. Ther. Sci.*, **21(2)**, 173-176 (2009).
- 3) R Endo, T Ono, S Oki, *et al.*, Effect of a 30 minute twice daily prolonged stretch for the prevention of joint contractures in rats, *J. Phys. Ther. Sci.*, **21(3)**, 227-230 (2009).

Kinesiology and motor control



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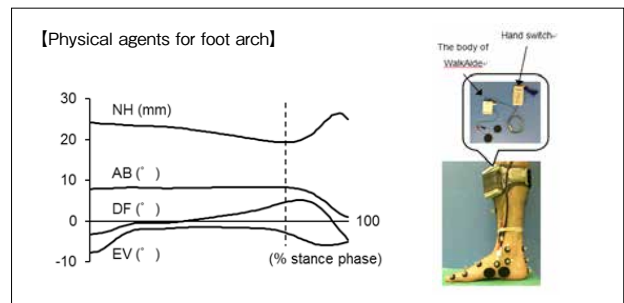
Research topics

- 1) Effects of traditional physical agents and therapeutic exercise
- 2) Disability science by observational motion analysis
- 3) Musculoskeletal motor control
- 4) Development and validation for training equipment and welfare device

Outline of Research

Studies on pathological motor control and traditional physiotherapy.
 Studies on human motion analysis theory and practice.

Our research group apply motional analysis devices to the study of Kinesiology and motor control. We primarily intend to make the NOIES to find a classic and new physiotherapy by using those devices.



Reference

- 1) Okamura K, Kanai S, *et al*, The effect of additional activation of the plantar intrinsic foot muscles on foot dynamics during gait., *Foot*, **34**, 1-5, 2017
- 2) Okamura K, Kanai S, *et al*, Does the weakening of intrinsic foot muscles cause the decrease of medial longitudinal arch height?, *JOSPT*, **29**, 1001-1005, 2017
- 3) Hasegawa M, Kanai S, *et al*, The Kinesiological Effect of Japanese Geta Clogs on Gait, *JOSPT*, **19**, 77-81, 20

Molecular Pathology and Oncology



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Research topics

Gastrointestinal cancers are the most frequent malignancies in Japan. Previous studies have indicated that a large number of genetic and epigenetic alterations in oncogenes and tumor suppressor genes as well as genetic instability determine the multi-step process of colorectal carcinogenesis. However, cancer tissue consists of stroma, and tumor growth is determined not only by tumor cells themselves but also by stromal cells. Recent studies have shown that interactions between tumor and stromal cells create a unique microenvironment. Our recent work regarding a role of bone marrow-derived mesenchymal stem cells (MSCs) on the growth and metastasis of human colon cancer. However, the actual role played by MSCs and the mechanisms underlying MSC-tumour interactions are superficially understood.

Outline of Research

The current themes are:

- 1) to clarify the importance of angiogenesis and lymphangiogenesis on cancer metastasis.
- 2) to clarify the role of cancer-stromal interaction to induce EMT

- at invasive edge.
- 3) to evaluate the mechanisms how MSC enhances metastatic ability of cancer cells.
- 4) to clarify the role of immune cells infiltration in the tumor-microenvironment.
- 5) Relation between gastric cancer and *Helicobacter suis* infection.

Reference

- 1) Sugizaki K, Tari A, Kitadai Y, et al. Anti-Helicobacter pylori therapy in localized gastric mucosa-associated lymphoid tissue lymphoma: A prospective, nationwide, multicenter study in Japan. *Helicobacter*. 2018;23(2):e12474.
- 2) Tari A, Kitadai Y, et al. Watch-and-wait policy versus rituximab-combined chemotherapy in Japanese patients with intestinal follicular lymphoma. *J Gastroenterol Hepatol*. 2018;33(8):1461-8
- 3) Yuge R, Kitadai Y, et al. Silencing of Discoidin Domain Receptor-1 (DDR1) Concurrently Inhibits Multiple Steps of Metastasis Cascade in Gastric Cancer. *Transl Oncol*. 2018;11(3):575-84
- 4) Takigawa H, Kitadai Y, et al. Mesenchymal Stem Cells Induce Epithelial to Mesenchymal Transition in Colon Cancer Cells through Direct Cell-to-Cell Contact. *Neoplasia*. 2017;19(5):429-38.
- 5) Sagami S., Kitadai Y, et al. Choline Deficiency Causes Colonic Type II Natural Killer T (NKT) Cell Loss and Alleviates Murine Colitis under Type I NKT Cell Deficiency. *PLoS One*. 2017;12(1):e0169681.

Physiological response analysis



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Research topics

- 1) Research on the effects of vibro-acoustic therapy on psychological aspects.
- 2) Research on the effect of thermal therapy by sea water and Nigari (clinical and molecular biology)
- 3) Research on the effect of somatosensory stimulation on the Nucleus basalis of Meynert

Outline of Research

Our research focuses on promoting mental and physical health of people. The research method performs somatosensory stimulation with device stimulation or direct stimulation. The effects are examined by analyzing changes in autonomic nerve (mainly total power), tympanic temperature, blood pressure and pulse due to stimulation.

The mainly target of somatosensory stimulation is the Nucleus basalis of Meynert (NBM) which promotes an increase in cerebral blood flow.

NBM is particularly involved in the attention function in the cognitive function.

Assessment tool	Before		After	
	(mean ± SD)	(mean ± SD)	(mean ± SD)	(mean ± SD)
DBD	40.00 ± 6.41	33.80 ± 10.13*		
DMAS (total 24 items)	47.30 ± 28.95	33.10 ± 22.23*		
:Depression and sadness (item 1-17)	32.90 ± 19.35	24.20 ± 14.08*		
:Overall dementia severity (item 18-24)	14.80 ± 10.87	8.90 ± 8.94		
MMSE	17.20 ± 6.19	17.70 ± 5.95		
:attentional disturbance	1.50 ± 1.72	1.710 ± 1.71*		

Notes: n = 10; *P < 0.05
Abbreviations: MMSE, Mini-Mental State Examination ; DBD, Dementia Behavior Disturbance scale ; DMAS, Dementia Mood Assessment Scale; SD, standard deviation.

Reference

- 1) Y. Koike, et al., Effect of Extremity Stimulation via Vibroacoustic Therapy on Elderly Nursing Home Residents with Depression and Attentional Disturbance: A Pilot Study. *International Journal of Geriatrics and Gerontology* (2018).
- 2) Y. Koike, et al., Low-frequency, whole body vibration induced neurite outgrowth by PC12m3 cells with impaired nerve growth factor induced neurite outgrowth. *Journal of Novel Physiotherapies* (2015).
- 3) Y. Koike, et al. Effects of Nonpharmacological Therapies for Disease of the Elderly. *Psychology Research* (2014).

Gerontology of ICF for the Elderly



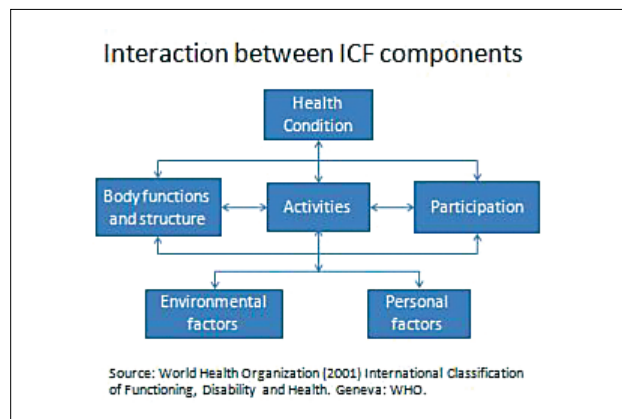
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Research topics

Since the population of Japan has been aging rapidly along with a notable decrease in birthrate. Studies on elderly health and quality of life are socially necessary. Elderly health and quality of life are closely related to a wide variety of factors such as the health condition of the individual, the contextual factors of the environment and personal factors.

Outline of Research

The studies of Gerontology are researched for the multiple disabilities involved by the elderly and the handicapped with functioning, disability and health (ICF). By conducting studies on the relations and interactions between these factors, we aim to find ways to enhance the ability of long-term care professionals, organizations, and systems to effectively respond to issues that affect elderly individuals and their societies.



Reference

- 1) H. Sumii, *et. al.*, "Achievements and Future Directions of the Long-Term Care Insurance System in Japan: Toward Social Kaigo Security in the Global Longevity Society", University Education Press, pp.424, (2014).
- 2) H. Sumii, *et. al.*, "International Dictionary of Long-Term Care Insurance: Globalization of Long-Term Care Insurance", University Education Press, pp.252, (2012).
- 3) H. Sumii, *et. al.*, "The Foundation of Kaigo Insurance Plan Managed by the Standard and Specialty of the Long-Term Care Services", University Education Press, pp. 291, (2007).

Organized Mechanism of Higher Brain Function



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Research topics

- 1) Pathophysiological study on motor, non-motor and cognitive function in neurological and geriatric disorders
- 2) Evaluation of cardiovascular autonomic function in movement disorders
- 3) Therapeutic intervention of medication and rehabilitation in cerebrovascular and neurodegenerative diseases
- 4) Epidemiological longitudinal study on prevention of lifestyle-related diseases in middle-aged and elderly women
- 5) Detection of super-early stage of Alzheimer's type dementia (AD) using AI and development of the intervention for the inhibition of AD progression.

Outline of Research

The human brain is organized with higher brain function. The human brain controls basic life: intelligence functioning, as well as the sensory, motor, and autonomic nervous systems. If part of this higher brain function is damaged, the human brain loses the organization. We focus on this organizational disorder: higher brain function disorder, sensory, motor, and autonomic nervous disorders and so on.

We research the pathophysiological characteristics of the organization disorders. We study evaluation of the organization

disorders using psychological, physiological, biochemical and imaging examination. We study clinical pharmacological approaches and rehabilitation to induce specific forms of plasticity for the organizational disorders. We carry out epidemiological and longitudinal studies of life style-related diseases, bone metabolism, arteriosclerosis and dementia related with this organization disorder. We research anti-aging methods and newtherapies for this organization disorder. We also promote a translational research between pathophysiological study of CNS disorders and AI research.

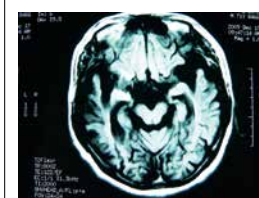


Fig. The MRI revealed severe atrophy of bilateral temporal lobe in a patient with Alzheimer's type dementia.

Reference

- 1) Harada T, *et al.* Impacts of Tai Chi on balance in healthy young adults. *IMJ* 25: 92-94, 2018.
- 2) Kamada S, Ichimura T, Harada T. Knowledge extraction of adaptive structural learning of deep belief network for medical examination data. *International Journal of Semantic Computing* 13: 67-86, 2019.
- 3) Harada T, *et al.* Impacts of high-resolution and high-cut music box audio on balance. *IMJ* 26: 118-121, 2019.

Plant Gene Engineering



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Research topics

1. Gene isolation and function analysis concerning fragrance synthesis in plant flower
2. Gene isolation and function analysis concerning flower organo- genesis
3. Production of useful crops with high commercial value applying molecular breeding, gene manipulation and plant transformation technique
4. Analysis of molecular mechanism of flower scent synthesis
5. Molecular breeding of woody oil plants, *Jatropha* and *Ricinus*

Outline of Research

We have been working on plant molecular genetics and development of gene manipulations concerning for plant molecular breeding to produce useful crops. Techniques, such as survey of useful genes, plant transformation, molecular analysis of gene expression and plant cultures have been usually utilized for research works.

Main works are, genetic analysis of interaction relating food taste between enzymes affecting plant cell wall texture and its inhibitor proteins; second, for increase production on the useful oil plant, *Jatropha* and *Ricinus*, genetic conversion of oily composition or flower organogenesis, and establishment of novel tissue culture system are analyzed; third is explication of genetic system

on fragrance synthesis of lily flower.

We have aim to isolate the genes concerning synthesis of flower smell and to produce the novel scent by recombinant plants; last is the research for the promotion of regional revitalization. To produce transgenic horticultural plant, for example, lily plant, with high commercial value, basic analysis for molecular breeding (gene isolation effecting on morphogenesis of flower organ and inflorescence and control of flowering time) are to be done.

Other works are exploitation for novel plant transformation technique, tissue culture propagation of rare plant species endemic to Hiroshima region, and molecular conversion of starch composition of edible lily bulb.

Reference

- 1) X-Q. Chen, N. Nagao, T. Itani, K. Irifune :Anti-oxidative analysis, and identification and quantification of anthocyanin pigments in different coloured rice. *Food Chemistry* 135 (2012) 2783–2788.
- 2) X-Q. Chen, T. Itani, X-J. Wu, Y. Chikawa, and K. Irifune1,;Physiological factors affecting transcription of genes involved in the flavonoid biosynthetic pathway in different rice varieties. *Plant Signaling & Behavior* 8:12, e27555;1-8,(2013)
- 3) Y.Ohchi, Y. Futamata, Y. Ishihara, K. Irifune and H. Kohmura: Development of a lightweight and cost effective growth medium using rice hulls mixed with soil for tomato bag culture during the idle period in rice nurseries. *J. Life and Environmental Sci.* 7:31-43(2015)
- 4) X-Q Chen, K. Irifune, N. Nagao, Y. Chikawa, X. Wu¹, T. Itani: Comparative evaluation of 2, 2-diphenyl-1-picryl- hydrazyl- hydrate (DPPH) free radical- and oxygen radical absorbance capacity (ORAC) assays in the measurement of the antioxidant capacities of pigmented rice cultivars. *Philippine Agri. Scientist* In press (2017)

Molecular Plant Pathology



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Research topics

Global loss of food caused by plant diseases has been estimated about 13% equivalent to feed 80 million people. So, we don't have any doubt on an importance to control plant diseases to supply enough food for human beings. For a hopeful human life, it is important to understand how plant pathogen invades specific plant species. Step by step knowledge given from our daily work will help us to construct an advanced environmental safe disease control system. Here we focused on clarifying a molecular mechanisms in virulence of *Xanthomonas oryzae* pv. *oryzae* and resistance of rice plant to the pathogen. We are also working on to establish an integrated pest management (IPM) system to decrease a disease severity of clubroot disease of crucifers caused by *Plasmodiophora brassicae*. And we are wrestling with pathogenic specialization in *X. oryzae* pv. *oryzae* and *P. brassicae* in local areas to provide useful information for breeding programs.

Outline of Research

1. Functional analysis of type III secretion proteins in *Xanthomonas oryzae* pv. *oryzae*.
2. Molecular analysis of expression of resistance associated genes in rice plant against *Xanthomonas oryzae* pv. *oryzae*.
3. Expression of *hrp* genes in *Xanthomonas oryzae* pv. *oryzae*.

4. Population analysis of physiologic races in *Xanthomonas oryzae* pv. *oryzae* around inland mountainous areas in Hiroshima Prefecture.
5. Resistance genes to *Xanthomonas oryzae* pv. *oryzae*.
6. Clubroot caused by *Plasmodiophora brassicae* is a soil borne disease of crucifers. We focused on clarifying resistant cultivars to races of the pathogen and looking for applicable materials to establish integrated pest management (IPM) to decrease the disease severity.



Bacterial leaf blight of rice



Clubroot of crucifer

Reference

- 1) T. Oku *et. al.*, Breakdown of clubroot resistance Hiroshimana 'CR Hiroshima No.2' (*Brassica rapa* L.), *J. Life and Environ. Sci.* 5, 1-7(2013)
- 2) A. Furutani, *et. al.*, Identification of novel type III secretion effectors in *Xanthomonas oryzae* pv. *oryzae*, *MPMI* 22, 96-106 (2009)
- 3) S. Tsuge, *et. al.*, Gene involved in transcriptional activation of *hrp* regulatory gene *hrpG* in *Xanthomonas oryzae* pv. *oryzae*. *J. Bacteriol.* 188, 4158-4162(2006)

Vegetable Crop Science



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Research topics

Development and improvement of cultivation method of vegetables. Especially, we investigate the effect of environmental stress to vegetable plant growth, yield, taste quality and ingredients.

- Long-term harvesting method of asparagus (Green, white, purple, pink).
- Forcing culture of asparagus.
- Bag culture method of tomato.
- Hiroshima specialty vegetables. (Summer autumn strawberry, tubers and roots, leafy vegetables etc.)
- Medicinal herbs.

Outline of Research

Agriculture is very important for the sustainable survival of the local region. In our lab., we want to contribute to regional development through vegetable cultivation research.

Recently, the kinds of vegetables and cultivation methods are extremely diverse. On the other hand, there are many issues that need practical solutions such as year-round cultivation, quality improvement, domestic/local production, sustainable cultivation and so on.

In our lab., we research about effect of environmental stress such as

light, water, temperature, soil and fertilizer to the vegetable plant growth, yield, appearance or internal quality and taste. We would like to contribute to smart agricultural research by cooperating with the fields of food processing and business management.



Reference

- 1) S. Motoki, H. Kohmura et al. Variations among regions of yield, quality and economical evaluation of summer-autumn-harvest cherry tomato in open field culture using non-training cultivation with net (sauvage cultivation), *Hort. Res. Japan*, 18(3),269-279,2019.
- 2) S. Yamamoto, H. Kohmura et al. Growth, yield and quality characteristics of 'Genji' and 'Shichifuku' sweet potato varieties introduced in the Meiji era in northern Hiroshima prefecture. *J. Life and Environment Sci.*, 11, 17-31, 2019.
- 3) H. Kohmura, T. Oh et al. Growth and internal quality characteristics of stem lettuce cultivated in northern Hiroshima prefectures. *J. Life and Environment Sci.*, 8, 29-45, 2016.
- 4) Y. Ohchi, K. Irifune, H. Kohmura et al. Development of a lightweight and cost effective growth medium using rice hulls mixed with soil for tomato bag culture during the idle period in rice nurseries. *J. Life and Environment Sci.*, 7, 31-43, 2015.
- 5) H. Kohmura, Y. Watanabe and N. Muto. Polyphenol content, antioxidant activity and surface colours of asparagus spears cultivated under different conditions of sunlight *Acta Hortic.* 776:255-260, 2008.

Ecology of Climate Change



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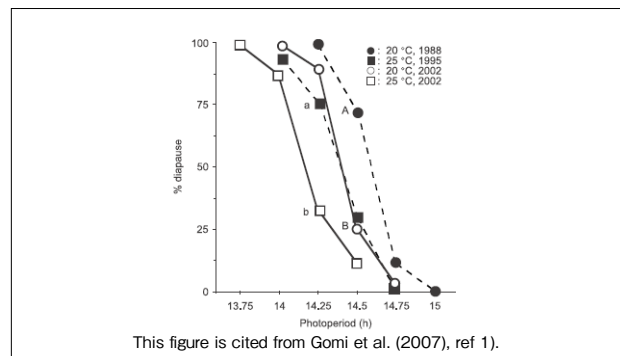
Research topics

- 1) Effects of climate change on life-history traits of insects, such as photoperiodic responses controlling induction of diapause and developmental rates.
- 2) Adaptational pattern to new environmental conditions, especially in introduced insects.
- 3) Ecology of insects related to seasonal adaptations and evolution of life cycles.

Outline of Research

We study adaptation of insects to environmental change, especially global warming. We investigate patterns and mechanisms for the shift of insect life cycles in relation to climate change. Our main research topic is effects of climate change on the life cycle and life-history traits, such as photoperiodic responses controlling diapause induction and developmental rates, in the fall webworm, *Hyphantria cunea* (Drury), (Lepidoptera: Arctiidae), in Japan. It was originally distributed in North America, and was accidentally introduced to Japan in 1945. A distribution area of this species has expanded from the invasion in Honshu, Shikoku, and Kyushu Islands. The life cycle of this species has changed from bivoltine to trivoltine recently in Fukui City (36° N) in Honshu Island. The critical photoperiod, defined as a photoperiod inducing

diapause to 50% of individuals of a population, has shifted in the Fukui population, in relation to the change of its life cycle (Fig.). This event is probably caused by global warming.



Reference

- 1) T. Gomi, M. Nagasaka, T. Fukuda, et al., Shifting of the life cycle and life-history traits of the fall webworm in relation to climate change. *Entomol. Exp. Appl.* **125**, 179-184 (2007)
- 2) T. Gomi Seasonal adaptations of the fall webworm *Hyphantria cunea* (Drury) (Lepidoptera: Arctiidae) following its invasion of Japan. *Ecol. Res.* **22**, 855-861 (2007)
- 3) T. Gomi, K. Adachi, A. Shimizu, et al., Northerly shift in voltinism watershed in *Hyphantria cunea* (Drury) (Lepidoptera: Arctiidae) along the Japan Sea coast. *Appl. Entomol. Zool.* **44**, 357-362 (2009)
- 4) T. Gomi, M. Natsuyama & N. Sasaki, Effects of sibling egg cannibalism on the development and survival of *Chrysomela populi* (Coleoptera: Chrysomelidae). *Appl. Entomol. Zool.* **50**, 451-455 (2015)

Science of Food Processing and Preservation



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Research topics

1. We study changes in chemical component in food, primarily fishery products during storage and processing and investigate the preservation of food quality during them. 2. We try to improve and control gel quality of fish meat products by using subsidiary materials. 3. We try to develop novel outstanding microorganisms for brewing products.

Outline of Research

1. Fish is a good source of high-quality protein as well as longchain n-3 polyunsaturated fatty acids eicosapentaenoic acid and docosahexaenoic acid. Fish is also rich in vitamins and minerals. However, the storage and processing of fish meat can bring about decreases in meat quality. Especially The oxidation of lipids and the subsequent degradation to odorous compounds are one of the most serious problems affecting the quality of fish. Thus, we analyze volatile compounds in raw or cooked fish meat to clarify compounds which are responsible for their odor. In addition, we develop a prevention method for the deterioration of fish odor during storage and processing.

2. Various additives are used in fish meat products, such as kamaboko, to reduce its cost, and improve and/or enhance its texture. Starch is one of the main additives. On the other hand, The proteases found in fish muscles are commonly

active at 50°C – 60°C and can cause rapid and severe degradation of myofibrillar proteins, particularly myosin heavy chain. This phenomenon, which is known as “modori,” lowers the gel strength. In contrast, deterioration in the quality of fish meat gel can also be suppressed by additives with protease inhibitors. Therefore, we try to improve and control gel quality of fish meat products by using subsidiary materials.

3. Fermented foods such as bread and sake are brewed with microorganisms. Because they are responsible for the quality of fermented foods, it is important to isolate and breed microorganisms for their quality. We have already isolated some yeast from fruits and flowers for baking good gluten-free rice flour bread. Thus, we try to develop novel outstanding microorganisms for brewing products.

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Natural Products Chemistry



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Research topics

- Data science
- Neuromarketing
- Smart agriculture

Outline of Research

To solve problems of agricultural management, we have been studying a method of information processing based on data, and neuromarketing by measuring cerebral blood flow. Furthermore, we are interested in research on the development, diffusion and issues of smart agriculture from a business perspective.

Specifically, we developed a web application, BuMoc, that embodies the automation (smartification) of 23 types of statistical tests. By using BuMoc, we aimed to enable anyone to conduct marketing research, consensus building, and strategy formulation while being aware of statistical thinking like data scientists, even if they do not have the knowledge or experience of statistical analysis. We also aim to establish a method for food-preference test by measuring cerebral blood flow (CBF) during mastication. we investigated psychophysiological food-preference when

chewing an apple by assessing CBF by using fNIRS. CBF signals suggested that the average rate of taste identification with the nameplate was high (94.5%). The conventional measurement of brain activity was limited to “seeing, sniffing, and drinking”. The ability to add “chewing” in food is expected to greatly expand neuromarketing. Furthermore, we have done research using satellite data for many years. Based on the research results using satellite data, we are trying smart agriculture by utilizing drones.

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Applied Plant Science



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Research topics

We are investigating genetic diversity of genetic resources (landraces and wild relatives) of cereals, mainly foxtail millet, common millet and Job's tears based on morphological characters and DNA markers. We are also constructing a genetic map of foxtail millet for positional cloning of genes involved in panicle morphology.

Outline of Research

- 1) We are investigating **genetic diversity** of foxtail millet landraces from various parts of Eurasia by analyzing morphological characters and **DNA markers** such as RFLP, rDNA and transposon display (TD) markers.
- 2) We are analyzing foxtail millet genes involved in **domestication**, **crop evolution** and **adaptation** to local environments such as *GBSSI* gene, *PPO* gene and *HDI* gene and revealed molecular evolution of the genes.
- 3) We are investigating molecular basis of endosperm with low amylase content by analyzing *GBSSI(waxy)* gene of foxtail millet, common millet and Job's Tears and

comparing the results with other major cereals such as rice, barley and maize.

- 4) We are constructing **genetic linkage maps** of foxtail millet by using SSR markers, indel markers and SNPs to map the genes involved in morphogenesis of foxtail millet.

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Cell Biochemistry Function



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Research topics

"Eat Healthy, Live Healthy."

Our mission is to scientifically evaluate the ability of certain food components to reduce the risk of disease. In China, it has traditionally been believed that foods and drinks are best at preventing illnesses and curing what ails us. Today, this is called Yaoshan (藥膳), 'cure through eating', in Chinese. The idea has spread throughout East Asia; it called Yaksun (약선) in Korean or Yakuzen (薬膳) in Japanese. So-called "superfoods" are well known as healthy foods that the body simply needs to survive, but that also provide health protecting properties. However, although "superfood" is a popular concept, in fact there is no official definition and we have little scientific evidence for the health effects of these foods. A adequate evidence-based scientific data that the claimed effect actually works are needed. We deliver evidence-based data analysis, previously unknown nutritional information, and food research solutions. We pursue these scientific goals by the unique breadth of our experimental methods, ranging from proteomics techniques, molecular cell biology, mouse models, and human subjects to molecular level studies. Our work includes products of the agricultural, marine products, and livestock industries .

Outline of Research

Areas of research focus include the following:
Biomarkers and Health Outcomes

- Biological markers of melancholia in mice stressed by wetting of the foot Search for stress markers in aging mice
- Search for stress markers in blood of wounded fish by life prolonging treatment
- Search for stress markers in beef before and after castration Functional Foods & Nutraceuticals
- Search for antidepressant foods by feeding to mice stressed by wetting of the foot
- Examine antioxidant activity in the Japanese colored cereals and legumes (unpolished rice, soy, adzuki bean, etc.) and in the Japanese edible wild mountain plants (Warabi; *Pteridium aquilinum*, Fuki; butterbur, etc.)
- Sugar analysis in some vegetables (tomato, asparagus, stem lettuce etc.)
- Tumor invasion assay with the lemon pericarp extract
- Anticancer activity analysis of vitamin C in mice unable to synthesize ascorbic acid

Reference

Environmental Plant Nutrition & Bio-resources Recycling



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Research topics

To increase the productivity and improve the quality of crops, especially green vegetables by the controlling nutritional conditions, the metabolic mechanisms are elucidated physiologically and biochemically. On the conservation of nutritional environments based on the nutrient recycle, the effective using methods of organic wastes such as oyster shells, garbage and livestock wastes on the agricultural lands are investigated for the decrease of environmental pollution, especially to prevent the soil accumulation of heavy metals.

Outline of Research

Physiological and biochemical analysis of plant nutritional mechanism, effective use of nutrients and environmental conservation based on the nutrient recycle.

In the environmental plant nutrition research, physiological and biochemical studies on the plant nutrition are conducted to investigate the metabolic mechanisms for increasing productivity and improving the qualities of vegetables by the control of nutritional conditions. In order to reduce an environmental pollution for nutritional environment conservation based on the nutrient recycle, examinations and evaluations are carried out the reuse of organic wastes, such as sewage sludge etc. effectively as

compost to farmlands.

To increase the effective reuse of oyster shells to agricultural production, the functions as leafy vegetable root elongation of oyster shell elements are elucidated as compared with other liming materials and the shells by each oyster-growing district, and the analysis of electron-microscopic structures etc. Moreover, the accumulation of secondary metabolites in functional plants, such as medicinal and sweet herbs, is also investigated by control of the culture-medium nutrition conditions with fertilizer application etc. About examination and evaluation on the effective reusing of organic wastes, such as food residual substance, sewage sludge, livestock waste etc., the most effectively recycling method is composting and application to the farmlands incorporating nutrient circulation. It is conducted to construct the bio-energy material plant production system using the compost as recycling product of organic wastes and abandoned farmlands. The heavy metals, such as Cd flow analysis with compost application is also important to maintain the farmland soil functions.

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Food Evaluation



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Research topics

Research on the evaluation of food quality using foodomics

1. Characterization of local agricultural products using metabolomic analysis
2. Development of new quality assessment methods for marine products using metabolomic analysis
3. Establishment of a novel foodomics analysis system

Outline of Research

Research on the evaluation of food quality using foodomics:

Specifically, in this study, we are applying metabolomic analysis to evaluate food quality, and conduct research to develop new evaluation methods for food and effective utilization of local agricultural resources.

1. Characterization of local agricultural products using metabolomic analysis:

The characteristics of agricultural products are being principally evaluated based on the information regarding the metabolic components obtained through metabolomic analysis. Data regarding the primary to the tertiary function of the agricultural products, and the safety of those products along with the usefulness of local agricultural products will be evaluated comprehensively. This will lead to the development of new processed products based on their usefulness.

2. Development of new quality assessment methods for marine products using metabolomic

analysis:

So far, a new evaluation method for assessing the freshness and taste of fish has been developed based on the metabolomic analysis. We are currently evaluating the usefulness of the developed methods using fish prepared under various experimental conditions. We are also evaluating genome-edited fish and fish sauce, which is a processed product made from fish.

3. Establishment of a novel foodomics analysis system:

We are currently conducting metabolomic analysis of the water-soluble primary metabolic components using gas chromatography mass spectroscopy (GC-MS). We are also planning to conduct comprehensive analysis of secondary metabolites, such as agricultural products, using high-performance liquid chromatography (HPLC) and liquid chromatography mass spectrometry (LC-MS). Also, omics analysis for components other than metabolites, such as genomics and proteomics, in order to analyze a wider range of metabolites as required will be conducted. We are also aiming to develop a novel food "deliciousness" evaluation system.

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Farming Systems



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Research topics

We study the difference of food production in the world from aspect of technology, policy and social condition.

- Comparative Farming Systems and Agricultural Policy
- Analysis of Food Trade and Management
- Gender and Development

Outline of Research

All most farmers lived at less-favoured area need to aid for maintaining agricultural production or activity. On the other hand population aging will weaken power and function of community. Our work explores how to change of these problems of the area. Including;

- Explore seeds of small business
- Women's empowerment

One of our small business project is grazing pig keeping. The aims of this experiment is feasibility examination of pig keeping systems combined with acorn-fed and grazing, as the first step of regional regeneration by small business in Shobara city located in mountainous area.

Fattening experiments was carried out in grazing land which is set up in mixed tree woods, and concentrates feed with crushed acorn was fed. A part of pigs was analysed the fatty acid composition. As the result the ratio of unsaturated fatty acid of acorn-fed and grazing systems is higher than usual feed systems.



Fig. Experimental grazing pig keeping

Reference

Applied Lipid Chemistry



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Research topics

- Study on oxidation stability of oils and fats.
- Application of enzymes for highly utilization of food materials, especially focusing on lipids.
- Screening and evaluation of physiological functions of foods and natural products *in vitro*.

Outline of Research

As mentioned above research topics, we study about the food chemistry based on lipid chemistry and enzymology.

1) Study on oxidation stability of oils and fats

Oils and fats are very important nutrients because they have high energy density, essential fatty acids and make foods tasty. Because foods containing oils and fats are susceptible to oxidation, however, it is very important to protect them from oxidation for keeping or improving their quality. We have investigated the effects of anti-oxidants and food emulsifiers on the oxidation of oils and fats.

2) Application of enzymes for highly utilization of food materials, especially focusing on lipids.

Using enzymes as a tool for producing physiologically functional compounds is an ideal strategy because they can carry out complicate reaction in mild conditions. Focusing on lipases and phospholipases, we have tried to produce oils and fats-substitute or novel physiologically functional compounds.

3) Screening and evaluation of physiological functions of food and natural products *in vitro*.

Some foods and natural products have attractive physiological functions, which have still not founded ever. Focusing especially on local ingredients, we have been screening and evaluated their physiological functions by physicochemical methods (*in vitro*).

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Food Process Engineering



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Research topics

- Development of functional foods made from agricultural products.
- Development of edible biodegradable material made from food by-products.
- Study of interaction between food ingredient and receptor on cell surface by using scanning probe microscope (SPM).
- Imaging of the surface structure of biomaterials by using scanning nearfield optical/atomic force microscope (SNOM/AFM).

Outline of Research

1. Development of functional foods made from agricultural products.
We evaluate a functional food made from local agricultural products, especially colored rice.
2. Development of edible biodegradable material made from food by-product.
Our objective is to measure of physical properties of the biodegradable film made from corn protein, zein.
3. Study of interaction between food ingredient and receptor on cell surface by using SPM (Fig. 1).
SPM silicon nitride probe was modified with an acetylated low-density

lipoprotein from human plasma (AcLDL). The area of SPM tip can be modified by physical adsorption. During modified SPM probe approaching on the receptor (LOX-1) - expressing cell, the cell reacted significantly.

4. Imaging of the surface of biomaterials by using SNOM/AFM.

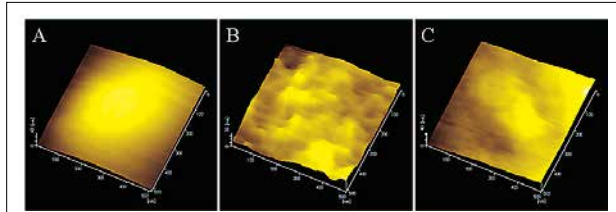


Fig. 1. SPM images of cell surface after adding AcLDL
A: 5 min, B: 10 min, C: 20 min.

We applied SPM and SNOM/AFM for the relationship between the fluorescent patterns and surface morphology.

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Biological rhythm for control plant growth



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Research topics

- Next Generation Agriculture
Cultivate crops with high efficiency in the controlled environment of a "plant factory".
- Circadian rhythm
Disturbance of rhythm in the body causes growth failure. Rhythm monitoring and control are important keywords.
- Synchronization in the community
Highly efficient agricultural practices in plant factories require control in units of communities.

Outline of Research

Agriculture is a primary and essential industry for humanity. However, it currently faces daunting issues such as a decrease in the number of workers and an aging population. Moreover, alley cultivation, which is a common agricultural method, is weather dependent, making it difficult to secure stable yields and income. As a means of solving such a problem, the "plant factory" has been garnering widespread attention in recent years. In plant factories, crops can be cultivated efficiently by managing and producing them in a controlled environment, similar to industrial products. However, such a cultivation method incurs huge production and maintenance costs. Therefore, methods of reducing costs, such as safe

disposal of crops that do not reach the harvest weight, should be undertaken. Simultaneously, research should be actively conducted to reach the goal of stabilization and growth control. For this study, it is important that the crop is both environmentally compatible and synchronized. The biological clock is employed as an index for matching/synchronization. If a plant clock cycle deviates from the external environment cycle, this can cause poor growth. Hence, it is important to control this deviation and synchronize the community with the outside environment. A "Circadian clock" is used as an index for matching/synchronization.

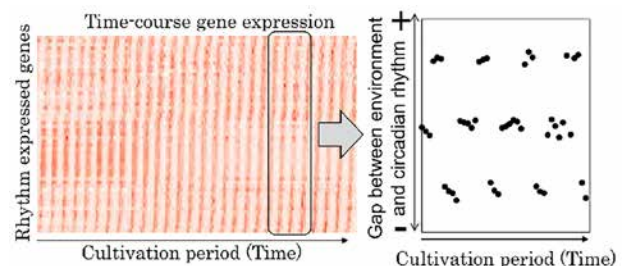


Fig. 1 Collapse of circadian rhythm and external environmental rhythm observed in the latter stage of cultivation

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Environmental Material Chemistry



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Research topics

We have investigated solar photovoltaic generation which drives solar cell composed of quite different principle hitherto, and developed the next generation solar cell by applying quantum dots, plasmonics, perovskites and strongly correlated electron system toward solving energy problems.

Outline of Research

Current energy dependence on fossil fuels such as petroleum has major problems such as exhaustion of resources and an increase in environmental burden due to CO₂ emissions. Toward this solution, we have noticed on solar energy. Current generation efficiency due to sunlight is ~ 15 %, which is a big subject to be very low. In order to far exceed the generation efficiency of the current solar cell, an idea based on a new principle completely different from the conventional one is necessary. Accordingly, we have focused on quantum size effects, surface plasmon resonance, perovskite semiconductors and strongly correlated electronic system optical functional materials, and are working on research on ultra-high efficiency solar cells.

1. **Quantum dots solar cell.** Silicon is currently used as the mainstream solar cell, and this theoretical limitation efficiency is shown to be about 27 %. We have attempted research on quantum dot solar cells with a theoretical marginal efficiency

of over 75 %, and progress research on ultra-efficient solar cells by establishing precise synthesis method for quantum dot and fabrication technology for the solar cell.

2. **Plasmonics solar cell.** Although great interest has been gathered for solar power generation, it is the current situation that it is not popular in general. It is one of the reasons that generation efficiency is very low. To improve the generation efficiency of conventional solar cells, we are studying the application of surface plasmon resonance using noble metal nanoparticles. Thus, we are studying plasmonics solar cells which dramatically increase the solar cell's ability to absorb sunlight.

3. **Perovskites solar cell.** Perovskite, which can be represented by the general formula ABX₃, can determine the chemical properties by the B atom, and the A atom can control the valence of the B atom and the crystal stability, and the X atoms can adapt the required properties. It is a substance whose chemical design flexibility is very large. We are developing novel photo functional materials design utilizing perovskite, aiming at ultrahigh efficiency solar cells.

4. **Photo energy conversion by applying strongly correlated electron system materials.** A lot of loss occurs at the current solar cells because a part of the photo energy becomes thermal energy because of the principle. If strongly correlated electron is applied, it considers that it is possible to convert it to power generation extremely efficiently without leaving little photo energy. We are researching for ultra-high efficiency aiming at this strongly correlated electron solar cell.

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Environmental Health Engineering on Sound Material-cycle Society



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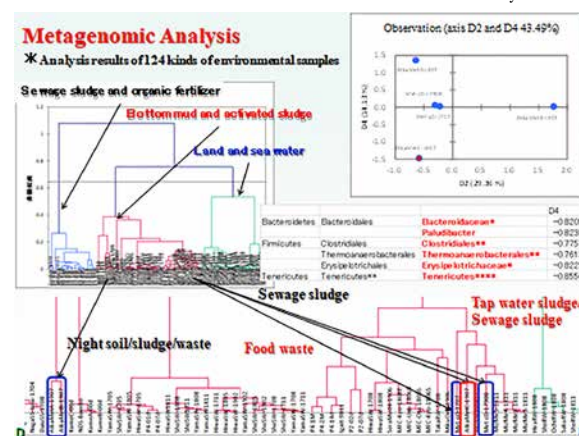
Research topics

1. Water treatment system by membrane filtration process.
2. Life Cycle Assessment of wastewater treatment system.
3. Advanced Biogas Recovery Process from Organic and Its Utilization.
4. Utilization and Risk assessment of Biomass.
5. Water environment evaluation by environmental DNA

Outline of Research

1. Water treatment system by membrane filtration process.
 Operation conditions, in solid-liquid separation or removal of pollutants, of a membrane filtration system are studied to make a proper formulation of permeation flux.
2. Life Cycle Assessment of wastewater treatment system.
 Efficiency for the environmental facilities is studied by Life Cycle Assessment.
3. Advanced Biogas Recovery Process from Organic and Its Utilization.
 Advanced bio-gas production system from organic wastes is studied on hydrogen and methane production experimental process.
4. Utilization and Risk assessment of Biomass.
 The risk on using biomass is assessed by Ames test, microbial survey and/or behaviors of chemical substances.
5. Water environment evaluation by environmental DNA

Environmental DNA extracted from various samples including organic sludge is used for evaluation of water environment and wastewater treatment system.



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Environmental Systems Engineering



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Research topics

- 1) Phosphorus and Potassium recovery and recycling/adsorption biomass residual
- 2) Heterogeneous Fenton reaction
- 3) Prevent of membrane fouling/effect of extracellular polymer

Outline of Research

- 1) Orange waste, an available biomass, was immobilized with zirconium (IV) to investigate its feasibility for phosphate removal from an aquatic environment. Kinetics, effects of pH and foreign anions, and the adsorption isotherm for phosphate have been examined
- 2) Influence of extracellular polymeric substances (EPS) secreted by cultivated laver on both transparency and sedimentary stabilization in Ariake Sea was experimentally examined. The laver culture experiment showed a production of EPS (evaluated by total sugar concentration, viscosity and molecular distribution) and showed an increase in dissolved organic carbon (DOC).
- 3) The Fenton method was applied to the removal of chemical oxygen demand using chromate (COD_{Cr}) and color from high-strength livestock wastewater. Also, in the present investigation an attempt was made to degrade organic pollutants in the textile effluent by homogeneous and heterogeneous Fenton

systems.

Experiments were carried out under the batch as well as under the continuous operating conditions.

- 4) Ashes from sewage sludge incineration have a high phosphorus content, approximately 8% (W/W), which indicates a potential resource of the limiting nutrient. Incineration of sewage sludge with subsequent recovery of phosphorus is a relatively new sludge treatment technique. In this article, the leaching of phosphorus by using sulfuric acid as well as hydrochloric acid by means of several batch experiments was presented. At the same time a selective recovery of phosphorus by adsorption was also discussed. The effects of acid concentration, temperature and time on extraction were studied.

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Instrumental Analysis of the Environment



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Research topics

The promotion of a green and recycling-oriented society represents the core of our research. We focus on the proper disposal of waste materials, along with basic studies of green processes achieved through heterogeneous catalysis. Our main research topics are: 1) energy-saving detoxification systems for endocrine-disrupting chemicals, based on the use of metallic calcium, 2) biomass conversion into useful materials using environmentally-friendly processes, 3) solvent-free organic reaction in solid state.

Outline of Research

The generic term 'dioxins', the family of which includes polychlorinated dibenzo-p-dioxins, polychlorinated dibenzofurans, and dioxin-like compounds such as coplanar polychlorinated biphenyls (co-PCBs), is used to describe highly toxic and mutagenic compounds in environment. Many methods that involve high-temperature or high-pressure dry hydrogen conditions to ensure adequate decomposition for persistent chlorinated aromatic pollutants present disadvantages for repeated synthesis or recovery of vaporized dioxins and co-PCBs. We discovered that highly efficient degradation of dioxins in solution, fly ash, or soil is accomplished in 24 hr using metallic calcium and Rh/C in alcohol in a sealed tube at 25 °C at 0.15MPa.1-3). On

the other hand, we show that this method can apply on the reduction of lignins to the corresponding aliphatic compounds, which are useful as a compatibilizing agent between polyethylene and polypropylene.

Moreover, we found development of dechlorination reaction of PCBs and dioxins in polluted soil, with 1-10% water content, added and mixed with the nano-size Ca/CaO dispersion, with subsequent stirring in a set time. The dechlorination of polluted soil recorded high efficiencies up to 99%. Furthermore, results show that our process of detoxification of POPs has an additional effect of insolubilization of toxic heavy metals such as lead (Pb), arsenic (As), cadmium (Cd), and chrome (Cr), simultaneously. We also indicated an effectiveness of solidification of cesium (Cs) by our nano-Ca/CaO dispersing mixture. Lastly, we affirmed that our method of dechlorination in solid phase works as a process of functional group transformation for organic compounds with wide variety of functional groups in the absence of solvents.

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Atmospheric Environment



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Research topics

Atmosphere as interface of biosphere has been under studies:

- (1) Developments of systems to measure gas exchange in environments and in ecosystems
- (2) Bio-meteorological measurements in ecosystems
- (3) Study on N_2O and NO emissions from soil
- (4) Study on gas emissions from polar soil
- (5) Study on degradation of bio-plastic films

Outline of Research

Atmosphere is an interface of various environments and living organisms and is a target of interdisciplinary studies. Atmosphere influences living organisms and is biologically affected at the same time. Due to recent rapid increase of human activity, a lot of greenhouse gases such as carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) are emitted to the atmosphere and atmospheric concentrations of greenhouse gases are rapidly increasing and are causing global warming. Therefore, precise understanding of variations of gas concentrations in the atmosphere and mitigation strategy are necessary.

To accelerate understanding atmospheric composition, measurements of gas exchange in ecosystems have been done. Recent intensive studies are

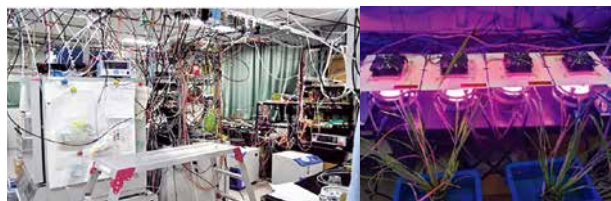


Fig.1 Automatic gas exchange measurement system in laboratory

development of systems to measure gas exchanges of soil and plants, which enables continuous and precise measurements of gas exchanges in laboratory (Fig. 1). The systems can monitor gas exchanges with changes in controls of environmental parameters such as various gas concentrations, temperature and humidity. The target of the systems can be soils, plants, various living organisms and bio-degradable bio-films. The systems can study mechanisms of them and can contribute to technical application.

Meteorological measurements and atmospheric monitoring in various ecosystems can also be done. International studies are also active. At the last stage of our studies, modeling studies are also done.

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Chemistry of Environmental Macromolecules



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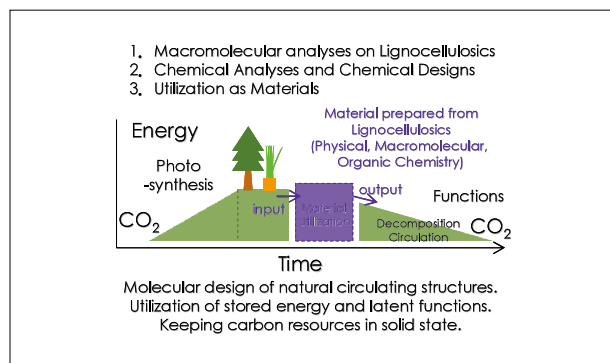
Research topics

Main research topics of our laboratory are investigations on both structural features and chemical utilizations of macromolecular components of lignocellulosics such as lignin, cellulose and hemicellulose.

- 1) Trials for preparations of fine chemical materials such as solar cells, conductive composites and functional additives for plastics from lignins and carbohydrates with keeping properties concerning to carbon circulation.
- 2) Analyses on photochemical behaviors of conjugated structures in condensed lignins and lignins-metal oxides composites.
- 3) Analytical apparatuses: UV-Vis, Fluorescence, TG-DTA, TMA, DSC, GC-FID, HPLC, SEC, CV, pH meter, Viscometer, Mechanical tester.

Outline of Research

- 1) Structural analyses and characterization of macromolecular materials derived from components of lignocellulosics.
- (2) Trials for applications of these macromolecular materials are also tried under molecular level.
- (3) Analyses of macromolecular materials based on physical chemistry



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Environmental Management Engineering



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Research topics

- Utilization of resource (e.g. building materials)
- Study for reduction of environmental load (e.g. CO₂ emission)
- Enhancement of LCA emission intensity database management
- Efforts for higher accuracy of LCA activities

Outline of Research

Construction of the society with lower environmental load is required. For this purpose, it is essential to discuss reduction of load based on quantitative analysis. We study the followings utilizing **life cycle assessment (LCA)**: A) Reduction of environmental load in every aspect of production, service, and system, based on LCA in actual practice. B) Investigation for improvement of issues related to environmental information and publication. C) Database management which is essential for analysis at LCA.

A) This study aims to suggest possibility of lower emission system based on the evaluation of resource recycling and of environmental load reduction using woody waste and building material. For example, in case of woody waste, a material flow chart was developed considering the total lifecycle of woody material. Then along the lifecycle, environmental loads such as CO₂ emission

were estimated. Based on the results above, utilization of woody waste material was discussed with focus on reduction of environmental load.

- B) Recent research has revealed there are issues in publishing environmental information. This study aims to clarify some by questionnaire and/or interview surveys and to suggest improvement of them.
- C) Development and appropriate management of database are essential for reliable LCA practice. This study aims to develop the estimation method of foreign countries database, and to develop a method of evaluating (verifying) the resultant data quality.

A: Reduction of Environmental Load Based on LCA in Actual Practice

- A-1. Woody material utilization that leads to environmental load reduction
- A-2. Building utilization that leads to environmental load reduction

B: Studies on Communication of Environmental Information

- B-1. For better use of environmental information on housing cases
- B-2. For better use of environmental information on office buildings

C: Studies on Management of LCA Database

- C-1. Way of estimating foreign countries' background database including unavailable ones
- C-2. Preventing assessment errors caused by quality differences in background databases

Reference

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Hydrospheric Environmental Chemistry



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Research topics

We investigate the role of trace metals on microalgae in hydrospheres.

- 1) Elucidation of iron uptake mechanism by eukaryotic phytoplankton
- 2) Elucidation of physiological and ecological specificity of microalgae causing red tides
- 3) Study on seasonal dynamics of microalgae and trace metals in hydrospheric environments

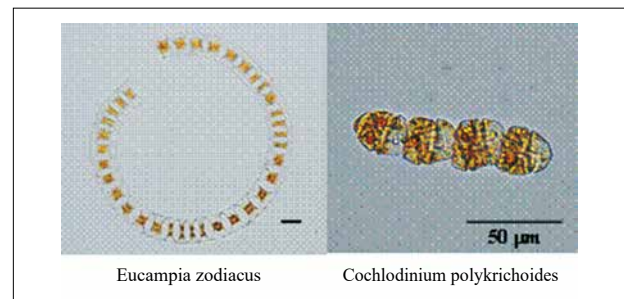
Outline of Research

Algal blooms have frequently occurred in coastal areas and sometimes formed **red tides** with water discoloration. These occurrences of toxic or harmful blooms represent significant and growing impacts on human health and fisheries resources throughout the world. Therefore, there is a pressing need to understand the mechanisms of red tide outbreaks in coastal areas, and to develop effective strategies to the threat of harmful algal blooms through management and mitigation.

Iron deficiency has been demonstrated to limit the growth of microalgae in regions of high nutrient low chlorophyll and in coastal waters. Uptake of dissolved iron (colloidal and soluble iron) is generally considered to be the norm for microalgae. However, bioavailable dissolved iron is present at extremely low concentrations in seawater, and most of that is shown to bind to organic ligands. Therefore, the natural organic ligands binding with iron have a

great influence on the iron speciation and the biological productivity in seawater. Some components of the natural Fe-binding organic ligands in seawater were suggested to consist of siderophores, which are produced by certain microorganisms such as marine bacteria.

Interactions between microalgae and other microbes in marine environments are very important for the **iron uptake** and the control of biological productivity in coastal areas. Furthermore, the mechanisms of iron uptake by eukaryotic microalgae have not yet been fully understood. In order to elucidate the role of iron uptake mechanisms in red tide occurrences, we investigate the effects of Fe-complexes on the growth of various marine eukaryotic red tide microalgae.



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Inorganic Analytical Chemistry



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Research topics

- 1) Elucidation of the state of iron in the sediment of Ariake Bay
- 2) Investigation of spread of sea water containing high manganese over Ariake Bay
- 3) Elucidation of the adsorption and desorption behavior of metals over the sediment of Ariake Bay

Outline of Research

Aquatic chemistry is concerned the chemical reactions and processes affecting the distribution and circulation of chemical species in natural waters. Our objects are to understand the relationship between environmental problems and aquatic chemistry of the elements other than macronutrients in estuaries. The problems in estuaries in Japan are red tides, anoxic water mass, the extinction of bivalves, and the decoloration of seaweeds. These problems, these phenomena, are thought to be mutually linked. For example, when red tide occur, much organic matter is supplied to the sediment, leading to much dissolved oxygen consumption due to the decomposition of the organic matter, and potentially to anoxic and hypoxic events.

The first objective is the elucidation of the effects of anoxic and hypoxic events on the behavior of metallic elements in Ariake bay. The bay has been one of the most productive bays in Japan. However, the occurrence of anoxic

and hypoxic events has been reported recently. Iron and manganese are reduced in and dissolved from sediments under anoxic and hypoxic events. The iron compounds in sediments has been investigated by using XANES in order to elucidate the environment in sediments and what chemical reactions have occurred. The high manganese concentration can affect bivalves. After the dissolution of manganese, the high manganese concentration keeps during a few days. Thus the bad effect of manganese can spread over wide area in Ariake bay.

The second objective is the elucidation of the effects of salt concentration on the behavior of metallic elements in Ariake bay. The much sediment are resuspended and the colloids are in sea water in Ariake bay. The sediment and colloids adsorb and desorb many kinds of metals during the fluctuation events of salt concentration. The adsorption and desorption change the behavior of metal elements in Ariake bay. In order to elucidation of effect of metal elements on environment, the effects of salt concentration on the metal element behavior especially aluminum, have to be investigated.

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Environmental Risk Assessment and Management



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Research topics

Our study has focused on microbial safety and sanitation of drinking water. Of particular recent interests are

*The rapid detection of indicator bacteria, intestinal virus and protozoa (*Cryptosporidium*) from various water environments using molecular biological assay. Especially, developing new *Cryptosporidium* antibody for specific and easy detection of oocysts from water samples.

*Enterotoxin gene positive A type *C. perfringens* spores as a microbial fecal source tracking indicator.

*Intestinal virus and its indicators (NoV, PMMoV etc.) detection/quantification from water environments using q-PCR and its fate under various water environment such as river, sea, sewage and water treatment include disinfection.

*Quantitative Microbial Risk Assessment (QMRA).

Outline of Research

1. Detection and analysis methods of waterborne microbial (*Cryptosporidium*, indicator bacteria and intestinal viruses) from water environments using molecular biological technique (q-PCR, FISH NGS etc.)

Fluorescence in situ hybridization (FISH) was assessed for specific detection and identification of *Cryptosporidium* oocysts under microscopic observation. Combining FISH with Fluorescence antibody, DAPI and

differential interference contrast observation were valuable for easily and collect identification of *Cryptosporidium* oocysts from other debris.

2. Surrogate indicator for fecal pollution and microbial source tracking indicator, such as anaerobic spores (*Clostridium perfringens*).

Anaerobic bacteria spores are used as an indicator of fecal pollution in a water environment. These spores resist various environmental stresses such as temperature, disinfections, sun light and a variety of biological activity. Spores high survivability in water environment is useful for detection of high resistant microorganism contamination including protozoa and intestinal viruses. However, distribution and classification of anaerobic spores in water environment is not clarified. In this study, anaerobic spores are isolated from human and livestock sewages and river water; then and identification is done based on the biochemical characteristics.

3. Quantitative Microbial Risk Assessment (QMRA).

Reference

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Adaptive Signal Processing for Environmental Systems



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Research topics

- 1) Active noise control (ANC) systems and applications in rotational machines, eco cars, etc.
- 2) Adaptive linear and nonlinear noise cancellers for speech enhancement using both bone- and air-conducted measurements.
- 3) Advanced neural networks and application to time-series prediction including solar radiation forecasting.
- 4) Adaptive vibration detection and neural network based fault diagnosis.

Outline of Research

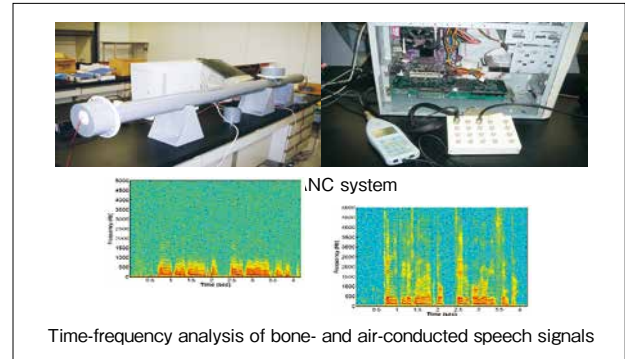
Analysis and processing of various signals and noises are required in real systems. It is a well-recognized fact that those signals and noises, including systems they belong to, are often time-varying. Adaptive algorithms and systems are developed and implemented to track their variations for different purposes.

First, **active noise control (ANC)** is a very important application area of adaptive signal processing. ANC systems enjoying low cost and high performance have been developed for real applications in rotational machines like strand-cutters, extruders, and eco cars. We are exploring novel system structures and algorithms.

Second, **nonlinear adaptive noise cancellers** have been developed for **speech enhancement** based on the use of both bone- and air-conducted measurements.

Third, nonlinear prediction algorithms have been developed for **time-series forecasting**. **Neural networks (NN)** like MLP, constructive one-hidden-layer NNs, and dynamic NNs have been applied.

Fourth, **adaptive vibration detection** and **fault diagnosis** has also been a research topic in recent years, and we are achieving great results.



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Intelligent Control of Environmental Systems



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Research topics

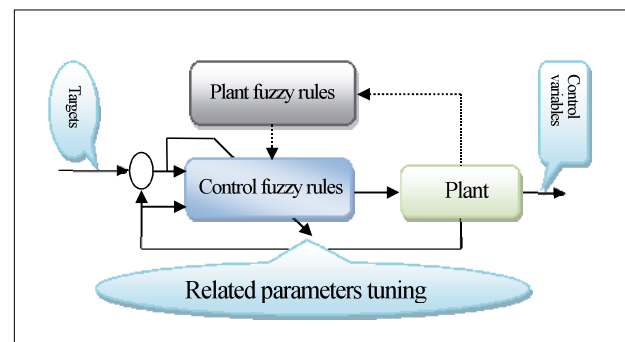
- 1) Water quality modeling of an urban stream and development of fuzzy water quality prediction model
- 2) T-S/polynomial fuzzy control system in consideration of modeling error and its application to intelligent environmental systems
- 3) Adaptive fuzzy control system using type-2 fuzzy sets and its inference

Outline of Research

Research interests consist of two parts: **adaptive fuzzy control system** design and its applications to some real objects such as environmental issues. For the first part, in order to design a stable fuzzy control system, usually two types of fuzzy models, i.e., the **Takagi-Sugeno** and **polynomial fuzzy models**, are used to synthesize a controller for the system concerned. Our study focuses on both the fuzzy models with system uncertainty including disturbance and modeling error and so on. Recently, we have been making a great effort and progress on the so-called **uncertainty observer**, which is involved in the controller design trying to improve control performance.

For the second part, the real objects are more complicated rather than purely mathematical. For example, environmental issues actually involve

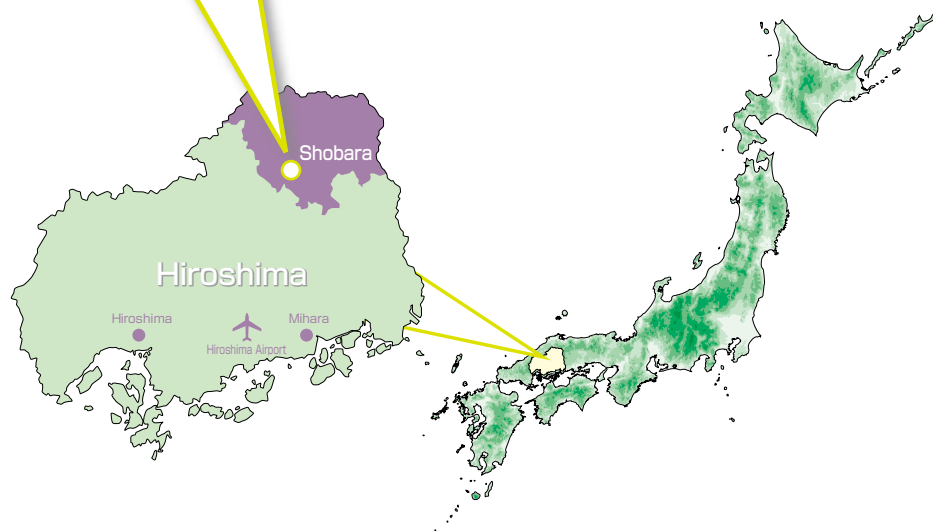
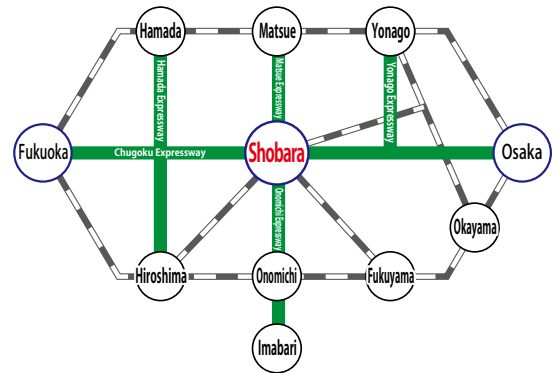
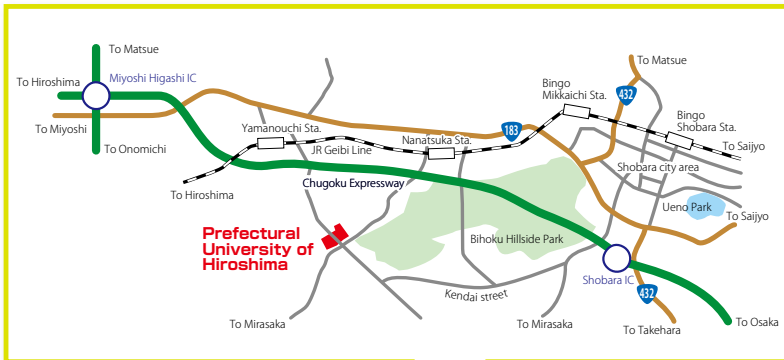
a lot of aspects such as climatic variation, deforestation, depletion of water resources, water/air/soil pollution and so on, in which the problems related to water are urgent and having a large influence on our daily life. The research focuses attentions on **water quality control** using fuzzy logic and the conventional control theories. The configuration of the control system is depicted in the figure.



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ACCESS



Access

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From Hiroshima Bus Center to Kenritsu Daigaku Bus Rotary : Take an express bus (approx. 2 hour)
- From JR Hiroshima Station to JR Bingo Shobara Station :Take the Kaisoku (Rapid) train on the Geibi Line,takes approx.2hr
- From the Shobara Bus Center or JR Bingo Shobara Station to Kenritsu Daigaku Bus Rotary : Take the School Bus (23 min.)



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