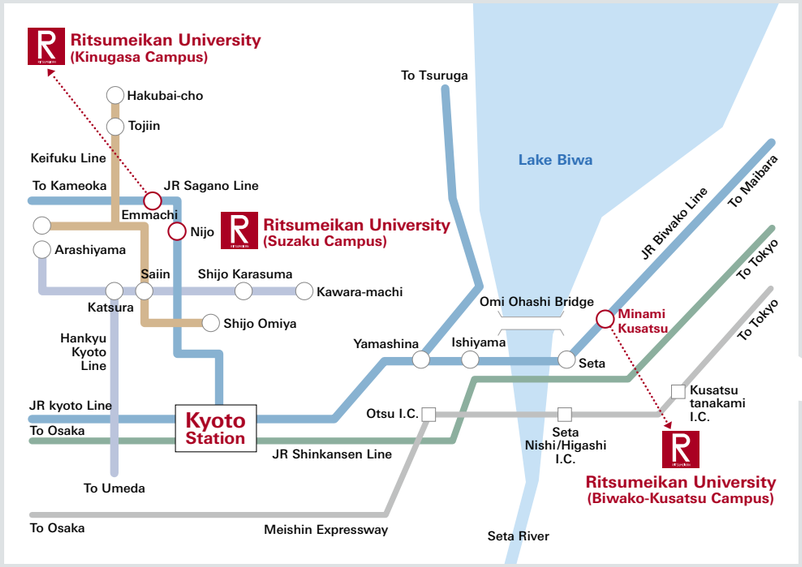
Access to Ritsumeikan



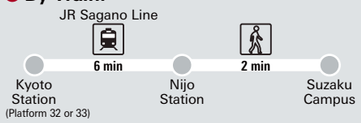
Getting to Kyoto Station from:
Tokyo – 2.5 hours by JR Shinkansen (Bullet Train)
Osaka (Kansai International Airport) – 1 hour 15 min. by JR Limited Express “Haruka” train

Ritsumeikan University (Suzaku Campus)

1 Nishinokyo-Suzaku-cho, Nakagyo-ku
Kyoto 604-8520 JAPAN
Tel. +81-75-813-8137

Getting to the Suzaku Campus

● **By Train:**

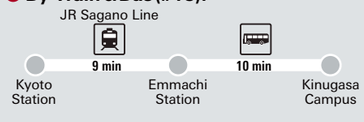


Ritsumeikan University (Kinugasa Campus)

56-1 Toji-in Kitamachi, Kita-ku
Kyoto 603-8577 JAPAN
Tel. +81-75-465-8224

Getting to the Kinugasa Campus

● **By Train & Bus (#15):**



● **By Bus(#50):**

Ritsumeikan University (Biwako-Kusatsu Campus)

1-1-1 Noji-higashi, Kusatsu
Shiga 525-8577 JAPAN
Tel. +81-77-561-2655

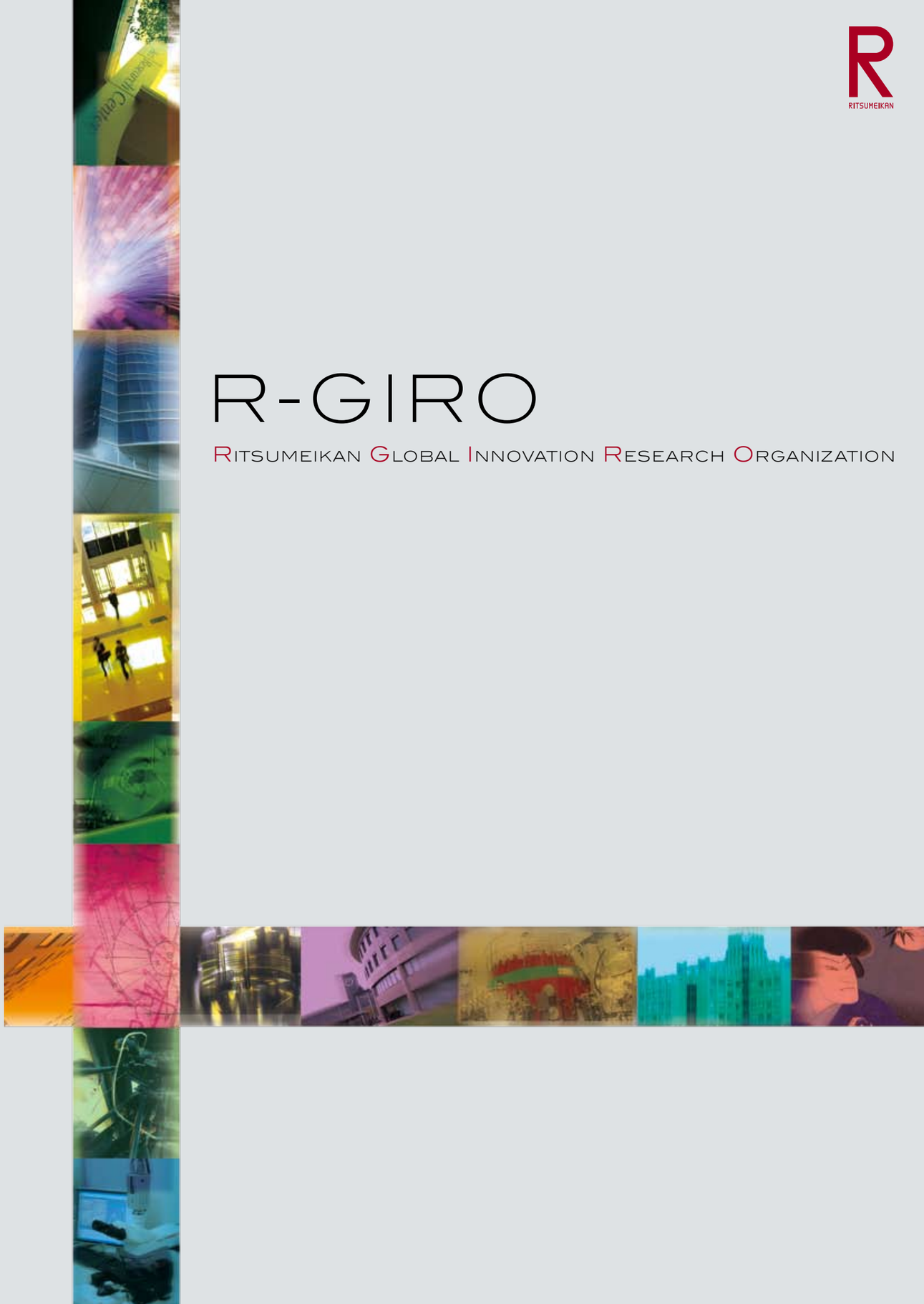
Getting to the Biwako-Kusatsu Campus

● **By Train & Bus:**

RITSUMEIKAN GLOBAL INNOVATION RESEARCH ORGANIZATION
R-GIRO

RITSUMEIKAN GLOBAL INNOVATION RESEARCH ORGANIZATION
http://www.ritsumei.jp/research/r-giro/

2011.5



RITSUMEIKAN

R-GIRO

RITSUMEIKAN GLOBAL INNOVATION RESEARCH ORGANIZATION

Ritsumeikan Global Innovation Research Organization

Since its establishment, Ritsumeikan has preserved the high educational standards characteristic of a private university in order to nurture high-caliber graduates by providing a system of education that equips students with a diverse range of skills and values. In the years ahead, Ritsumeikan must also focus on meeting the demands of our changing society by focusing on education that produces highly creative graduates. To this end, students must gain a high level of theoretical knowledge, be actively involved in the cutting-edge research conducted by our academic staff, and be inspired to explore areas of the world about which we know very little. With these goals in mind, we hope to train highly motivated graduates who are ready to tackle the challenges faced in the real world.

At Ritsumeikan, we believe that the first step towards nurturing such graduates is to improve the standards of current research by creating global leading research centers. We believe such research centers will help young researchers develop into world class scientists who are capable of overcoming the tide of globalization and lead Japan into the future.

It is also important that our students understand the social duty of those at the forefront of science and technology. Scientists must do more than simply respond to the demands of society; they must also contribute to the progress of humankind while being ever conscious of the importance of our coexistence with nature. Today, as the earth's environment undergoes a rapid transformation, it is our mission to nurture young scientists capable of driving scientific and technological progress forward while remaining keenly aware of the changing natural environment.

In response to the changing role of academia, Ritsumeikan University established the Ritsumeikan Global Innovation Research Organization (R-GIRO) in April 2008. The organization places great emphasis on developing the next generation of young researchers, and focuses on those research issues that Japan must address with greatest urgency at the beginning of this new century.

The 20th century is often referred to as the century of science and technology. It saw the fruits of scientific and technological progress bring immense benefit to humankind answering our demand for material goods and longer life. These benefits were the collective result of the efforts of countless individuals over many years, all of whom used knowledge as a powerful tool to answer humankind's curiosity about the hidden truths of nature, create an ubiquitous society and respond to the growing demand for a more comfortable lifestyle.

However, we must not forget that only those living in developed nations have been able to fully enjoy the benefits that science and technology have brought. Moreover, we must also remember that there are always negative aspects to balance out the positive. While the word 'Growth' can be used to summarize the rapid advances in our material society produced by scientific and technological innovation in the 20th century, such innovation has also facilitated the global destruction of nature, exemplified by global warming, the depletion of resources, and food shortages. Additionally, the previous century has also left humankind with an unprecedented number of unresolved issues, such as the polarization of wealth, moral decay, and the escalation of religious conflict.

Science and technology in the 21st century must tackle these inherited issues and work towards the creation of a society capable of co-existing with nature. As we battle with issues of the destruction of Earth's natural environment, there is no doubt that we must work towards creating an affluent society that is able to operate sustainably.

R-GIRO aims to contribute to society through education and research, focusing on the issues that need to be overcome in order to create the kind of sustainable society we need. To this end, R-GIRO has identified six areas which need to be urgently addressed: environment, energy, food supply, materials & resources, medical treatment & health, and safety & security. Since April 2008, R-GIRO has been conducting policy-driven, systematic research in these six areas, primarily in the natural sciences. There are currently 22 projects re-examining nature from a multitude of angles through innovative dynamism arising from various interdisciplinary collaborations, academia-industry partnerships, and cross-institutional alliances.

In addition, several new research areas were added in 2009 as part of our efforts to work towards the realization of a sustainable and affluent society from a humanities and social sciences perspective, namely human life & value, peace & governance, and Japanese & regional studies. Also included in 2009 was a newly created integrated research area that combines natural sciences with humanities and social sciences. Today, these new research areas account for 11 of the 33 projects currently underway. With around 50 young researchers participating, these projects are also vital in developing future scientific talent that will become the future drivers of innovation. We also anticipate further development in our integrated research involving natural sciences, humanities, and social sciences, and we are confident that the results of research conducted at R-GIRO will contribute towards humankind's primary aim for the 21st century – the realization of a society capable of coexisting sustainably with nature.

R-GIRO President
Kiyofumi Kawaguchi
[Chancellor, The Ritsumeikan Trust
President, Ritsumeikan University]

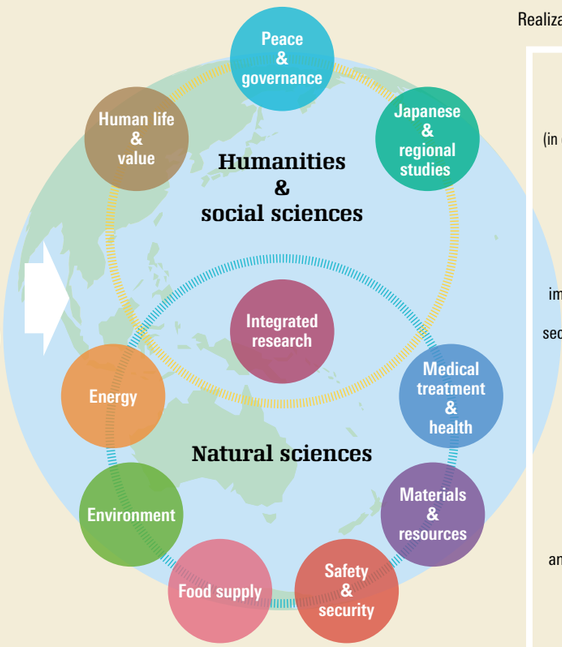
Deputy President
Masanori Murakami
[Vice-Chancellor,
The Ritsumeikan Trust]

Ritsumeikan Global Innovation Research Organization
R-GIRO

Ritsumeikan University initiatives

20th Century science and technology: The positive and the negative

R-GIRO



Duties of science and technology in the 21st century

Realization of a human and ecological society

2050
Realization of a human and ecological society
(in coexistence with, and adapted to, nature)

2025
Establishment of a human and ecological urban model in Japan

Increase awareness about the importance of coexistence with nature among students in primary and secondary education who will shape the society of tomorrow

Creation of new interdisciplinary research area
Establishment of integrated interdisciplinary research base

2009
Establishment of humanities and social sciences research programs

2008
Establishment of natural sciences research programs

List of selected projects in each research area

In order to achieve its founding objectives, drive research forward, and create new research areas, R-GIRO has held internal calls for Research Program proposals from 2008 to 2010.

List of projects in each Research Area (Natural sciences)

Research Areas	Research Progects	Leaders	Position	Department	Adoption fiscal year
Environment	Establishment of Cell Line from Rare Species Lives in Lake Biwa and Their Application as Biosensor	Tatsuyuki Takada	Professor	Pharmaceutical Sciences	2010
	Supreme Collateral Utilization System toward Efficient Material Cycle: Microbial Recovery of Phosphate and Rare Metals	Tadayuki Imanaka	Professor	Life Sciences	2009
	Development of High Power Deep UV Semiconductor Light Emitting Diodes and the Device Application to Solve Bio and Environmental Issues	Yoshinobu Aoyagi	Professor	R-GIRO	2008
	Basic Technology Development and Strategic Innovations towards a Low-Carbon Society	Zhou Weisheng	Professor	Policy Science	2008
Energy	Application of Solid Oxide Electrolyte Cell to the Energy and/or the Environmental Device	Yoshinobu Yoshihara	Professor	Science & Engineering	2008
	Development of High Efficiency Multijunction Thin Film Solar Cells for Energy Security	Hideyuki Takakura	Professor	Science & Engineering	2009
Food supply	Construction of Food Production System Based on Symbiosis Material Circulation Society	Motoki Kubo	Professor	Life Sciences	2008
	Improvement in Agricultural Production by Developing Advanced Technology for Breeding, Cultivation, and Disease Prevention by Application of Microorganisms	Hisaaki Mihara	Associate Professor	Life Sciences	2010
Materials & resources	Environment-Friendly Photoactive Materials Based on Naturally Occurring Tetrapyrroles	Hitoshi Tamiaki	Professor	Pharmaceutical Sciences	2009
	Formation of Functional Soft Materials Based on Elemental Resources	Hiromitsu Maeda	Associate Professor	Pharmaceutical Sciences	2008
	Development of Organic-Inorganic Hybrid Nano Materials and Control of Their Organized Structures	Osamu Tsutsumi	Associate Professor	Life Sciences	2008
	Engineering Materials Research Project for Sustainable Development	Kei Ameyama	Professor	Science & Engineering	2008
Medical treatment & health	Research for Drug Development and Useful Functional Organic Molecule Creation Based on Sustainable Advanced Synthesis	Yasuyuki Kita	Professor	Pharmaceutical Sciences	2009
	Integrative Study for Elucidating the Mechanisms of the Protein Folding and the Protein Folding Diseases	Minoru Kato	Professor	Pharmaceutical Sciences	2009
	Drug Development using a Gene Regulation Mechanism by Natural Antisense Transcripts	Mikio Nishizawa	Professor	Life Sciences	2008
	Pioneering Studies of Regenerative Medicine by Glycotechnology	Hidenao Toyoda	Professor	Pharmaceutical Sciences	2008
	Fusion between MEMS and BME on Multiple-Scale	Satoshi Konishi	Professor	Science & Engineering	2008
	IRT-Based Haptic Collaborative Virtual Environment for Tele Surgery Training through Ultra-realistic Communication	Hiromi Tanaka	Professor	Information Science & Engineering	2009
	Digital Atlases of Human Anatomy and Computer Assisted Diagnostic System	Yen-Wei Chen	Professor	Information Science & Engineering	2008
	Development of Biosimulators and Analysis Tools	Akinori Noma	Professor	Life Sciences	2008
	Integrated Research of Sports and Health Innovations	Tadao Isaka	Professor	Sport and Health Science	2010
Safety & security	Invisible, Secure, Safe and Dependable Platform to Support Our Lives	Koichi Mouri	Associate Professor	Information Science & Engineering	2009

List of projects in each Research Area (Humanities and social sciences)

Human life & value	Learner's Science as an Application of Science for Human Services Creating a New Discipline	Akira Mochizuki	Professor	Letters	2010
	Frontier of Applied Illusionology	Akiyoshi Kitaoka	Professor	Letters	2009
	Constructing the Center for Law and Psychology	Tatsuya Sato	Professor	Letters	2009
	Social Studies on Barrier Free Access to Digital Books	Shinya Tateiwa	Professor	Graduate School of Core Ethics and Frontier Sciences	2011
Peace & governance	Towards New Peace Studies : A Study of Reconciliatory Governance and Sustainable Peace Building in Post-Conflict Areas	Jun Honna	Professor	International Relations	2010
	Mutual Understanding and Collaboration between Northeast Asia, Korea and Japan - from a Viewpoint of Peace Making	Nobuhiro Katsurajima	Professor	Letters	2009
	Asbestos Disaster and the Policy Science of Relief, Compensation and Prevention System	Hiroyuki Mori	Professor	Policy Science	2009
Japanese & regional studies	World Wide Co-Ownership on the Materials of Japanese Art and Culture by Digital Archiving	Ryo Akama	Professor	Letters	2009
	Forced Removal, Incarceration, and Repatriation of the Overseas Japanese during World War II and the Post-War Reconstruction of the Japanese Society	Hiroshi Yoneyama	Professor	Letters	2010
	Digital Museum of Kyoto	Keiji Yano	Professor	Letters	2009

List of projects in each Research Area (a newly created integrated research area)

Integrated research	A Trial R&D Project of Human Dimensions Programme on Global Environmental Change Based on Local Carbon Sequestration Systems through Cool Vegetable Agriculture	Hidehiko Kanegae	Professor	Policy Science	2010

1

Environment

[Research Project]
Establishment of Cell Line from Rare Species Lives in Lake Biwa and Their Application as Biosensor

Biosensors: Contributing to the conservation and breeding of endemic species in Lake Biwa, and the evaluation of environmental chemicals

Keywords

Gnathopogon caerulescens
Corbicula sandai Reinhardt
Biosensors
stem cells
cell differentiation

Developing biosensors through the study of Lake Biwa's endemic species

Modern society is overflowing with diverse chemicals that bring a multitude of benefits. Some concern remains, however, about the potential negative effects of these chemicals on human health as well as other organisms. In particular, their effects are known to be more prominent in stem cells having differentiation capabilities and cells undergoing cell differentiation than in differentiated cells. Currently, however, no accurate evaluative system is available; this project therefore aims to use stem cells as biosensors to establish a precise evaluative system for the effects of chemicals on cell differentiation.

Our research is unique in using cells from aquatic species endemic to Lake Biwa to conduct cellular level analyses and compare the effects of chemicals on both humans and endemic species. Water contamination by chemicals affects both humans and endemic species and is a serious issue in Lake Biwa, which has long served as an important water source for the Kyoto-Osaka-Kobe region. Species endemic to the lake, such as *Carassius buergeri grandoculis* (nigoro-buna), *Gnathopogon caerulescens* (hon-moroko), *Oncorhynchus masou rhodurus* (Biwa-masu), and *Corbicula sandai Reinhardt* (Seta-shijimi), are significant biological resources both for biodiversity and for local food and culture.

Contributing to the conservation of natural environment and the discovery of useful substances through biosensor

The *in vitro* differentiation into germ cells using ES and iPS cells of mice, will be tried to establish stem cell biosensors.

First, vectors which express fluorescent protein (GFP, RFP) under the control of germ cell specific promoters will be constructed. These vectors will be introduced into the mouse ES and iPS cells to establish reporter cell lines (biosensors). Next, transfected stem cells will be differentiated under the presence of environmental chemicals such as bisphenol A. The number of cells which express fluorescent proteins will be analyzed to investigate the risk of chemicals. Once stem cell biosensors for germ cell differentiation is established, similar biosensors can be created using cells of endemic aquatic organisms that are more directly affected by water quality; this will allow direct investigations into the effects on endemic species. We will also establish biosensors using ES cells for the differentiation into other functional cells, such as adipocyte and osteoblast differentiation. These biosensors allow us to investigate the effects of chemicals on specific cell differentiations and to find new substances such as those inhibiting adipocyte differentiation, making it possible to expand the research into drug discovery.

Our project aims to proceed basic research using endemic species of Lake Biwa, for which cell biological research has been hardly applied despite their importance as rare organisms and as food resources, and to connect research to regional environment, people and industries through contribution of scientific findings obtained through this project. R

College of Pharmaceutical Sciences
Professor TATSUYUKI TAKADA (Ph.D.)

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2

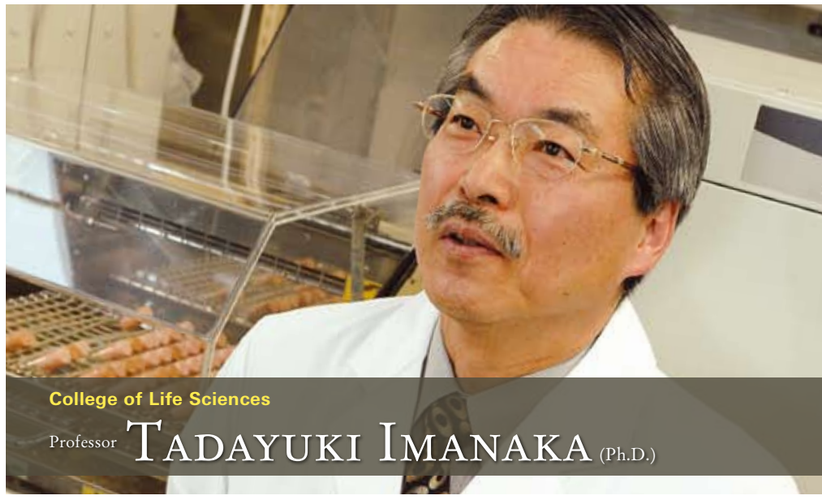
Environment

[Research Project] Supreme Collateral Utilization System toward Efficient Material Cycle: Microbial Recovery of Phosphate and Rare Metals

Presenting a new material cycle model – from Lake Biwa to the rest of the world

Keywords

Collateral utilization
Phytic acid
Clarification of Lake Biwa
Material cycle
Detritus layer
Phosphate recovery
Oligotrophic microbes



College of Life Sciences
Professor TADAYUKI IMANAKA (Ph.D.)

Lake Biwa – a lake in a unique situation

Water quality improvement is a crucial aspect of global environmental issues, and we have been focusing on Lake Biwa in our efforts to make improvements to aquatic environments. Lake Biwa is one of the oldest lakes in the world, with a history spanning 4 million years. It is also home to a very large number of endemic species, due to its long history of environmental isolation with little influence from outside. In addition, the lake exists in close proximity to humans, with 14 million people using the lake's water for drinking and other uses. In other words, amongst the lakes in the world, Lake Biwa is a rare example in that it is intimately associated with human activity while maintaining aspects of its isolation. We believe that research and projects based on this lake will help us build models for solving issues surrounding lake environments worldwide.

Recovery and secondary utilization of harmful substances

The project aims to improve the water clarification mechanism of Lake Biwa by comprehensively examining the issues relating to the material cycle system of the lake's aquatic environment and making improvements to rate-controlling steps which are found to be inhibiting the cycle.

A major characteristic of our research is that microbes are used to convert the rate-controlling substances of the cycle into usable substances. In addition, as well as improving the water's clarification mechanism, we aim to build a system in which substances which are projected to be in short supply in the future, such as phosphate and rare metals, are recovered and re-utilized as a resource. Such studies of material cycle systems extending as far as secondary utilization of materials have rarely been attempted in the past.

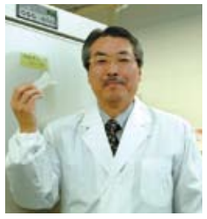
Handling of oligotrophic microbes.

Success in isolating microorganisms which decompose phytic acid

In Lake Biwa, increasing levels of eutrophication and effluent discharge have caused organic matter, heavy metals, and other harmful matter to accumulate as a layer of sludge above the detritus layer on the lake bed, causing a deterioration of water quality. In addition, it has been revealed that global warming is having an effect of stagnating the water flow and depleting the amount of dissolved oxygen at the bottom of the lake. This causes an increase in the number of anaerobic microorganisms, as well as a depletion in the number of aerobic microorganisms which decompose substances such as phytic acid, leading to a vicious cycle.

First of all, we established an environmental assessment system that uses microorganisms as a barometer. Project team members had already established a technique for measuring the amount of microorganisms present in a soil sample. We applied this technique to the aquatic environment to measure the number of bacteria in samples of mud taken from the lake bed.

Next, we seek to decompose sludge by introducing microorganisms that decompose phytic acid and lecithin into the lake. We have already succeeded in isolating microorganisms that decompose phytic acid which is composed of bound phosphates.



With a piece of Antarctic ice.

We also aim to recover free phosphates using microorganisms that form polyphosphates. Similarly, we intend to establish a system for recovering potassium using microorganisms that decompose anthocyanin. We will continue to search for new microorganisms. In the future, we intend to expand our research into using extremophiles such as oligotrophic microbes in order to recover rare metals. R

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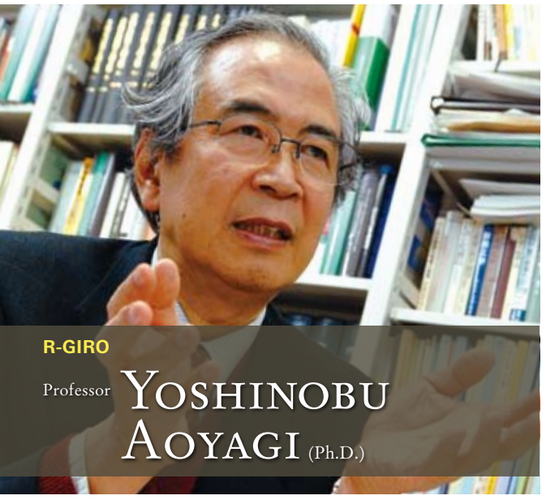
3

Environment

【Research Project】 Development of High Power Deep UV Semiconductor Light Emitting Diodes and the Device Application to Solve Bio and Environmental Issues

Fusion with the field of electronics will shed light on solutions to environmental issues

Keywords
Nitride semiconductors
Metalorganic chemical vapor deposition (MOCVD)
Molecular beam epitaxy (MBE)
Light-emitting diode (LED)
Power electronics
Environmental electronics
High-output deep-UV light emitting devices



Nitride semiconductors offer promising potential

Nitride semiconductors have been gaining attention in recent years as a key material for supporting science and technology in its crucial role in resolving important social issues in the 21st Century in fields such as energy, environment, medicine, and safety.

In particular, development of a device which emits light with short wavelengths in the deep-UV region of 200-350nm has the potential to resolve a broad range of issues at once. For example, it can be applied in sterilization for preventing hospital infections, used to break down persistent substances such as PCB, or used to assist water purification. One estimate places the potential market size of this technology as high as 5 trillion yen if it becomes possible to apply it to a wide range of fields, such as lighting, sterilization and sanitation, medicine, and water quality control.

However, a method for efficient, high-output light emission in the deep-UV region is yet to be successfully established anywhere in the world.

Development of a high-output deep-UV light emitting devices

One of our aims is a development of a high-output deep-UV emitting element. We have already established several techniques and methods to make this possible. One of these is a pioneering of a technology for forming a vertical-type structure of light-emitting elements using aluminium gallium nitride (AlGaN). Because a scaling law applies to the vertical-type structure, a 10-fold or even a 100-fold increase in output are not outside the realm of possibility.

In addition, we are working to increase the internal quantum efficiency of the AlGaN crystal in order to further improve its quality. Conventionally, it has been considered impossible to form quantum dots with quasi-phase matching. We succeeded in forming quantum dots with lattice matching by introducing an anti-surfactant and reducing the surface energy. In addition, we used the MOCVD technique to develop a new technique called alternate co-doping, as well as succeeding in forming a high-concentration p-type epilayer.

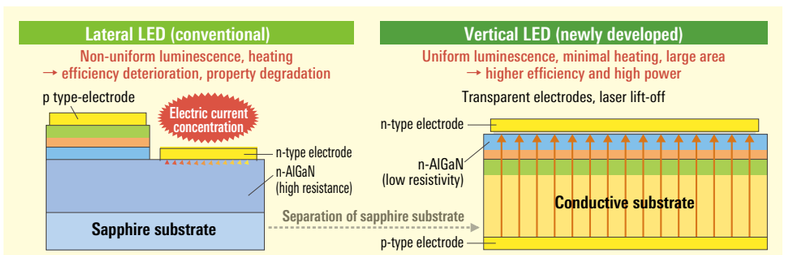
Laser processor

We are currently working to optimize the device structure using simulations, and thus increase its output. Our target is to develop a device capable of emitting UV-light within the most crucial 260nm-330nm range at 100mW, which is 100 times greater than the 1mW output currently possible.

As well as the deep-UV region, the project is also focusing on the infrared zone on the other side of the spectrum. A group led by Dr. Yasushi Nanishi is working to develop a high-efficiency infrared emitting element that uses infrared light sources. We are also working on developing a high-speed electron device with a high output, a high breakdown voltage, and a high energy efficiency, using indium nitride (InN).

The concept of "environmental electronics" - from Ritsumeikan to the rest of the world

Through this project, we would like to pioneer a new concept of "environmental electronics", which we would like to spread from Ritsumeikan University to the rest of the world. This is a concept in which environmental issues, conventionally addressed mainly via conceptual approaches, is also tackled from another angle using firm hardware through the use of electronics technology. In order to achieve this aim, development of deep UV light emitting devices is a typical candidate which can apply to many environmental issues like sterilization, water purification and so on. R



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4

Environment

【Research Project】
Basic Technology Development and Strategic Innovations towards a Low-Carbon Society

Realization of a low-carbon society through innovations in technological, economical, and social aspects

Keywords
Sustainability
Low-carbon community
Basic technology development and transfer
System innovation
Sustainable society model experiment
Strategic evaluation system

Project activities with priority
1 – Comprehensive utilization of bamboo forests
2 – Conception of a Japan-China safe and secure agricultural zone
3 – Conception of a low-carbon society pilot model project
4 – Design and evaluation of distributed energy system
5 – Development of the assessment model for low-carbon community

Promotion of a low-carbon economy across national borders

It is humankind's common goal to realize a low-carbon society. Although great effects have been made to save energy in developed countries such as Japan, in order to reach a real low-carbon society, it is necessary to cooperate with the developing countries, on a global scale.

Although having great potential to reduce CO_2 emissions, there are many barriers, including economic and technological ones, against the CO_2 emission reduction activities in developing countries.

However, once the co-benefits of shifting to a low-carbon economy, such as economic growth and pollution reduction become apparent, powerful incentive will be received for developing countries to cut their emissions. Developed countries can help developing countries to gain such co-benefits, and in return, receive corresponding economic and environmental merits. It is believed that such a mutual cooperative relationship between developed and developing countries is the key to achieve a low-carbon society.

Killing many birds with one stone, and strategic innovation

In our project, three aspects, namely, technology, economy, and society, are paid the main attention. We aim at creating a road map to a low-carbon society by executing pioneer research in each of the three aspects, developing a vision for strategic innovation, and developing the "Ritsumeikan Model", which can evaluate the balance among economy, environment, and society comprehensively.

A specific research that is currently underway is the pilot project focusing on the city of Huzhou, China, which has been specified as the 'circular economy model city' by the Chinese government. Huzhou is also one of the world's leading producers of bamboo. We are intending to establish a methodology for the "Clean Development Mechanism (CDM)" that makes use of Huzhou's vast bamboo resources. We are also working towards setting up a "Japan-China safe and secure agricultural zone", making the most of various agricultural resources in the local area.

In addition, we are researching on optimal plan of distributed energy systems through cooperation between urban and rural areas. Bamboo-derived biomass, solar energy system, and low-emission transportation system, are paid the most attention. At the same time, we are also taking various society-based approaches, such as measurement of happiness index and design of welfare systems.

Furthermore, we intend to carry out comparative research with existing projects in Japan. Through the execution of these projects, in addition to realization of a low-carbon society, some other benefits, such as improvement of economic efficiency, reduction of pollution, and insurance of energy security, can be received.

An interdisciplinary project involving a variety of cooperation

This project is driven forward through a variety of cooperation, such as those between theoretical and empirical approaches, humanities and sciences, as well as cooperation between organizations and across borders. Our eventual aim is to set up a research centre towards a low-carbon society and train researchers with international leadership.

The benefit of a low-carbon community is not limited to combating the global warming. It will also play a crucial role in creating a sustainable society in which economy, environment, and society are at a balance. R

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5

Energy

[Research Project]
Application of Solid Oxide Electrolyte Cell to the Energy and/or the Environmental Device

Solid oxide fuel cells with instantaneous start-up will revolutionize the future market for fuel cells

Keywords
Fuel cell
SOFC
Quick start
Porous solid oxide electrolyte cell
Gas permeable type
YSZ, GDC

College of Science and Engineering
Professor YOSHINOBU YOSHIHARA (Ph.D.)

Researching low-cost fuel cells made of a variety of materials

The polymer electrolyte fuel cell (PEFC) is thought of as a promising technology for the future fuel cell market. Benefits of PEFCs include a short start-up time as a result of its relatively low operational temperature of about 100°C. However, they are problematic in that they require a large amount of platinum as well as high-purity hydrogen. It is thought that any potential industrial use of PEFCs will be hampered by issues such as cost and development of the necessary infrastructure.

We, on the other hand, have been focusing on the solid oxide fuel cell (SOFC). With the SOFC, expensive platinum is not necessary as a catalyst, and a variety of fuels can be used other than high-purity hydrogen. Furthermore, the SOFC has an added benefit that it has a generation efficiency of over 50%, which is higher than that of the PEFC. There are however, problems that need to be overcome. Extremely high operational temperature (800°C to 1000°C) is required to get electrolyte ion conductivity and this would lead to a long start-up time. However, we believe that if we could find a way to resolve these problems and pave the way to a compact, thermally self-supporting SOFC system with a short start-up time, it could have an impact so large that the SOFC may replace the PEFC.

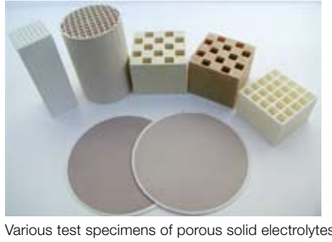
Development of the gas permeable type solid electrolyte

So far, we have developed a cell that has a gas permeable type solid electrolyte, and designed a diesel engine exhaust gas clean-up system. Here, the diesel exhaust is channelled from the anode side of a porous solid electrolyte towards the cathode side, and a voltage applied between the electrodes; this results in a movement in the minute amount of oxygen ions flowing in the electrolyte, causing an oxidation of particulate matter (PM), such as soot, at the anode, and a reduction of nitrogen oxides (NOx) at the cathode. As a result, we have succeeded in simultaneously cleaning up more than 90% of both the NOx and the PM using an extremely weak electrical power. This exhaust gas clean-up system, based on the electro-chemical reaction, can be used to reduce NOx and PM emissions in diesel vehicles.

Obtaining the necessary temperature for generation through heat from combustion

Normally, a SOFC is an airtight cell in which the anode and cathode are isolated from each other; therefore, the fuel and the air do not directly react. However, if a porous, gas permeable type structure is used as the cell, the heat energy from the combustion of fuel and air can be utilized directly via the cell. This means the cell can acquire, in a short space of time, a temperature at which ion conductivity can be obtained, without the need for an external heat source. This attempt to transfer a part of the chemical energy into heat energy through combustion, in the context of fuel cell reactions, is unique in the world.

Our experiments have confirmed that by causing a part of the fuel at the anode side to react with the air at the cathode side, and forming a flame on the cell, the cell reaches its operational temperature of over 700°C in approximately 10 seconds. We believe that this would allow us to design a compact, thermally self-supporting SOFC system with a short start-up time. R



Various test specimens of porous solid electrolytes.

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6

Energy

[Research Project]
Development of High Efficiency Multijunction Thin Film Solar Cells for Energy Security

High-efficiency thin-film solar cells hold the key to the energy of tomorrow

Keywords
Solar cells
Devices
Compound semiconductors
High quality film deposition
Organic semiconductors
Multi-junction
Global environment protection

Lower cost and higher efficiency through the use of chalcopyrite

Our project focuses on chalcopyrite compound thin-films for the development of solar cells which are both cheap and highly efficient. The advantages of using chalcopyrite are that it has superb photoelectric properties, and that it requires a thinner power generating layer than in the case of silicon crystals used in conventional solar cells, which allows for lower material cost.

A conversion efficiency of 20.0% has been achieved with solar cells that have typical thin-films made of Cu (In, Ga) Se_2 (CIGS). This is a value that matches that of polycrystalline Si solar cells. Our aim is to develop a chalcopyrite thin-film solar cell with a wide band gap Eg of between 1.9eV and 2.3eV, and thereby pave the way for the development of a solar cell with a conversion efficiency of 30%.

Development of solar cells with a wide band gap energy

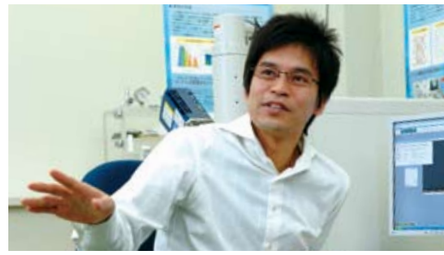
First, we designed a number of thin-film solar cell devices with various band gap energies of between 1.0eV and 2.3eV, and embarked on manufacturing high-quality chalcopyrite thin-film crystals for each device. So far, we have employed high-quality thin-film fabrication technology that uses vacuum deposition in order to deposit Cu (In, Al) Se_2 and Cu (In, Ga) Se_2 films with a band gap energy of between 1.0eV and 1.3eV. We are currently working on adjusting the structural ratio to form films with a band gap energy of 1.3eV to 1.9eV. In addition, we are also experimenting with deposition of Cu (In, Al) S_2, which is a sulfide chalcopyrite, in our attempt to obtain cells with an even wider band gap energy (1.9eV to 2.3eV).

Next, we will further boost solar cell efficiency by designing a multi-junction thin-film solar cell able to absorb solar radiation from across a wide portion of the solar spectrum, formed by layering chalcopyrite films with different band gap energies. Through a preliminary calculation, we estimated that a conversion efficiency of 40% can potentially be achieved using 5 or 6 layers.

For the future, one possibility which we are currently envisaging is integration with organic thin-film solar cells. We hope to resolve various disadvantages facing both organic and inorganic solar cells in our drive to further lower cost and boost efficiency.

Design of systems that utilize solar power

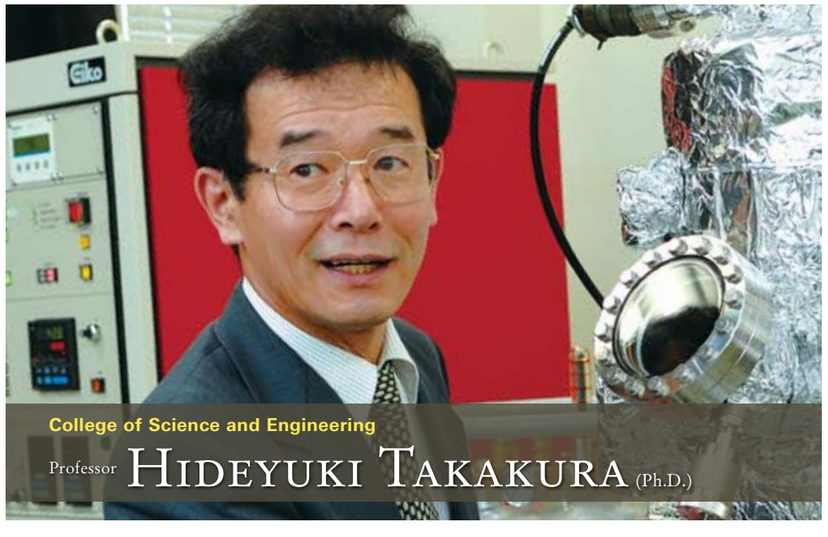
In Japan, which relies almost entirely on imports for its primary energy supply, future energy security is a crucial issue directly linked to our lives. Sunlight is one energy source that Japan has its fair share of, which makes solar power an ideal option for our nation. Its importance is also significant in terms of global environmental protection.



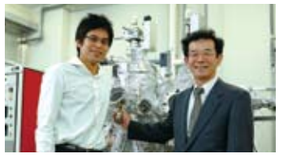
Joint Researcher
Associate Professor Takashi Minemoto

In order to further spread the use of solar power, it is necessary to bring down the cost of solar generation to match that of conventional electricity, as well as to develop solar cells with greater efficiency in generating power. We believe that our project will present us with one way of resolving these issues.

However, designing solar cells will not, by itself, present us with a solution to the issue of energy. What we eventually need is a comprehensive mechanism for utilizing solar power, such as establishment of necessary infrastructure for distributing electricity, and creation of an international standard which would allow electricity to be supplied on a global scale. Our ultimate aim is to create a base for conducting research into establishing such a system. R



College of Science and Engineering
Professor HIDEYUKI TAKAKURA (Ph.D.)



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7

Food supply

[Research Project]
Construction of Food Production System Based on Symbiosis Material Circulation Society

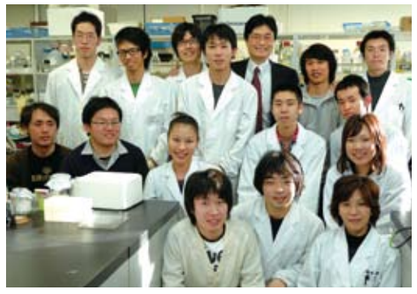
Using science to tackle the issue of food safety and security through precision assessments of agricultural environments

Keywords
Material cycling, Symbiosis
Environmental evaluation system
Bio-monitoring
Food safety and security
Food production
Food production system
Bacteria
Biomass

Development of agricultural land assessment techniques based on microorganisms

The aim of our project is to examine the principle of “food safety and security” from a scientific viewpoint, and to use our findings to help implement measures that leads to true food safety and security. Agricultural land environments worldwide changed drastically in the past 50 years due to way of unseeing chemical fertilizers. In its natural cycle, the soil is fertilized by the decomposition of organic matter by microorganisms. However, once the microorganisms in agricultural land are killed off by direct application of inorganic chemical fertilizers, subsequent application of organic farming methods will not result in sufficiently high productivity.

In our research, we have developed an original method of quantitatively measuring bacteria numbers through extraction and analysis of environmental DNA (eDNA), and established a technique of agricultural land environment assessment which uses the number of microorganisms in the soil. Though a demonstration of this technique, we found the average number of microorganisms in 1g of agricultural soil to be 3.5 billion cells, and discovered that a drop in this number to below 200 million renders the soil inactive, stopping its natural material cycle.



In addition, we have also developed a new technique of estimating the rate-controlling substances at work in each stage with the nitrogen and phosphorus cycles in the agricultural environment. This technique can be used to improve soil environments in which the organic matter is not being broken down properly, as it allows the application of microorganisms or enzymes that are effective in replacing the rate-controlling substances for the relevant stages in the breakdown process.

Assessment and improvement of agricultural land and crops

In our project, we are aiming to lay out a standard for assessing agricultural land environment based on our scientific qualitative technique, create an environmental assessment system, and establish methods for agricultural land assessment.

In addition, we intend to uncover the mechanisms which drive the nitrogen, phosphorus, and potassium cycles, and develop new methods of analyzing the quantities of microorganisms which drive each of the cycles. We are also working to refine techniques for a post-assessment application of microorganisms and biomass material to improve the organic quality of agricultural land.

Furthermore, we also intend to develop a technique which assesses farmland to forecast crop yield, through creation of databases relating to farmland environment and plant growth. Once we determine accurate methods for assessing farmland, establish a method of assessing crops, and identify the materials necessary for agricultural land improvement; we will proceed to conduct field demonstrations in Shiga Prefecture, Yamagata Prefecture, and Hokkaido.

Creation of a system which encompasses all stages including distribution

The scope of our research is not limited to the production of food. We believe that in order to boost the rate of food production, it is crucial to also address the issue of business profitability of food production. Our ultimate intention is to introduce elements of IT technology to create a comprehensive high-efficiency system that encompasses everything from agricultural land improvement to food production and distribution. R

College of Life Sciences
Professor MOTOKI KUBO (Ph.D.)

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8

Food supply

[Research Project] Improvement in Agricultural Production by Developing Advanced Technology for Breeding, Cultivation, and Disease Prevention by Application of Microorganisms

Diverse and unique microorganisms lead to the ultimate safe and labor-saving agriculture

Keywords
Microorganisms
Breeding
Cultivation
Pest- and disease-control
Agriculture
Enzymes

Utilizing microorganisms with diverse and unique metabolisms to increase agricultural production

Although a great variety of microorganisms exist, only limited species are utilized in industry. The diverse and unique metabolites, enzymes, and proteins produced by microorganisms exhibit interesting bioactivities. Our mission is to elucidate structures and functions of microbial enzymes and metabolites in order to make their practical application possible in a variety of fields. This will allow us to contribute to the sustainable development of our society.

Two particular issues facing us today on a global scale are food and the environment. We believe that microorganisms have important roles in the development of agricultural techniques that minimize environmental impact, maximize product safety and quality, and accordingly contribute to boosting the agricultural economy. Our project aims to increase agricultural output by developing next-generation breeding, cultivation, and pest control techniques that utilize microorganisms.

Developing a microbial factory that provides diverse microorganisms and enzymes with useful functions

The basis of this project is the microbial factory. In coordination with other R-GIRO projects, we plan to collect microorganisms from a diverse range of environments and to develop a so-called “factory” for microbial functions and metabolic systems.

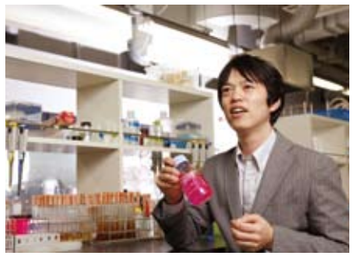
One principal research theme is cell wall lytic enzymes from microorganisms. Glucanase and other cell wall lytic enzymes are known to break down the cell walls of plant pathogens. Today, pest and disease control is a major issue in crop cultivation. Therefore, this kind of research may help pave the way towards microorganism-derived enzyme pesticides using cell wall lytic enzymes.

Our research into the functional analysis of sulfur/selenium-delivering enzymes applicable to the production of cofactors and useful biofactors containing sulfur/selenium, has provided some interesting clue to the application of enzymes. Selenium is an essential trace element for mammals: it is present in selenoprotein as a selenocysteine residue and plays a crucial role in catalytic reactions. Sulfur plays a number of significant roles in the body. In previous research, we found that during sulfur/selenium insertion, specific sulfur/selenium-delivery mechanisms, mediated by interactions between multiple proteins, led to high enzyme functionality and specificity. The use of such proteins allows the efficient insertion of sulfur/selenium into biofactor precursors to create sulfur/selenium-containing biofactors.

Applying research findings to the development of breeding, cultivation, and pest control techniques

We plan to elucidate a variety of microorganism environmental response systems, such as those for light, temperature, gas, metal, and nutrients. We also plan to develop practical methods, easily applicable on-site by agricultural workers, which are simple to use, inexpensive, and utilize of bioassaying methods. In addition, we will be conducting research geared at establishing safe and reliable pest- and disease-control systems that utilize the characteristics of natural biomolecules, such as the aforementioned cell wall lytic enzymes. R

College of Life Sciences
Associate Professor HISAAKI MIHARA (Ph.D.)



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Materials & resources

[Research Project]
Environment-Friendly Photoactive Materials Based on Naturally Occurring Tetrapyrroles

Development of various devices using artificial photosynthesis technology

Keywords
Tetrapyrroles
Chlorophyll
Photosynthesis
Supermolecular chemistry
Self-aggregation
Photoactive materials
Devices

Environment-friendly photoactive materials based on naturally occurring tetrapyrroles

Various types of tetrapyrrole-based compounds, such as chlorophyll and heme, are found in natural systems. Recent research has indicated *in-vivo* important roles of these compounds, which attract much attention from most biological fields. For example, altering the metabolism of tetrapyrroles may allow us to turn plants evergreen or to induce plant death, and new synthetic tetrapyrroles would be useful for killing cancer cells through photodynamic therapy.

In the above scientific filed, we are working to unravel the relationship between structures and functions of tetrapyrroles at a molecular level. One of the objectives is a creation of a photoactive energy conversion material.

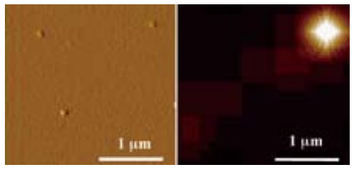
Creation of an artificial photosynthetic antenna

In our previous research, we analyzed the functions of natural chlorophylls, successfully synthesized new chlorophyll molecules, and prepared an artificial photosynthetic antenna that absorbs light and transfers excited energy.

Natural organisms usually require both pigments and proteins for the formation of the antenna supercomplex. However, it has been discovered that green anoxygenic photosynthetic bacteria have unique extramembranous antenna complexes (chlorosomes) in which special chlorophyll pigment molecules self-aggregate to form the antenna complex. We introduced specific moieties at the peripheral positions of the synthetic chlorophyll and can form its self-aggregates with a well-organized supramolecular structure. The self-aggregates readily light-harvest and energy-transfer even in the absence of any proteins.

We tried to prepare the artificial model of chlorosome. First, we synthesized a synthetic model by modifying easily available chlorophyll *a*. In a natural chlorosome, chlorophyll molecules self-aggregate in a hydrophobic environment inside lipid self-assembling micelles. We confirmed that the synthetic chlorophyll molecules self-aggregate in a biomimetic micelle.

The above model micelle system was fragile, so we polymerized the membrane surface in order to stabilize it both physically and chemically. Such a system with a 100-nm diameter was modified on any substrate to give a relatively stable light-harvesting and energy-migrating system.



Atomic force microscopy image (left) and fluorescence microscopy image (right) of artificial chlorosome.

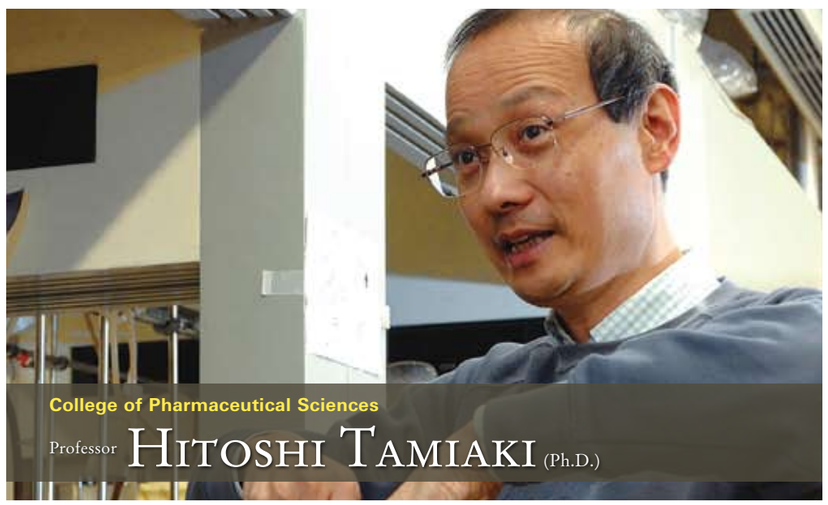
Development of devices using new types of tetrapyrroles

In our project, we are elucidating the various functions of tetrapyrroles to explore potential applications. The metabolic mechanism of tetrapyrroles includes numerous minor components which are yet to be identified. We are working to identify these molecules and to further understand their photosynthetic and degradation pathways.

Most genes of main chlorophyll synthesis have been characterized, but those for numerous other minor substances are yet to be identified. We are determining them by biochemical and synthetic techniques. Typically, we are studying synthetic routes of 7-formyl group of bacteriochlorophyll (BChl) *e* and of 8-ethylidene group of BChl *b* and *g* as the targets.

Furthermore, we aim to create photoactive materials with new types of self-aggregating tetrapyrrole molecules, and to develop devices using these novel materials. We believe that such devices will play a part in the future development of environmentally friendly solar cells and photo-conversion systems.

Potential application of tetrapyrroles is not limited to the field of new energy. Its scope stretches further over a multitude of fields, including food, environment, and medicine. R



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Materials & resources

[Research Project]
Formation of Functional Soft Materials Based on Elemental Resources

New concepts and new properties through the synthesis of the molecules that exhibit spontaneous self-assemblies

Keywords
Organic synthesis
π-Conjugated molecules
Pyrrole rings
Self-assembly
Soft materials
Supramolecular gel
Stimuli-responsive behaviors

"Cooperative effects" of covalent bonds and intermolecular interactions

It is so interesting and essential in science to synthesize new molecules, to prepare their self-assembled structures, and to explore their potentials for useful materials. Formation of new molecules enables us to obtain new properties and functionalities and, as a result, to create new concepts. Organic synthesis, as a crucial protocol to form and break various atomic (covalent) bonds, allows us to provide new values based on the material resources. Further, in biotic systems, various molecules act as building blocks of self-assembled structures using intermolecular (noncovalent) interactions to exhibit the properties that are not observed in the individual molecules. From the background as mentioned above, one of the aims in our research group is to explore potential applications of novel molecules that form self-assembled structures using both covalent bonds and intermolecular interactions.

With group members (students) to perform the project research

Synthesis of novel π-conjugated molecules

At first, in this research project, we attempt to synthesize π-conjugated molecules, whose structures are totally new. π-Conjugated molecules exhibit characteristic electronic and optical properties due to their fairly delocalizing (moving) electrons. The planar geometries in π-conjugated molecules are also essential to form stacking assemblies. Therefore, we have been investigating to prepare π-conjugated dye molecules as essential building units of soft materials, such as gels and liquid crystals.

Among the π-conjugated species, we have focused on pyrrole ring, which is a planar essential component of biotic dyes such as chlorophyll and heme; the nirogen site of pyrrole ring as well as its planar structure can behave as an interaction site to fabricate supramolecular assemblies. So far, we have reported various pyrrole-based π-conjugated structures that form self-assembled structures. Therefore, we have been enjoying the investigations on the π-conjugated molecules consisting of pyrrole rings, which form the complexes with metal cations (positive-charged species) and those with anions (negative-charged species) along with the supramolecular assemblies.

Formation of stimuli-responsive soft materials based on π-conjugated molecules

It is a crucial step in this research project to obtain new utility π-conjugated acyclic molecules such as metal ligands and anion receptors, prepared from starting elemental resources. For example, using metal cations as adhesives, some of the π-conjugated acyclic molecules are found to afford metal coordination polymers like linear strings, which are folded and transformed to emissive colloidal spheres.

On the other hand, we have prepared emissive anion receptor molecules, which "recognize" anions, that is, act as "sensors" that show the color and emission changes by interaction with anions. Further, based on the stacking properties of the receptors due to their planar geometries, introduction of appropriate peripheral substituents has resulted in the formation of soft materials such as supramolecular gels and hydrophilic vescicles. The supramolecular gels consisting of anion receptors show the anion-responsive behaviors that mean the transitions from gel to solution state upon the addition of anions. Recently, we have found the organized structures comprising alternatively stacking positive- and negative-charged species in the solid state using receptor-anion complexes as "planar anions".

We have just started the chemistry on the formation of soft materials using the interactions of charged species along with the examinations on anion-responsive behaviors and tunable properties. We are challenging to exhibit new concepts and new properties and, further, to extend our field to develop useful devices based on the organic synthesis that can control the arrangements of atoms and molecules to give utility materials. R

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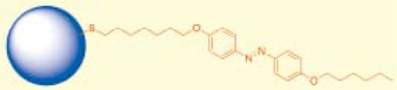
Materials & resources

[Research Project]
Development of Organic-Inorganic Hybrid Nano Materials and Control of Their Organized Structures

Organic-Inorganic Hybrid Nanoparticles: Toward High-Performance Nano-Devices

Keywords
Organic-inorganic hybrid materials
Liquid crystals
Photonic control
Nanoparticles
Nanostructure control
Self-organization
Stimulus responsive materials

College of Life Sciences
Associate Professor Osamu Tsutsumi (Ph.D.)



Hybrid of organic and inorganic materials in nanometer scale

Creation of nanoscale high-performance materials

Metal nanoparticles have attracted great interest because of their unique physical and chemical properties based on the quantum-size effects. Therefore, they have been expected to be applicable to novel materials for the electronics, photonics, and magnetic devices. For example, a one-dimensional arrangement of metal nanoparticles is expected to be utilized for nanoscale wires for integrated circuits, and those would allow a significant increase in the performance of the devices and a dramatic reduction in the size. Our project aims to create high-performance and multi-functional materials by precisely controlling the ordered structure of materials in nanoscale.

Controlling the organized structure of nanoparticles using liquid crystals

As mentioned above, in terms of device application the nanoparticles should be arranged in the ordered structure. Furthermore, in order to optimise the functions of the materials it is also interest to control the spatial arrangement and distribution of the nanoparticles by an external stimulus. To date, one dimensional (1D), two dimensional (2D) and three dimensional (3D) arrangements of the various metal nanoparticles have been accomplished by the “top-down” methods, for example nanolithography, template synthesis methods, and so on. However, it is necessary to develop more simple and easy method known as the “bottom-up” process. In this method, metal nanoparticles are spontaneously arranged by programmed organic molecules.

Liquid crystals (LCs) are one of the self-organized organic materials and show long-range order, cooperative effects, and anisotropic nature in optical and electrical properties. Therefore, the LCs are considered to be one candidate for the materials to induce the spontaneous arrangement of the nanoparticles. In addition, since the LCs show also fluidity, we can easily control the phase structure of LCs as well as the direction of their molecular orientation by external stimuli such as an electric field and light. So far, we have developed many photoresponsive LCs, and it has been demonstrated that the LC phase structure, the direction of the molecular alignment and the distribution of the photoresponsive molecules in the LC phase can be controlled by light.

We believe that the spatial arrangement and distribution of the metal nanoparticles could also be controlled with the photoresponsive liquid crystals. When the photoresponsive LCs were introduced to metal nanoparticles, the nanoparticles can spontaneously show the 1D, 2D and 3D arrangements, depending on the phase structure, and we might control those self-organized nanostructure of the particles by photochemical reaction of the photoresponsive LCs. We therefore decided to combine liquid crystals with inorganic nanoparticles, to develop a completely new sort of material: organic-inorganic hybrid nanoparticles.

Challenge to create high-performance devices based on nano-hybrid materials

Our research consists of three parts: organic materials, inorganic materials, and an evaluation of the hybrid materials, so that in this project the specialists in those areas are organized into each group. In this project, we seek to develop fundamental understanding the relationship between nano-structures and properties of the materials for device application.

Our organic-inorganic hybrid nanoparticles are quite new type of multi-functional materials having both properties of organic and inorganic materials. We are challenging to find new phenomena and functions appeared by controlling the nanostructures, and we aim to create new high-performance electronic, optical and magnetic devices based on our hybrid materials. R

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Materials & resources

[Research Project]
Engineering Materials Research Project for Sustainable Development

Creation of harmonic-structure materials give rise to a new paradigm in material design

Keywords
Harmonic structure
Nano / Meso bimodal materials
Manufacturing
Low environmental impact materials
Volume reduction / substitute materials
High-reliability / design optimization
High-performance processing

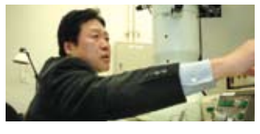
Research towards creation, assessment, and processing of high-efficiency materials

Japan's manufacturing base industry, and thus its economic development has been supported by its world-leading materials, machine manufacturing, and processing industries. For Japan to maintain its leading role in these fields against a backdrop of various issues such as depletion of natural resources and the need for environmental protection, it is necessary to establish technologies with even higher levels of efficiency in terms of creation, design, and processing of materials, while at the same time cutting the usage of rare elements and harmful substances.

Our project aims to investigate high-efficiency use of engineering materials, through comprehensive research, involving expertise from several different fields, into the three areas of 1) creation, 2) property assessment and design optimization, and 3) high-precision processing of materials. Such research also fulfil a role of an ideal education opportunity.

A new idea of “nanoscopic / harmonization"

In the world of material development, the general trend has been focused on ultra-fine grain refinement alongside uniformity. However, with materials which are both “ultra-fine” and “uniform”, it is difficult to achieve both strength and ductility – conflicting, but desirable properties - at the same time. However, the severe plastic deformation process enables to create a “nanoscopic / harmonization” material which overcomes this trade-off. This signifies a birth of a new paradigm in the field of material design.



By applying severe plastic deformation to various metal powders, it is possible to manufacture combined-structure powders comprising of a *shell* section, i.e., surface area of the powder, having a nano grain structure that exhibits high strength, and a core section, i.e., center area of the powder, having a mesoscopic crystal structure that exhibits high ductility. Sintering this powder has an effect of harmonizing the nanoscopic and mesoscopic structures, allowing us to create a material which exhibits high strength while maintaining high ductility.

We expect such materials to be useful for application in medical equipments by making the most of their high strength, light weight, high toughness properties.

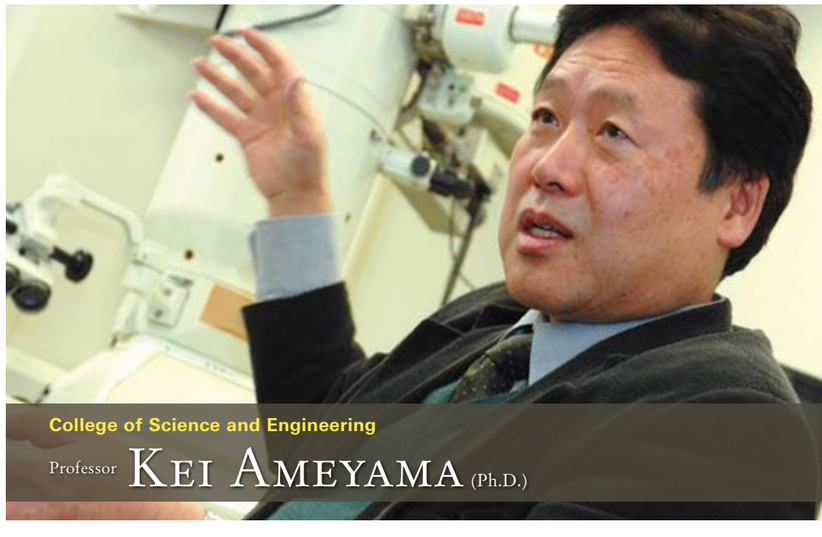
Towards practical application through assessment, design optimization, and processing

Alongside material development, we are also working towards practical application of the materials by carrying out demonstrative experiments, various assessments, and design optimizations. We are carrying out microscopic structural analyses, assessments of static properties such as regular- and high-temperature strengths, assessments of dynamic properties such as fatigue and impact strengths, and assessments of physico-chemical properties such as corrosion- and heat-resistances. Processing properties such as processing performance and workability are also assessed in order to improve the materials.

We believe those materials which we create will eventually meet the demands of a variety of sectors, such as in the fields of medicine, environment, and energy.

We also aim to work towards development of human resources. We are working to create a system for nurturing technical and research personnel with expertise not only of material development, but also variety of fields such as material assessment. R

Spark Plasma Sintering Apparatus
Sinters non-equilibrium powders through rapid heating, allowing sintering of materials such as ceramics and metals making use of their non-equilibrium conditions.



College of Science and Engineering
Professor Kei Ameyama (Ph.D.)

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Medical treatment & health

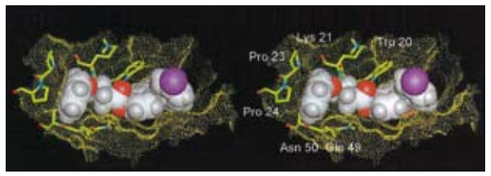
【Research Project】 Research for Drug Development and Useful Functional Organic Molecule Creation Based on Sustainable Advanced Synthesis

Search for unknown compounds and reactive properties using iodine, a sustainable representative element

Keywords

Iodine
Hypervalence
Organic synthesis
Functional molecules
Environmental harmony
Element strategy
Organic catalysts

College of Pharmaceutical Sciences
Professor YASUYUKI KITA (Ph.D.)



Optimization research of lead compounds using interactive docking study in the search for diabetes drugs.

Focus on iodine – a plentiful and safe resource

Since the turn of the century, the field of organic chemistry has seen increasing interest in development of synthetic reactions that meet the requirements of environmentally-friendly, sustainable chemical technologies.

Until now, we have been conducting total synthesis of natural products which have outstanding bioactive properties, yet have complex structures and are only available in trace quantities; and using these substances for making lead compounds. Iodine is a substance which first attracted our attention nearly 30 years ago. It is one of very few resources for which Japan is self-sufficient; with about 40% of the world's iodine production taking place in otherwise resource-poor Japan. In addition, unlike heavy metals, it is suitable for “green chemistry” which does not burden the environment. We believe that further research into developing methods for utilizing iodine for organic synthesis and new materials has the potential to establish a new industry unique to Japan.

Successful development of an environmentally friendly synthetic method which replaces heavy metals

We have developed a distinct synthetic method using unique active species and reactants which are derived from environmentally-friendly iodine etc. instead of highly, toxic heavy-metal reactants, and used this method for successful total syntheses of various complex natural products.

Additionally, we have established new skeletal construction methods that use oxidizing and reductive capacities of sulfur, iodine, and radical species and cations of carbon, nitrogen, and oxygen, etc. These have gained high acclaim both from within and outside Japan as a key reaction that enables synthesis of various useful substances. What was particularly groundbreaking was a discovery that cation radicals form on aromatic rings on using hypervalent iodine reactants. We have overcome numerous hurdles which were previously said to be difficult; for example, we successfully performed a catalytic utilization of hypervalent iodine reactants and highly asymmetric reactions, which were successfully applied to cross-coupling reactions of deactivated aromatic-series compounds without using metal.

In our project, we aim to examine the characteristics of key reactions which use hitherto unknown properties of representative elements, such as the development of environmentally friendly synthetic methods which use hypervalent iodine, and new skeletal constructions and functionalizations involving high-order utilization of sulfur.

Already, we have successfully pioneered total syntheses of antitumor natural products such as discorhabdin, frederica-mycin A, and γ-rubromycin. We are building upon the base research into utilization of the properties of iodine and sulfur in order to actualize facile and efficient syntheses of synthetic intermediates and derivatives of these natural products; and using the results of bioactivity assessments of these to design target compounds, to pave the way to drug development.

Development of new materials which contain iodine

For the future, we would like to not only use iodine as an organic synthetic tool, but also work on designing compounds for the purpose of developing new materials which contain iodine. One example which we are focusing on is diaryliodonium salt compounds. These compounds, having strong carbon-iodine bonding, have unique properties which cannot be created with other elements, and we are hoping that they may actualize novel characteristics or functionalities.

We intend to work on demonstrating the usefulness of iodine as a resource, not merely as a substitute to rare metals but as a superior replacement to rare metals, with a focus on bioactive substances such as pharmaceutical synthetic intermediates. Anticipation of the future in which our research come to fruition in the form of newly developed drugs is our biggest motivation. ®

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Medical treatment & health

【Research Project】 Integrative Study for Elucidating the Mechanisms of the Protein Folding and the Protein Folding Diseases

Study of protein folding/misfolding sheds light on potential cure for neurodegenerative diseases

Keywords

Protein folding
Protein misfolding
Designed peptides
Amyloid fibril
Intermediates
Neurodegenerative diseases
High-pressure spectroscopy
Water and proteins

From the protein folding/misfolding mechanism to protein folding diseases

The three-dimensional structure of protein is closely related to its functions. Recent research has revealed that structural abnormalities resulting from incorrect protein folding (“misfolding”) are the cause of many neurodegenerative diseases such as Alzheimer's disease and BSE. This finding has resulted in the protein folding problem rapidly gaining importance as a crucial issue in the progress of medicinal science as well as a pure scientific interest. It is very much possible that elucidation of this problem would pave the way towards treatment of a large number of neurodegenerative and other protein folding diseases.

In our project, we are tackling this difficult challenge by consolidating expertise from a variety of academic fields, from physical chemistry to biochemistry, molecular biology, physiology, and pathology.

Analysis of protein structures through a variety of experiments

The process of protein folding involves an intermediate state in which the structure is metastable. In this state, the structure is not yet fully stable, and the segment which normally forms the helix structure rarely misfolds to form the β-sheet structure. This results in aggregation of protein, leading to formation of amyloid fibril, and loss of normal protein function. This is associated with onset of protein folding diseases such as neurodegenerative diseases. In other words, the intermediate stage is the turning point between normality and abnormality.

Our project is being promoted by dividing it into three stages. For stage 1, we are investigating the mechanism of protein folding. The structure of protein is being studied under a variety of conditions, using both natural proteins and artificially designed peptides. The study employs a wide variety of analytical techniques, such as infrared and Raman spectroscopy, fluorescence spectroscopy, NMR, and X-ray crystallography. It is known that a high-pressure environment is effective in capturing the intermediate states, and we are therefore also employing various high-pressure techniques.

It is also important to note that the analysis of water-protein interaction is an important key for unlocking the principle behind protein structure formation. We are therefore conducting systematic research into the thermodynamic quantities of water-protein interaction.

Elucidating the misfolding process

For stage 2, we are focusing on the protein misfolding/aggregations. Understanding this misfolding process is the key to understanding protein folding diseases as mentioned above. Therefore, we are using artificial peptides and mutant-type proteins in order to analyse the process of amyloid fibril formation for Aβ-peptide, thought to be a leading candidate for the cause of Alzheimer's disease, and α-synuclein, thought to be related to Parkinson's disease.

Raman scattering measurement

The final stage 3 involves research of the actual diseases. In our study of Alzheimer's disease, we are seeking to determine the environmental factors which cause Aβ-peptide fibril accumulation in the brain using *in vivo* experiments. Similarly, we are working to uncover the molecular mechanisms involved in the relationship between misfolding amyloid fibril formation of α-synuclein and Parkinson's disease.

Our ambition is to take our research towards development of drugs which can cure neurodegenerative diseases. When realized, it will undoubtedly have an immeasurable impact in the fields of medicine and health care. ®

College of Pharmaceutical Sciences
Professor MINORU KATO (Ph.D.)

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Medical treatment & health

[Research Project]
Drug Development using a Gene Regulation Mechanism by Natural Antisense Transcripts

Investigation of functions of natural antisense transcripts to develop novel nucleic acid drugs

Keywords
Antisense transcript
Non-coding RNA
Inflammation
Nitric oxide
Cytokine
Sense oligonucleotide

Focus on the potential roles of natural antisense transcripts

RNA transcribed from DNA consists of not only messenger RNA (mRNA) that encodes a protein to be translated, but also another RNA species that does not code any proteins, known as non-coding RNA (ncRNA). Recent genome-wide transcriptome analyses have revealed that ncRNA is much more abundant than previously expected. Our project focuses on a natural antisense transcript (also called antisense RNA), which has the same sequence as the antisense strand of a gene and is classified ncRNA in many cases.

We have been investigating the natural antisense transcript that may have unknown functions, although the antisense transcript was long thought to be '*junk*'. We have proposed a hypothesis that the antisense transcript interacts with mRNA to regulate mRNA stability and thus protein synthesis.

Discovery of natural antisense transcripts that stabilize mRNA

Many viruses and bacteria, when grow in the body, cause inflammation. Bacterial endotoxin and viruses stimulate Kupffer cells (resident macrophages in the liver) to produce nitric oxide (NO) with inducible nitric oxide synthase (iNOS). The stimulated Kupffer cells release cytokines, *i.e.*, proteins that transmit intercellular information, and then stimulate hepatocytes to produce NO. This molecule has high chemical reactivity and thus has antiviral and bacteriocidal effects. We demonstrated that both sense and antisense strands of *iNOS* gene are transcribed to mRNA and an antisense transcript, respectively, in rat hepatocytes and that the antisense transcript stabilizes iNOS mRNA. This novel mechanism to stabilize mRNA works after transcription.

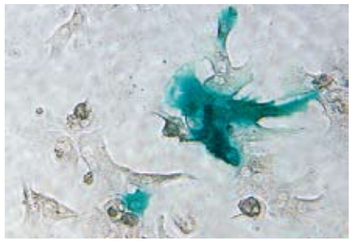
Excess NO production causes inflammation and tissue injury, although an adequate amount of NO protect the body from viruses and bacteria. For example, a large amount of NO dilates blood vessels and exacerbates endotoxin shock (or septic shock).

Moreover, we found that a sense oligonucleotide (short DNA fragment), which has the same sequence as iNOS mRNA, inhibits the interaction between mRNA and antisense transcript, resulting that degradation of iNOS mRNA and then reduce iNOS. This indicates the iNOS sense oligonucleotides can be used as a new nucleic acid drug based on the novel post-transcriptional mechanism.

Development of drugs to target natural antisense transcripts

In our project, we are trying to treat septic shock through administration of iNOS sense oligonucleotides to animals. It is easily speculated that the gene regulation mechanism mediated by natural antisense transcripts is not limited to *iNOS* gene but also to many cytokine genes. We have already discovered natural antisense transcripts in several cytokine genes, and one of them is involved in virus infection (patent pending). Furthermore, we have started developing a program to design sense oligonucleotides based on the two- and three-dimensional structure of RNA.

We hope that our novel nucleic acid drugs, *i.e.*, '*sense oligo drugs*,' may be applied to many diseases that are involved in iNOS and cytokine genes. We believe that this project will, in the future, lead to development of drugs for treating diseases, such as hepatitis C and new types of influenza. R



Primary cultured rat hepatocytes to analyze expression of natural antisense transcripts

College of Life Sciences
Professor MIKIO NISHIZAWA (M.D., Ph.D.)

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Medical treatment & health

[Research Project]
Pioneering Studies of Regenerative Medicine by Glycotechnology

Elucidation of glycan functions will guide the regenerative medicine towards a new stage

Keywords
Glycans
iPS cells
ES cells
Monoclonal antibodies
Glycosaminoglycans
Proteoglycans
Reprogramming

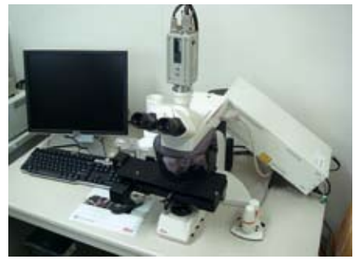
College of Pharmaceutical Sciences
Professor HIDENAO TOYODA (Ph.D.)

Elucidation of the undiscovered roles of glycans

Glycans play important physiological functions in the body, bonding with various molecules such as proteins. Disorders in glycan structures can lead to a variety of diseases, such as cancer, Alzheimer's disease, diabetes, muscular dystrophy and immune deficiency. Glycans also play a role as markers in the differentiation and reprogramming of cells. It is supposed that many antibodies for human iPS and ES cells recognize glycans. This is closely related to the fact that the structure of glycans on cell surfaces vary between tissues and cells even for proteins having the same amino acid sequences. They change widely in the cells depending on the developmental stages and the pathological conditions. Despite the crucial roles in the body, changes in glycan structures are not yet sufficiently understood. Structural changes during the course of cell reprogramming and differentiation would have a great academic impact. Furthermore, glycobiology would be expected to supply applications in the field of regenerative medicine, a recent new medical domain. In this joint project with the university's Research Center for Glycobiotechnology, we intend to explore the biological roles of glycans found on iPS and ES cell surfaces during cell reprogramming and differentiation. These results contribute to develop safe and efficient cell culture techniques in regenerative medicine.

Focusing on the glycosaminoglycans and proteoglycans

Glycans bonded to protein can be categorized into *N*-glycans, mucin-type glycans and glycosaminoglycans (GAGs). In this project, we focus on the structural and functional analysis of GAGs. Some projects are currently under examination using a new method of monoclonal antibody production in the Research Center for Glycobiotechnology. Here, we are attempting to create new antibodies to iPS cell surface glycans using human iPS cells as the immunogen. We are planning to examine the types of glycans on human iPS and other cell surfaces by using the antibodies. Additionally, we are trying to understand the GAGs and proteoglycans in cell surfaces. We already have compared ES cells with differentiation-induced ES cells, and found that the amount of GAGs in ES cells were reduced to less than a tenth in comparison to cell strains used for routine experiments. In other words, the amount of GAGs and proteoglycans were kept extremely low levels in ES cells. This is very useful information for study on ES and iPS cells. We are now working on the improvement of sensitivity for analyses of GAGs and proteoglycans.



The laser microdissection apparatus: magic tweezers able to isolate a variety of cell groups

Understanding of the glycan functions will make progress in regenerative medicine

Analyses of GAGs and proteoglycans will provide important information for researching the processes of DNA initialization in somatic cells, creation of iPS cells and differentiation of the stem cells. The information may assist in making iPS cells without gene transfer. Furthermore, it may be possible to prevent the formation of teratomas caused by contamination of undifferentiated iPS or ES cells. In addition, if we were able to create antibodies to human iPS cells, this would allow highly efficient and high-quality cloning of human iPS cells. We are also aiming to use our research project for nurturing excellent young scientists. R

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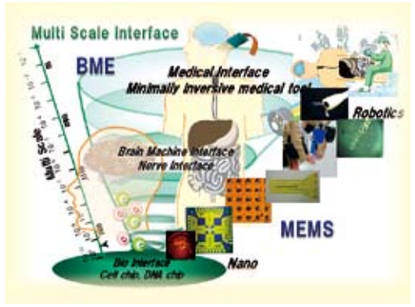
Medical treatment & health

[Research Project]
Fusion between MEMS and BME on Multiple-Scale

Creation of mircoscopic interfaces which revolutionize medical technology

Keywords

MEMS
μTAS
Multi-scale interfaces
micro-machines
BME



Taking on the challenge to develop multiscale interfaces for BME

As a result of dramatic advancements in semiconductor manufacturing technology, the field of microelectromechanical systems (MEMS) in which this technology is applied is also evolving spectacularly. It is well known that MEMS are used in a variety of devices in everyday use, such as mobile phones and automobiles. MEMS can be applied to a broad range of fields, from electrical and mechanical fields to chemistry, biotechnology and medicine. In recent years, there is particularly strong interest in the potential application of MEMS in biotechnology and medicine as an interface that is highly compatible with the living body.

Our research group has been conducting research into application of MEMS to biomedical engineering (BME). Living bodies handled in BME vary widely from large-scale bodies such as organs, tissue, and cells (and constituents), to those in the milli-, micro- and nanoscales; and MEMS have the potential to be applied to whichever scale necessary. In our project, we are building upon our achievements so far in our aims to develop an interface for a new technology that combines MEMS and BME.

Development of minimally invasive medical tools

So far, our research team has developed medical tools and devices of various scales. An instance of our achievements in the milliscale, is the development of pressure-driven actuators that move in a bending motion. An example is a 7mm-long, approx. 1mm-thick robotic microfinger made of silicone rubber. Based on the same technology a pressure-driven tool, in the form of an end scope device for insertion into the body for securing an operative field, was also jointly developed with medical institutions.

Another joint development with medical institutions involved that of a transplant tool for transplanting cell sheets into the eye. The sheet is initially flat with dimensions of 2.5mm × 2.5mm × 350μm, but can be transformed through application of pressure into a cylindrical body with a diameter of 1.3mm. A cylindrical body can be accommodated within a hypodermic needle which is used to inject it into the eye. The cylinder leaves the needle (with a diameter of about 2mm) at the back of the eye and opens up into a sheet form, allowing the cell sheet to be transplanted onto the affected area from a horizontal direction.

Realization of cellular sub-micro scale size scale medical devices

We have also successfully developed many tools and devices in relation to smaller microscale interfaces. One of these is the study of nerve interfaces. We have developed electrodes and the consequent device in which measurement electrodes of about 200μm attached to a nerve measures nerve signals from the brain, and stimuli electrodes directly controls muscular contraction.

On an even smaller nanoscale, we are developing a MEMS chip able to manipulate cells, or measure and analyze cellular signals. A microchannel array with 64 holes of several μm traps cells in the channel sections using suction, and can apply stimuli to cells or measure cellular signals via electrodes built into the channels. The ability to organize a large number of cells is crucial for the process of tissue formation in regenerative medicine.

More than 10 years of research has resulted in ever-expanding potential for interaction with the living body using multi-scale interfaces in the fields of biotechnology, neurology, and medicine; and materialization of various applications in the form of tools which meet the requirements of clinical practice. We intend to continue working on laying the foundations for new groundbreaking technologies while keeping a close eye to keep up-to-date with the changing requirements. R

College of Science and Engineering
Professor SATOSHI KONISHI (Ph.D.)

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Medical treatment & health

[Research Project] IRT-Based Haptic Collaborative Virtual Environment for Tele Surgery Training through Ultra-realistic Communication

Reality-based simulation with realistic sensation reforms medical training and education system

Keywords

Haptic collaborative virtual environment
Information and Robot Technology
Ultra-realistic communication
Virtual medicine
Tele surgery training
Haptic interfaces
Volume modelling
Soft tissue simulation

Ultra-realistic communication brings reality closer in the field of medicine

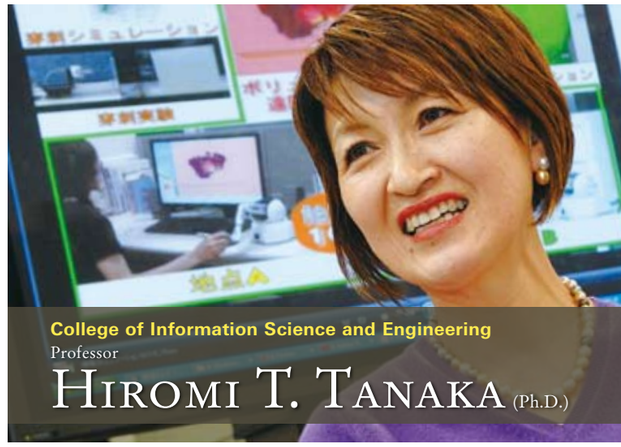
Surgeons have conventionally relied on clinical experience and animal experimentation to improve their technique and knowledge. In recent years, increasing concerns about these conventional methods in terms of patient and animal welfare have been accompanied by a new field known as medical robotics or virtual medicine. Technical progress in this field has led to a greater emphasis on modeling and simulations in study of soft tissues and surgeon training.

Already, haptic devices are in practical use, and research on haptic communication and haptic collaborative virtual environment (HCVE), in which haptic information is shared remotely, are underway. However, a physics-based haptic simulation of soft tissues, with realistic 3-dimensional sensation is yet to be developed. There are also issues in terms of communicating in real-time. Full streaming of entire 3-dimensional medical images requires vast amounts of data processing equipment and an ultra high speed communication system. Our project aims to resolve these technical issues and develop a new form of ultra-realistic communication which can be applied in the field of medicine.

Towards HCVE in which the human body can be visualized and touched

With our research, we are taking on two challenges. Our first aim is to achieve a way of reproducing three-dimensional visual and haptic information of soft objects that accurately simulates the elasticity and texture of such soft tissues of a real human body. The second is the development of a HCVE system through which visual and haptic information for tele surgery training can be shared remotely at haptic rate (1000Hz), among remote sites of medical workplaces with various computation powers

Firstly, with the co-operation of the Shiga University of Medical Science, micro force sensors and magnetic resonance cross-sectional imaging (MR) apparatuses are used to take images of the inside of the body. Based on these real data, we are seeking to establish automatic human body modelling methods in which internal structures and deformation properties such as elasticity and viscosity (e.g. depressions caused by manually pushing on the skin surface) are automatically extracted.



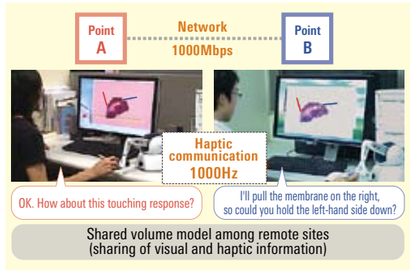
College of Information Science and Engineering
Professor HIROMI T. TANAKA (Ph.D.)

Enabling remote sharing of real time interaction and touch

The next task is to establish a rendering methods of soft objects in which deformations and interactions of such inhomogeneous soft tissues are displayed visually and haptically. Factors such as deformation properties, and frictional forces, are taken into account in generating haptic information which accurately reproduces the touch of the target soft objects. Forces involved in the interaction of the soft objects with one another, or with tools, must also be accurately reproduced.

We are seeking to develop a simulation for minimally-invasive surgery that involves surgical operations such as detachment, cutting, and needle insertion etc., using the online-remesh technique in which a mesh structure of a soft object is adaptive to dynamic changes in deformation. Additionally, the volume data of unstructured grids, in which lattice points become irregularly and unevenly distributed after above surgical simulation, are standardized into data that can be N-dimensionally differentiated, and visualized in real-time.

We are intending to develop volume-based ultra-realistic communication systems that involve transmission of only the minimal operation parameters, rather than a large-capacity transmission of the complete volume data of deformed objects. In this method, identical simulation models are pre-installed at each remote site; and the operation carried out on the target is simulated simultaneously at each site through synchronized transmission of operation parameters.



Shared volume model among remote sites
(sharing of visual and haptic information)

We have already developed a simulation model for the perforation of the liver, and demonstrated that the positions and strengths of tactile contacts on the liver surface can be remotely reproduced through 1000Hz haptic communication which is comparable to real time tough. Our goal is to develop a remote haptic collaborative virtual environment system in the next few years. We believe that development of such a system as a skill transfer and educational medium would revolutionize the field of medical training. R

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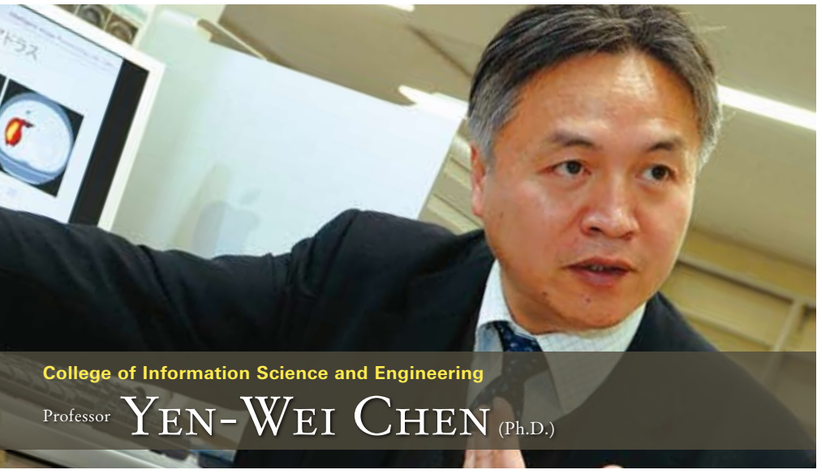
Medical treatment & health

[Research Project]
Digital Atlases of Human Anatomy and Computer Assisted Diagnostic System

A new method of analyzing multidimensional medical data that dramatically improves the accuracy of diagnosis

Keywords
Multidimensional medical image data
Computer assisted diagnosis (CAD)
Digital atlas of human anatomy
Tensor-based statistical analysis
Organ variability



College of Information Science and Engineering
Professor YEN-WEI CHEN (Ph.D.)

Research Aims

In recent years, medical imaging, including computed tomography (CT), magnetic resonance imaging (MRI), and ultrasound imaging, has made remarkable progress. Such medical imaging systems have opened up completely new possibilities for radiologists and surgeons. Computer assisted diagnosis (CAD) and computer assisted surgery (CAS) have become one of the major research subjects. As one of research projects of Ritsumeikan Global Innovation Research Organization (R-GIRO), we are working toward developing an intelligent CAD system. The system consists of three modules: database module (statistical atlas of human anatomy), image processing module (image enhancement, image segmentation, image registration), and visualization module (volume rendering).

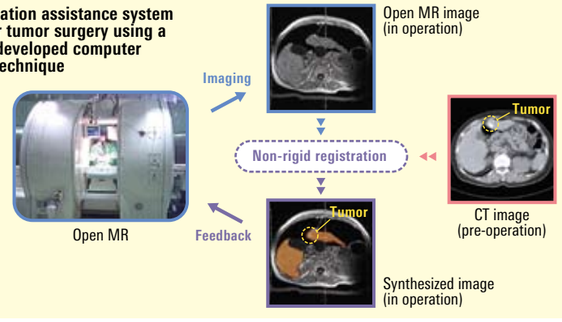
Digital Atlas of Human Anatomy

Atlas of human anatomy is an important teaching tool in the medical community. In the recent years, digital atlases of human anatomy have become popular and hot topics in medical image analysis research field. The digital atlas can be categorized as probabilistic atlas, statistical shape atlas (statistical shape model) and statistical appearance (volume) atlas (statistical appearance (volume) model). The basic idea of the digital atlas is to capture the organ variability of its position, shape and voxel intensity (texture) from a training set (either different individuals (inter-patient variability) or the same individual (intra-patient variability)). In this project, we focus our researches on digital atlas of the liver. We constructed probabilistic atlas, statistical shape atlas (statistical shape model) and statistical appearance (volume) atlas of the liver. We also apply our digital atlases to diagnosis of liver disease.

Analysis and Visualization of CT Images of Liver for Surgical Planning

Analysis and visualization of liver geometry, its tumors and hepatic vessels have a critical impact on liver diagnosis and treatment planning. In this project, we develop a liver CAD system which segments liver, extracts hepatic vascular structures; including hepatic artery from the first phase, portal vein from the second phase, and hepatic vein from the third phase, and visualize results. ®

A navigation assistance system for liver tumor surgery using a newly-developed computer vision technique



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Medical treatment & health

[Research Project]
Development of Biosimulators and Analysis Tools

Computer simulations of Cell and Tissue functions herald a new age for the world of medical diagnosis and treatment

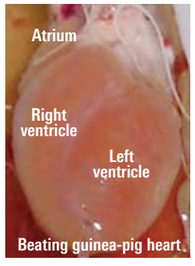
Keywords
Biological functions
Biosimulation
User interfaces
PathoPhysiological simulations
Drug effect simulations
Medical systems biology

Spatio-temporal simulation of vital functions

The Medical Science is mostly described by written text. This method may lead to individual discrepancies in the level of understanding and skills obtained, because of difficulty in quantitative estimation in our mind. This project is, on the other hand, a groundbreaking attempt at quantitative and comprehensive understanding of functions of cells and tissues. We aim at finally reproducing human vital functions on computer. We believe that realization of this aim would not only signify technological progress but also enable participation of personnel from outside the medical sector, resulting in dramatic progress in the field of medicine.

We are conducting research, based on results from scientific experiments, into mathematically representing vital functions as a function of space and time using a computer, and simulating clinical conditions, treatments, and response to drugs.

Already, we have been successful in building a comprehensive model of cardiac muscle, and simulating an impairment in the pumping ability of the heart (i.e. the condition which appears during heart failure) and its response to drugs. We attached electrodes to ventricular muscle cells isolated from a guinea pig heart and applied electrical stimuli, measured changes in calcium concentration and muscular cell contractions, and replicated this on a computer. With this model, we are able to input a given experimental condition such as an application of a stimulus, and simulate the resulting changes in calcium concentration and contraction of the muscle cells. Next, we applied 5000 cell parameters replicated in the simulation to a model of the left ventricle of a human heart, and succeeded in replicating the overall movements of a human heart in a 3-dimensional model.



Nevertheless, we estimate that the extent of this simulation is only 10-20% of what is possible with the technology currently available. Our current aim is therefore a further refinement of this model of cardiac muscle cells. Additionally, we are attempting to base this model to develop other cell models, such as that of pancreatic insulin-secreting cells.

Development of a platform for bio-simulator

A further achievement of ours is that it is now possible to conduct a collective systems biology analysis of all the interactions which play a part in cardiac muscle contraction. Cellular membrane excitation, excitation contraction, energy metabolism such as mitochondrial ATP synthesis, and nervous control all closely interact in cardiac muscle contraction. We have developed a platform through which these can all be analyzed. We are working to continue improving this platform for use in our development of cell models with even greater efficiency.

Our ultimate aim is to develop a bio-simulator with a user interface suitable for practical use. We are also looking to develop educational material for the fields of medicine and physiology.

Concept of an interdisciplinary research center

A particular characteristic of our research is that it is an amalgamation of various academic fields, involving personnel with expertise in engineering, mathematics, IT, medicine, and pharmaceutical science.

Medical systems biology is currently under the spotlight as the field which would establish the basic technologies for the medicinal science and medical care of tomorrow. We hope to base our experience of this project to create a new research center in which the various fields amalgamate in order to nurture the young scientists of the next generation. In Spring 2009 saw the establishment of the Ritsumeikan University Research Center for Bio-simulation. We believe that a creation of a medical systems biology research center focused on our university will have great significance on the development of this new academic field. ®

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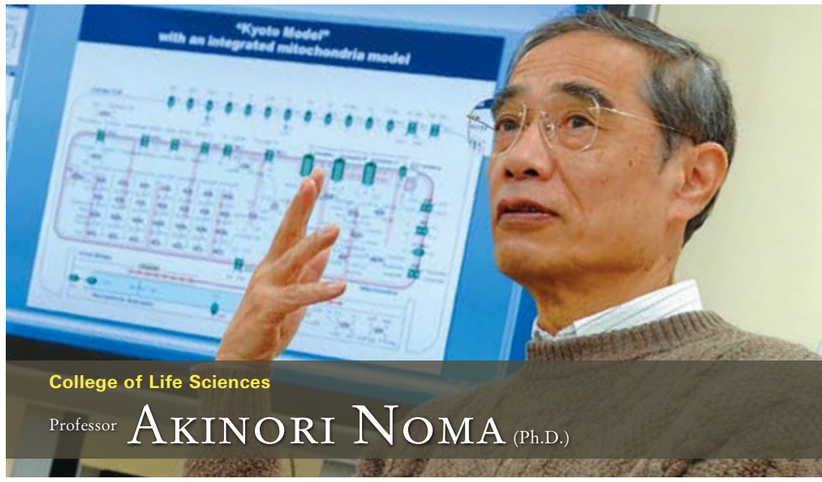


College of Life Sciences
Professor AKINORI NOMA (Ph.D.)

21

Medical treatment & health

[Research Project]
Integrated Research of Sports and Health Innovations

Sport and Health Science: Expanding the horizon of academic newest playing field

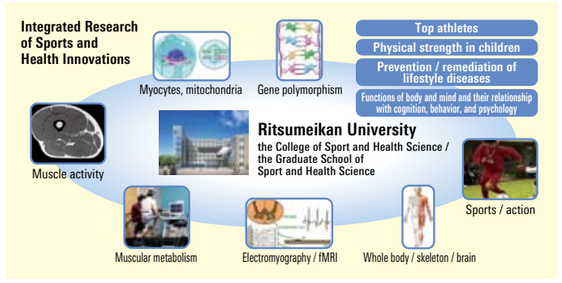
Keywords
Genes
muscle metabolism
top athletes
aging
metabolic syndrome prevention and remediation

Towards the establishment of an international research base for sport and health science

Today, the promotion of sport and physical health is an issue being addressed on a national level. In 2000, the Ministry of Education, Culture, Sports, Science and Technology (MEXT) launched the *Basic Plan for Promotion of Sports*, followed in 2001 by the Ministry of Health, Labour and Welfare (MHLW) announcing its *National Health Promotion Movement in the 21st Century* (Healthy Japan 21) program. In 2008, MHLW launched compulsory Specific Health Examinations and Specific Health Guidance, designed to prevent and solve the growing problem of metabolic syndrome.

The establishment of this kind of government-level framework is just one side of the story; there are also greater demands for empirical researches into the prevention and remediation of lifestyle diseases and into the improvement of performance in sports. Today, such researches are being actively pursued, and findings are being steadily accumulated.

The College of Sport and Health Science and the Graduate School of Sport and Health Science were established at Ritsumeikan University in April 2010 in response to this trend.Today, our unrivalled team of world-class sports science researchers is ideally placed to establish an international research base. Going forward we will seek to expand the horizons of this new academic field.

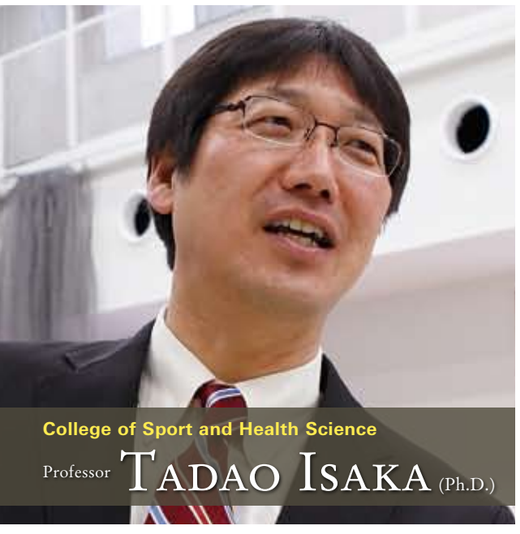


From genes, through individuals, to groups: a comprehensive approach

Our project envisages creation of a research base for conducting comprehensive researches encompassing subjects of all ages, spanning diverse themes from general health care to optimal training for top athletes. The uniqueness of our project lies in the fact that we are not restricted to research on a micro, individual, or group level but are instead able to pursue a comprehensive approach. This unprecedented research will encompass genes, cells, individuals, groups, and health and performance of top athletes; conventional research in this field generally approaches such themes individually.

We have four principal interdisciplinary research themes: (1) performance improvement for top athletes; (2) physical strength improvements in children; (3) prevention and remediation of lifestyle diseases; and (4) illumination of mind/body functions and their relationship(s) with cognition, behavior, and psychology. Our research will extend throughout and beyond the University, utilizing our network of international researchers. We will publicize our findings on a global scale.

This project covers basic research with a new perspective and expands beyond to practical applications benefiting people and society. Progresses have already been made in gene analysis and molecular–biochemical analysis, which may lead to practical uses in exercise–nutrition formulas and exercise techniques.



College of Sport and Health Science
Professor TADAO ISAKA (Ph.D.)

The practical application of sports biomechanics

My participation in this project is from the perspective of sports biomechanics. We have developed a muscle strength training device that uses electrorheological fluid clutches to obtain variable mechanical impedance and a load display function.

Many conventional training machines have a mechanism that uses only one of the inertial, viscous, and elastic components of mechanical impedance, and in which load cannot be controlled during use. Our machine uses a driving motor and an ER clutch, making it possible to adjust the output torque by controlling the electrical current; to freely combine the three components of mechanical impedance; and to instantaneously change the load during exercise. We have achieved 3-D visualization of the three components that constitute muscle performance, namely strength, speed, and angle. We believe that this can be used to increase muscle performance with pinpoint accuracy, and work is currently underway to demonstrate and verify its effects. In collaboration with other researchers, we hope to propose practical solutions including new training techniques, performance optimization, and to develop new ideas on how the brain controls motion. R

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Safety & security

[Research Project]
Invisible, Secure, Safe and Dependable Platform to Support Our Lives

Building a platform for supporting software security from development to execution

Keywords
Information security platform
Software platform
Privacy protection
Dependable software

The need for improvements in software security

In this day and age, where every aspect of our society is reliant on information and network technology, there is an ever-increasing importance in the role of software through which such activities are carried out. On the other hand, it is proving to be difficult to maintain adequate security on overcrowded networks, with issues such as information security violations and malware infections causing problems worldwide. In order to live safely and securely in a highly networked society, it is crucial to improve the security of software that support such a society, including those areas which are invisible.

However, this is not an easy task. Firstly, it is not practically possible to predict and prepare, at the point of software development, for every malicious attack or unexpected scenario. Secondly, because a computer has multiple software, each developed by different people, running simultaneously at any one time, there is a risk of a weakness in one software causing damage to the rest. Furthermore, even if the software is initially secure, this may be subsequently compromised due to changes made during an update or inadvertently by the user. These issues have the potential to occur at any given stage of the software's life cycle, from its design to its execution. The objective of this project is development of a new measure to resolve these issues.

Creation of a platform for software development

We are aiming to create a structure in which the level of security for every stage - from development to generation and execution of the software - is improved; and the amount of actual damage due to any unexpected scenarios is kept to a minimum. A characteristic of this project is that we are seeking to treat the entirety of the software's life cycle as a whole, in order to create a platform that remains consistent throughout. Consistency is maintained by coordinating each stage so that information obtained during each stage is shared, and actively implementing mechanisms for supporting the subsequent stages. Another characteristic is that we are developing a system which can be applied to the existing software, and which will prevent a degradation of security levels from being made during software updates. These two characteristics are novel approaches which are unprecedented.

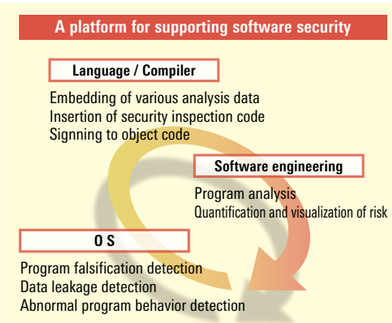
Co-ordination between development support, compiler, and OS

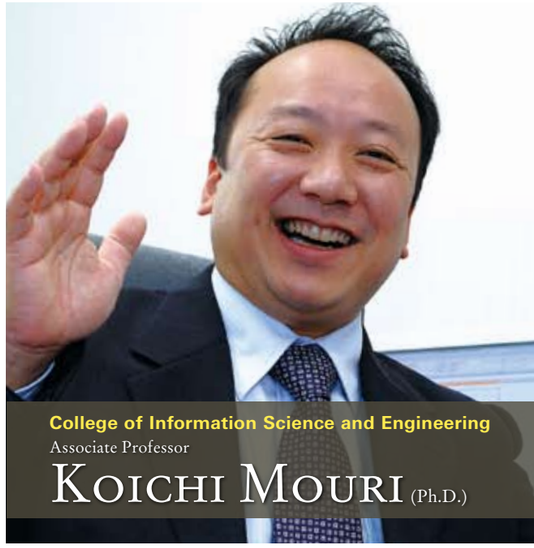
The platform which we are aiming to develop consists of a secure software development support, a secure compiler, and a secure operating system (OS). For the initial software design and development phase, we aim to improve the quality of the software by attempting to identify factors that affect the security of the program to quantify and visualize the risk to the software. We are also exploring methods to evaluate security.

In relation to the secure compiler, we are aiming to establish a method of inspecting the security of the generated program through a static analysis of the program. We are also exploring methods of analyzing the types of system calls and sequence in which system calls are invoked, as well as methods of analyzing file access and data flow. We will develop a method of embedding these items of information in the object code to provide to the secure OS in order to support dynamic testing.

For the secure OS, we are building a system which monitors software to ensure they are running correctly. We will develop methods of inspecting the execution sequence and data validity, and of controlling the range of data transmission.

We believe that this platform has potential uses in a wide range of applications from everyday life to the fields of society, medicine, and environment. In building a platform for safety and security that will benefit society, we are confident that our research will have large impact and significance in the coming future. R





College of Information Science and Engineering
Associate Professor
KOICHI MOURI (Ph.D.)

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Human life & value

[Research Project] Learner's Science as an Application of Science for Human Services Creating a New Discipline

From Science for Human Services to Learner's Science: Creating a new discipline

Keywords

Learner's science
science for human services
active learners
service learning
learner centered learning

A new type of human services to support active learning

Over the past 10 years, we have been trying to create “the science for human services (Taijin-Enjo gaku)”. Generally speaking, the aim of human services is to allow individuals with any type of disability to expand their options for participating in society in greater accordance with their self-determination. Put simply, the discipline research about philosophies, methodologies, and techniques to support such individuals so that they have greater freedom in terms of what they can choose to do.

To develop the discipline further, we have established a more universal objective, namely providing support to individuals that enables them to remain so-called “active learners.” They are, for example, expected to proactively innovate, rather than passively await support or instruction.

Such approaches in the human services field can be applied, more universally, to career support for students, corporate employees, and other members of the general public, notwithstanding disability. As well as implementing human services, we aim to establish a methodology that enables individuals involved in both human services and learning to continue being active learners in a variety of social arenas, including universities. Our ultimate aim is to establish a new discipline of "Learner's Science", representing an unprecedented initiative to expand the scope of science for human services to a more universal level.

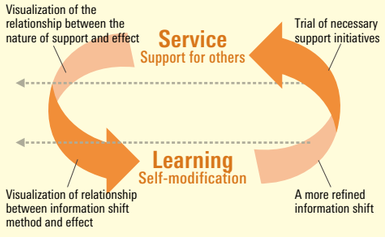
Supporting active learning through Student Job Coaching

The project aims to achieve the practical implementation of and education about science for human services, and one method employed will be the use of Student Job Coaches. This initiative, launched in 2004, involves students working to help individuals with disabilities to adapt to the workplace. The students’ role is to assist individuals in the acquirement of both specific vocational skills and the meta-skills that will enable them to create environments. In other words, the Student Job Coach supports individuals with disabilities as they become active learners, while simultaneously aiming to make active learners out of the students themselves.

Career support through “Service- learning”

The program seeks to support learners through “service-learning” based education, where learners are independent in their learning and keen to practically apply knowledge. Service-learning refers to an initiative in which learners link their social and community activities and work experience to their learning methods. Specifically, we aim to use the aforementioned Student Job Coach system and support for students with disabilities as foundations for enhancing the career prospects of students. Ultimately, we aim to expand the system to make it more universally applicable, thereby allowing our methodologies for career support, including the Student Job Coach system, to be make use of in wider contexts, such as in other universities.

We are transforming direct support for individuals with disabilities into support for individuals to become active learners, regardless of disability. This makes our project a groundbreaking initiative, one which seeks to transform science for human services into a new discipline of learner's science. R



College of Letters

Professor AKIRA MOCHIZUKI (Ph.D.)

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Human life & value

[Research Project]
Frontier of Applied Illusionology

From psychology to real life: Envisaging the practical application of visual illusions

Keywords

Visual illusion
Illusion
Color perception
Spatial perception
Visual completion

College of Letters

Professor AKIYOSHI KITAOKA (Ph.D.)

Developing basic research on visual illusions into real-life applications

Visual illusions are visual perceptions of a target object that deviate from the true characteristics of the object, where the brain perceives the object differently to the state in which it actually exists. The use of computers has brought about remarkable progress in the past 20 years.

The scope of visual illusion research is extremely diverse, ranging from studies of visual illusion of shape (geometrical illusion) to those of color, brightness, completion, and depth. The vast body of knowledge thus accumulated has the potential for application in diverse fields, including medicine, welfare, architecture, transportation, and environmental design.

Diverse applications of visual illusion: From the early detection of glaucoma to traffic jam prevention

Some of our current research projects are moving towards practical application. One such project examines extinction illusion. There is an area on the retina, known as the blind spot, which has no stimulation of light due to penetration of optic nerves. The brain compensates for the lack of visual perception in this area through a process known as visual completion; this is kind of extinction illusion. The blind spot region is not simply rendered invisible, but is patched up to match the surrounding pattern through a phenomenon known as "filling-in". We are hoping to apply the phenomena associated with extinction illusion towards the development of an early discovery technique for glaucoma.

Another project is developing a method in which the visual illusion of a vertical gradient, in which an uphill gradient is perceived as a downhill gradient, or vice versa, when a road is viewed head-on, is used to develop traffic jam countermeasures. Sag sections of roads, where the gradient changes from downhill to uphill, are susceptible to traffic jams. This project works in partnership with experts in traffic jam and relevant authorities to explore methods for counteracting the visual illusion of vertical gradient that occurs in sag sections.

We are also working towards the application of color illusion in the fields of barrier-free color vision and universal design, such as design that calls attention to crucial content and the use of colors also visible to those with color anomalous vision.

Stationary image appearing to move due to differences in luminance contrast

We also have a strong body of results from numerous other basic research projects into other visual illusion types. One of these is the anomalous motion illusion shown in a stationary image. We studied the mechanism behind the Fraser-Wilcox illusion, reporting that the degree of visual illusion increases when the regions with differing luminance are arranged in a sequence of dark, moderately dark, bright, moderately bright, and dark. An artwork “Rotating Snakes”, an illusion utilizing this principle, proved popular.

Through another research project that similarly focused on differences in luminance, we were able to discover that the brain processes areas with high luminance contrast faster than areas with low contrast, resulting in a visual illusion.

We aim to continue to shed light on the mechanisms behind various visual illusions, and to continue to discover illusions that affect our living environment. We will apply our findings towards improving the living environment and contributing to medicine and industry. R

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Human life & value

[Research Project]
Constructing the Center for Law and Psychology

Creating a judiciary based on human understanding by combining law and psychology

Keywords

law and psychology
legal clinics
clinical justice
Saiban-in system (Japanese mixed jury system)
trans-disciplinary approach

College of Letters
Professor TATSUYA SATO (Ph.D.)

Promoting a New Trans-disciplinary Structure: Collaboration between Law and Psychology

Since the launch of the Saiban-in system (Japanese mixed jury system), in which lay citizens participate in the judiciary system, the importance of collaboration between law and psychology has been widely recognized. Our project aims to address some of the issues which extend in these two fields through trans-disciplinary perspective.

Our major advantage is that we have established a structure for a trans-disciplinary model in which solutions can be shared, rather than the conventional inter-disciplinary model which only shares problems. We have realized diverse collaborations in order to conduct joint research and held workshops regularly. We have also established strong partnerships with the members of local bar associations in order to enhance the tie between the researchers and practitioners. In order to attain substantial debate, we work with professionals in foreign countries such as South Korea, Canada, and Australia, who have an interest in law and psychology.

Tackling the Modern Issues of Lay Judges and Clinical Justice

Our team of talented researchers is conducting various research projects on various themes. One area of our study looks into the influence that media might have on the citizens who are potential lay judges. We carry out psychological experiments, using multiple newspaper articles, to investigate their influence on lay citizens, and consider how some of the findings can be applied to the current criminal procedures.

We also carry out research into clinical justice. There is of widespread concern for our juvenile justice system, which was established more than half a century ago, and is no longer compatible with the rapid increase in juvenile crime. The question here is how to integrate calls for severe punishment and ago adequate support for victims into the prevention of crime through the clinical study of justice and offense. In order to provide new proposals for these issues, we are not only trying to clarify the present situation in our country, but to investigate that of other countries such as Canada and Australia as well, which have implemented problem-solving courts.

Advantages and Disadvantages of "Transparency" of the Trials

The third theme of our investigation is the "transparency" of trials under the Saiban-in system. Visual and audio recording of the interrogation process is considered to implement the transparency of investigations. However, studies show that the recording of interrogation needs to be conducted with great care. One study shows, for example, that the mere difference of the video camera angle affects the viewers' evaluation of the credibility of the confession which is being recorded. Our own experiments have also confirmed similar results.

Concerning confessions made during police interrogation, in order to evaluate the credibility, the time line of the interrogation should also be carefully examined. Whether the confession is made only once or made repeatedly in a consistent manner needs to be considered. To this end we are developing a 3D viewer, known as the KTH Cube system which enables to present debatable issues and transitions of confessions in a visible manner.

In the Forefront of International Research

Other areas of our study include issues such as the relationship between extinctive prescription and post-traumatic stress disorder (PTSD), and the effects of psychiatric evaluations on lay judges' decisions in the Saiban-in system. It is important to note that a research structure such as ours is very unique even on a global scale. Our ultimate goal is to create a research and educational base where experts on law and psychology can conduct trans-disciplinary studies on even broader range of issues and transfer their findings to the prospective law students, who will then be able to apply them to society in the future. R

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Human life & value

[Research Project]
Social Studies on Barrier Free Access to Digital Books

Assisting the spread of electronic books for people with print disabilities

Keywords

Electronic book
Accessibility to reading materials
Copyright
Assistive technologies
Information policy

Proposing an "ideal model" for electronic books to increase accessibility to reading materials

People with visual disabilities and other print disabilities have limited access to books. While Braille books are available, such books are far fewer than printed books in terms of number/titles. Until now, the visually disabled have had to digitize books by themselves, assisted by their supporters, and use text-reading or Braille translation software. Electronic books could improve this situation.

If electronic book data is used to develop a system that automatically reads text aloud or translates text into Braille, the visually disabled will be able to read books almost as freely as the unimpaired. Electronic books could enlarge letter size, reverse text color over the background, and create multimedia text by adding images/sounds, which would benefit those with low vision and reading disabilities disorders. With the recent growth of the electronic book market/increase of electronic libraries, we are now poised to drastically improve reading material accessibility for these people.

Yet, we cannot meet the needs of the visually disabled merely by developing technology/tools; we must set up standards/systems for promoting electronic books and create a mechanism to deliver such to a wide range of users. In Japan, however, few researchers have studied "accessibility to reading materials" with an aim to identify the ideal model for electronic books.

This project is designed to collect information on global trends of electronic books, as well as to compare/analyze, internationally, problems to be overcome to achieve greater "accessibility to reading materials" through electronic books. Besides working toward achieving tangible results, we will offer necessary information, report research findings externally, and make policy proposals in contributing to improving electronic books, making them more useful to/widely available for those with reading difficulties. We are confident that proposing an "ideal model" for electronic books while the electronic book market is still at a very early development stage will allow us to considerably contribute to increasing "accessibility to reading materials."

Exploring ways to digitize books while not damaging the copyright holder interests

Having previously cooperated together, the project members understand what needs to be done and have built research expertise. This project has revealed some issues that must be addressed when facilitating digitization of books.

First, we should address the issue of "reproduction," which especially concerns the publishing industry. The 2009 amendment of the copyright law largely relaxed restrictions, allowing university/public libraries to offer reproductions of digitized publication data to "those with visual imparities/difficulties in visual recognition." In this project, we are exploring ways to reproduce digitized data while not damaging copyright/publication right holder interests, from legal/policy perspectives.

Partnership required among university libraries as an essential condition for effective/extensive digitization of books

Another issue is that the task of digitizing books requires a lot of cost, time and labor. When digitizing the text of an existing book, we must cut the book into pages, copy/scan each page, and feed the data into a computer using OCR software that converts images into electronic documents. We must also proofread the resulting documents. Specialized books for students of universities/other higher educational institutions are published only in limited quantities, making digitization of such books too costly to be commercially viable. We expect university/public libraries to play a leading role in digitizing such books. Currently, libraries digitize books separately as needed, hindering availability of electronic books. We believe we are responsible for proposing measures to build a network connecting university libraries to ensure that digital data held by these libraries is shared among them to the maximum extent.

In this project, we employ an interdisciplinary approach, encompassing the studies of digital society, disabilities, assistive technologies, and information policy, and by making policy proposals based on the project results, we hope to contribute to increasing accessibility to reading materials through effective use of electronic books. R

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Graduate School of Core Ethics and Frontier Sciences
Professor SHINYA TATEIWA

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Peace & governance

[Research Project] Towards New Peace Studies : A Study of Reconciliatory Governance and Sustainable Peace Building in Post-Conflict Areas

Moving beyond traditional academic borders to promote the lasting peace

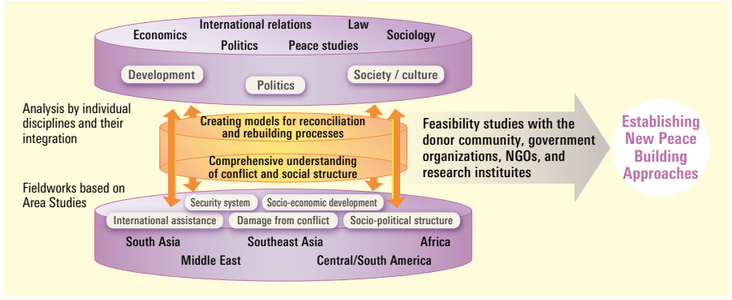
Keywords

Peace studies
international cooperation
conflict
reconciliation-oriented governance
establishment of sustainable peace

Towards an integrated approach for the study of conflicts in the 21st century

Civil wars in Africa, the failing states in the Middle East, separatist movements in Asia, and insurgency in Central and South America represent the type of conflict in the globalizing world of the 21st century. Many of them are not inter-state wars but internal conflicts. In contrast to the major conflicts in the 20th century, most of which resulted from political and ideological rivalries, today's conflicts stem from the complex interaction of multiple factors, including religion, ethnicity, global arms proliferation, poverty, resource exploitation, and environmental degradation.

In order to build a lasting peace, it is vital to implement measures envisaging both security and socio-economic development, and to establish a post-conflict state-society relationship in which the local population is at the center of the reconstruction initiative. To meet the challenge, there is a clear limit for a single academic discipline. There is an urgent need to integrate expertise from a diverse range of academic fields in order to establish a comprehensive approach to the study of post-conflict peace-building.



Creating Models for Sustainable Peace

Our project aims to analyze the complex relationships between the various issues that lie behind the current conflicts. Our advantage is the institutional commitment of College of International Relations which embraces experts of various issues linked with peace studies. They will mobilize knowledge from different areas to tackle with the shared goal of establishing sustainable peace in post-conflict countries. Our college has an ability to promote such an interdisciplinary study on the peace-building.

Our main targets are post-conflict nations in five regions: Africa, the Middle East, South Asia, Southeast Asia, and South America. Our research will explore the problems of post-conflict reconciliation and social reconstruction, and analyze the multisectoral factors which have caused vulnerabilities, such as socio-political antagonism, economic underdevelopment, the lack of credible security apparatus, and the mismatching of international assistance.

By comparing regional trends, we attempt to model "best practices" of sustainable reconciliation.

The scope of this research, however, is not limited to this. We also intend to localize these models and work in partnership with local NGOs, think-tanks, international organizations, and research institutions in order to provide policy proposals for peace-building. We plan to publicize our findings widely both in Japan and aboard.

For myself, the main focus of current research is politics and security in Southeast Asia. One of the factors causing political instability in Southeast Asian is the emerging violence of organized crime. In the age of globalization, the reach of crime transcends borders and affects the entire Southeast Asia. This problem is known as non-traditional security threat. I am involved in various research projects to address this problem and to promote effective counter-measures.

Our project is designed to encourage a new generation of researchers in peace studies. We hope that our project will generate a new wave of young scholars who respect the importance of area studies, multi-disciplinary approach, and the nexus between security and development. These three perspectives are crucial for developing a new paradigm of peace studies in the 21th Century. R

College of International Relations
Professor JUN HONNA (Ph.D.)

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Peace & governance

[Research Project] Mutual Understanding and Collaboration between Northeast Asia, Korea and Japan - from a Viewpoint of Peace Making

Confronting the history of Japan and Northeast Asia, and working toward the creation of lasting peace

Keywords

Peace
security
perception of history
Northeast Asia
South Korea

The need to establish a peaceful, win-win society in Northeast Asia

The relationship between Japan and the rest of Northeast Asia is a complex knot of old and recent history, and is afflicted by many issues that remain unresolved, such as discrepancies in historical perception. Furthermore, while the significance of the US-Japan alliance framework underwent changes following the end of the Cold War, new tensions have emerged to threaten the stability of Northeast Asia, such as North Korea's nuclear and rocket programs. Today, against the backdrop of the breakdown of the Cold War system, globalization, and the dramatic economic and cultural growth of Northeast Asia, there is an increasing need to seek out opportunities for communication and cooperation between Japan and the rest of Northeast Asia toward the aim of establishing a peaceful, win-win society in the region.

Our project aims to study the history of Japan and Northeast Asia, especially the Korean Peninsula, in order to establish a clear and specific vision for building sustainable peace, and to make policy suggestions accordingly.

Interdisciplinary research in security, democracy, and the understanding of history

The ultimate aim of our project is the publication of a comprehensive report that brings together our vision for a peaceful, win-win Northeast Asian society. Specifically, we are fostering interdisciplinary research on the three themes of security, democracy, and the understanding of history, with research being conducted in diverse fields.

As part of our research into security, we will work with South Korean universities to conduct social research on statistics and discuss Northeast Asia security issues, perform source analyses, and create reports on policy proposals. On the topic of democracy, we will analyze legislative and political changes in Northeast Asia, with a particular focus on the democratization of South Korea, and develop this into peace studies. We also aim to analyze the differences in the understanding of history that exist between the peoples of Northeast Asia, the historical context of such differences, and the interaction between these differing historical perceptions.

College of Letters
Professor NOBUHIRO KATSURAJIMA (Ph.D.)

I personally have been conducting a comprehensive study of "Joseon History", a historical text compiled by the Korean History Compilation Committee of the Governor-General of Korea during colonial rule. Through the re-examination of this text, I have been able to highlight differences between the views and attitudes towards the recording of history in Japan and South Korea, as well as investigate colonialist attitudes in recent academia in terms of the history of ideas.

Promoting academic exchanges and communicating research results at home and abroad

The scope of this project encompasses academic exchange and the sharing of findings and information with various experts, both at home and abroad. Our achievements to date include hosting the Korean Studies Forum for Young Researchers and issuing a large volume of publications. We are particularly focused on hosting symposiums and conferences for South Korean academics to attend. In March 2010, we published the first issue of a new research journal, "Ritsumeikan Journal of Korean Studies". The publication includes not only our research results but also reviews of new academic publications from South Korea, representing a practical undertaking for an academic exchange that transcends the border between the two countries.

The Ritsumeikan Center for Korean Studies plays a key role in these undertakings. The Center has a multitude of strong links with universities and institutions in South Korea, and has built up a global reputation for the breadth and depth of its achievements. We hope to continue making the most of the Center's body of information, knowledge, human resources, and networks in our ongoing research work, events, and publications; through such activities we hope to pave the way towards effective policy suggestions. R

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Peace & governance

[Research Project]
Asbestos Disaster and the Policy Science of Relief, Compensation and Prevention System

Shedding light on the asbestos crisis to prevent future damage internationally

Keywords

Asbestos
Public Policy
Interdisciplinary Research
Complex Stock Disaster

College of Policy Science
Professor HIROYUKI MORI (Ph.D.)

Damage from asbestos crisis set to continue

Occupational and environmental damages caused by asbestos is the most serious case of industrial pollution in history, and is an urgent issue facing humankind on a global scale. Health problems resulting from exposure to asbestos can take anything from 15 to 40 years to manifest. This asbestos pollution is a "complex stock disaster", in that asbestos causes damage at every constituent economic part of its life cycle, from production to distribution, consumption, and disposal; it also damages at length, without degrading.

In developed nations, where asbestos has been used for many years, the focus today is on regulating its use and establishing systems for compensating and assisting victims. However, mass consumption of asbestos continues throughout Asia and other developing regons, where the damage is steadily growing. A solution is urgently needed to prevent the extensive damage which will otherwise be inevitable.

Highlighting and communicating worldwide the realities of asbestos damage

The first aim of this project is to shed light on the realities and mechanisms of asbestos damage, both in Japan and worldwide. Victim relief systems can only truly be developed once we have established the causes of asbestos damage, and the parties responsible. To this end, we will perform interdisciplinary analyses, based on fieldwork results, on matters including the state of asbestos use; location, production, and trading statuses of asbestos-related firms; conditions of asbestos pollution; official labor and environmental policies; and social welfare systems in each respective region.

Asbestos has been primarily used as building materials, and thus one study involved an investigation of asbestos damage and its causes among construction workers. We are also conducting a study of the neighborhood around the former Kubota Kanzaki plant, in Amagasaki City, where one of the world's most serious environmental exposure incidents occurred.

We are also performing studies of asbestos damage and government countermeasures in other Asian countries. Asbestos-related firms moved their activities from Japan, which underwent economic growth and introduced asbestos regulations earlier than other nations, to South Korea, and onto Indonesia and China. We also discovered that asbestos legislation in South Korea and Taiwan is primarily based on Japanese regulations. Further, the policies of certain Asian countries that continue to allow the use of asbestos mirror Japan's own experiences during the period of high economic growth.

We therefore believe that our next role is to communicate Japan's experiences and our findings from various studies to an international audience, particularly to the Asian region.

Establishing a system for damage prevention and victim assistance

We will look at various international economic and social situations in detail, as well as at public systems, in order to clarify what diversity and similarity exists in damage and public systems. This will contribute to the further development of Japan's system.

Our project will take an interdisciplinary approach, involving political science, administrative science, fiscal science, economics, law, architecture, and medicine, to respond to diverse issues. Other complex stock disasters, such as soil contamination, will occur in the future. We believe that our research is the key to establishing systems for disaster prevention and victim assistance, and it is this belief that drives our research forward. R

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Japanese & regional studies

[Research Project]
World Wide Co-Ownership on the Materials of Japanese Art and Culture by Digital Archiving

Digital archiving of Japanese art and craft in international museums and galleries

Keywords

Digital archive
Japonism
arts and craft
museum network
ukiyo-e

Japanese art and craft as ambassadors for Japanese culture

Historically, Japanese art and craft artifacts have been exported in large volumes, partly due to an export policy adopted by the Meiji government to acquire foreign currency. The role played by these artifacts, as outstanding ambassadors for Japanese culture, cannot be underestimated. However, many of these art and craft pieces are hidden away in the vaults of museums, their existence known only within the museum themselves; this is an unfortunate loss of multiple opportunities to share and communicate Japanese culture.

This project aims to resolve this problem by working towards using a unique digital archiving technology, designed to facilitate the sharing of academic information on such cultural resources among museums across the globe.

Archiving Japanese art in museums and galleries with unique digital archiving technology

The project is based around a digital archiving technology developed mainly by the Ritsumeikan University Art Research Center (ARC). The ARC's image database presently comprises around 250,000 *ukiyo-e* woodblock prints, 16,000 stage photographs, 13,000 pieces of literature, and 20,000 kabuki programs, as well as many more valuable pieces.

Our main advantage in organizing this project is our unique combination of skills and expertise, including a method developed by us for photographing large quantities of art and craft in a short space of time, and professional expertise in photography related to restoration, storage, and source materials. We also have an array of specialist equipment that can be taken abroad with minimal manpower. Major museums and libraries in Europe and America have recognized our method as following the ARC model. Our achievements thus far include the digital archiving of *ukiyo-e* and other prints managed by the Japanese section of the British Museum, as well as other archiving successes in France, Germany, Belgium and other European countries. In February 2010, we commenced the archiving of artifacts in partnership with Italy's Edoardo Chiossone Museum of Oriental Art, one of the most famous worldwide for its collection of Japanese art pieces. We are also working on archiving projects in many other museums, including the Czech National Museum and National Gallery, the Oriental Art Museum in Venice, the Chester Beatty Library in Ireland, and the Smithsonian Museum in the USA.

College of Letters
Professor RYO AKAMA

A public access digital database promoting an international hub of digital resources

This project aims to build on our achievements so far and to further expand our network, establishing partnerships with both major museums and with the numerous state- and privately-owned institutions that own Japanese art pieces. We will also look to conduct the exhaustive digital archiving of as many items as possible, in order to further promote and facilitate the sharing of resources for research based on Japanese arts and culture.

Another important aspect of our digital archiving work is the positive effect it has in training young researchers, boosting their practical skills and confidence. In the course of digital archiving, young researchers are able to pick up knowledge and skills relating to restoration and archiving, and come into contact with magnificent pieces of art and craft that would otherwise be inaccessible. It goes without saying that such experiences represent a major contribution to their professional development.

The most significant feature of this project is that the archived information is made available to the public in the form of an image database. Our unique online viewing system, designed with the end user in mind, makes it possible to share the large volume of important pieces of Japanese art and craft, which are located throughout the globe, and for them to be utilized as essential resources for research into Japanese arts and culture. We believe that in the future Ritsumeikan University will continue to play a major role as an international hub of digital cultural resources. R

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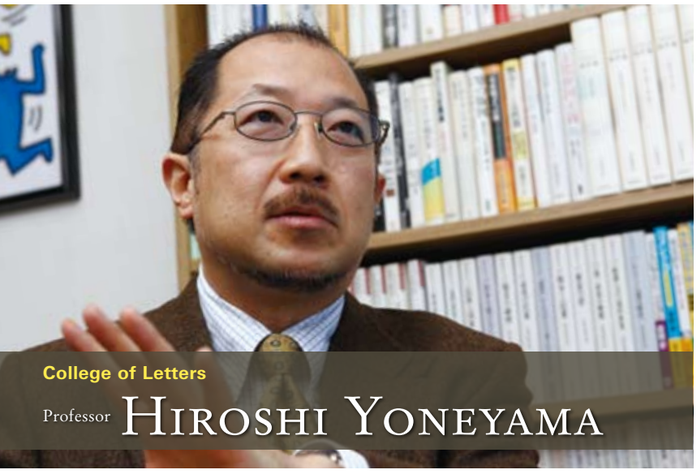
Japanese & regional studies

[Research Project] Forced Removal, Incarceration, and Repatriation of the Overseas Japanese during World War II and the Post-War Reconstruction of the Japanese Society

Presenting new perspectives on contemporary forced migration issues through the re-examination of the Japanese experiences

Keywords

Pacific Rim region
World War II
forced migration
security
peace building



College of Letters

Professor HIROSHI YONEYAMA

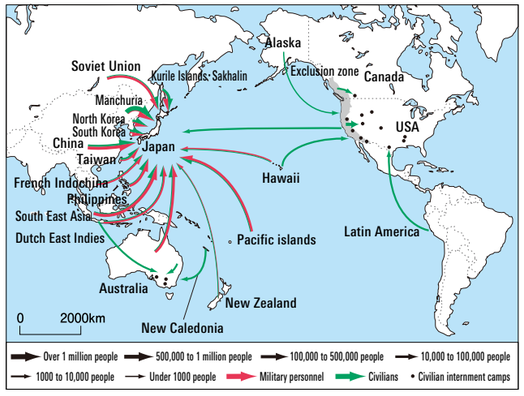


Figure showing the forced migration of Japanese nationals and ethnic Japanese as a result of WWII. Main forced migration routes and internment camps are displayed. Figure by Takafusa Iizuka

Assessing the significance of Japanese emigration as a key to understanding today's Japan

Extensive overseas experience of the Japanese people is considered to be the result of economic growth of the 1970s. International travel by the Japanese before that, however, was far more common than widely thought. At the start of the Pacific War in 1941, approximately 5% of Japanese lived overseas, either in foreign countries or overseas territories. Such outflow of population has not been sufficiently acknowledged, which has hindered us from learning from Japan's collective overseas experiences of the past. We believe that assessing the meaning of Japanese overseas experience—especially the relationship with local societies or governments—will provide valuable insights in a global age that requires us to search for ways to coexist harmoniously with the rest of the world.

This project focuses on the forced displacement, internment, and repatriation of overseas Japanese resulting from the Pacific War. As a result of either the outbreak or the end of the war, 3.5 million people (5% of the mainland population) were subjected to forced migration, internment, and/or forced repatriation. These events are in many ways similar to other, better-known historical incidents, such as the expulsion of Germans in the aftermath of World War II, or the bloody ethnic cleansing that occurred in many regions by the heightening of ethnic and local nationalism after the Cold War. We therefore believe that this research will also provide meaningful insight into present-day issues such as refugees and the forced migration of ethnic groups.

Using government records and first-hand recollections to build a picture of forced migration

Our project will first focus on policies of national and local authorities, including colonial governments. We will examine public documents and secondary sources to examine the formation of exclusionary policies against Japanese nationals and ethnic Japanese. We also intend to use fieldwork and primary sources to verify how Japanese nationals and ethnic Japanese tried to adapt to forced migration.

Forced migration in modern times should also be examined as an economic issue. In American history, which is my speciality, the internment of Japanese nationals and Japanese Americans has only been considered in the context of citizenship, constitutional rights, and racism. We therefore intend to examine how economic assets, such as shops, fishing boats, and farmland of the expelled Japanese were utilized by the local people, and how the transfer changed the societies.

Using interdisciplinary collaboration to gain a full picture of forced displacement

Experts from a diverse range of fields—such as American history, Japanese history, geography, and cultural anthropology—engage in research in North and South America, the Pacific islands, Australia, and East Asia, in other words, the whole of the Pacific Rim region. We intend to engage the findings of our studies with those of other large-scale forced migration, the refugee problems, and ethnic cleansing in the Twentieth Century. R

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Japanese & regional studies

[Research Project]
Digital Museum of Kyoto

Taking a virtual odyssey through Kyoto and its history in a digital museum

Keywords

Digital museum
digital humanities
geographic information systems
Japanese culture
Kyoto

Kyoto's cultural assets reproduced as "Virtual Kyoto"

The project has been building a digital archive of important tangible and intangible cultural assets, located or originating principally in Kyoto, including scenery, paintings, and festivals. The results are now being used in global-level research and as educational resources for young researchers. Our next initiative is creating a digital museum, which we hope will be a meaningful contribution to the local community and wider society.

"Virtual Kyoto" is a virtual time-space representation of this most historical city of Kyoto. This program aims to use the already complited Virtual Kyoto as a platform for digital contents that represent tangible and intangible cultural assets, including *ukiyo-e* woodblock prints and traditional performances.

Using cutting-edge geographic information systems and virtual reality technologies to achieve four-dimensional space

Virtual Kyoto, the platform for the digital museum, is a digital representation of the unique scenery of Kyoto, created using a state-of-the-art geographic information systems (GIS) and virtual reality (VR) technologies.

One of the unique characteristics of Virtual Kyoto is that it represens a four-dimensional space, in which a temporal dimension has been added to the three physical dimensions. We have successfully digitalized a variety of two-dimensional data, such as photographs, maps, pictures, and paintings. This data includes aerial and street-level photographs taken during the Showa period (1926-89) and topographic maps and cadastral maps during the Meiji (1868-1912) and Taisho (1912-26) periods, as well as medieval illustrated folding-screens such as the *Rakuchu Rakugai-zu* (Scenes In and Around the Capital). Together, they combine to create a three-dimensional representation of Kyoto's urban scenery from the past to the present. Virtual Kyoto makes it possible to replicate the transition of this historic city throughout time and into the future.

Virtual Gion Festival and Kyo-machiya on Virtual Kyoto

This project includes an attempt to replicate the street of festival floats, from the 14th century to the present. The entire festival experience will be recreated, from floats and crowds to sounds. To this end we have trailed one of the floats, *Fune-boko* since July 2009. From this, an experimental digital archive of float construction, components, music, decorations, townhouses, and warehouses was constructed. Digital archiving of all components and a virtual replication of the assembly process should be completed after the 2011 festival.

We are also working on a replication of city scenery, incorporating three-dimensional models of structural cultural assets such as Kyo-machiya (traditional Kyoto townhouses), modern buildings, and major shrines and temples. As part of this initiative, we have collected and stored GIS data relating to the position and appearance of around 48,000 Kyo-machiya, photographing their façades; the cooperation of Kyoto City and many volunteers has been invaluable here. This information will be incorporated into Virtual Kyoto to replicate city scenery of the past, present, and future.

Ultimately, we intend to make the results of our research public as a digital museum. Ideally, the initiative will also allow us to strengthen our ties with Kyoto's museums and galleries. We are looking forward to completing what will be a unique museum, which will make virtually accessible a vast quantity of rare cultural resources to the general public. R

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College of Letters

Professor KEIJI YANO (Ph.D.)

Integrated research

【Research Project】 A Trial R&D Project of Human Dimensions Programme on Global Environmental Change Based on Local Carbon Sequestration Systems through Cool Vegetable Agriculture

An innovative rural development systems using by rural biomass activating rural social capital, traditional knowledge and technology toward mitigation & adaptation for climate change as a "human dimensions programme on global environmental change"

Keywords

CCS
(Carbon Capture and Seguestration)
biomass carbonization
carbon credits
Cool Vegetables
Agri-industry & rural development

Carbon sink-farming as a tool to fix CO_2 emissions

On September 22, 2009, Japan's then Prime Minister, Yukio Hatoyama, announced at the United Nations Climate Change Conference that Japan will aim for a 25% cut in CO_2 emissions by 2020, compared to 1990 levels. With even a 6% cut on 1990 levels – Japan's emission reduction target under the Kyoto Accord – proving difficult to achieve, this new target will require drastic changes in social systems and technology. To this end, we are working on carbon sequestration testing through carbon sink-farming, or "Cool Vegetables" farming.

The Cool Vegetables farming method uses combustion heat from unused biomass resources in rural areas to carbonize those same resources without using other energy sources. The resulting carbon is buried, thereby improving agricultural land. Our testing site, in Kameoka City, Kyoto Prefecture, has been active since 2007.

Boosting rural economies with CO_2 emission trading and crop branding

The potential merits of Cool Vegetables carbon sink-farming are significant and diverse. It would contribute significantly towards achieving our new greenhouse gas emission reduction target. We are establishing carbon storage systems in which biomass resources (bamboo groves, agricultural waste) are carbonized and mixed with compost before being applied to farmland, thereby sequestering carbon from the land surface into the ground in a stable state. Our estimates suggest that applying 25t of biomass carbon (80% carbon content) per hectare to the 4.65 million hectares of Japan's farmland would make it possible to sequester carbon levels equivalent to an additional 1.3 times the annual CO_2 emission cut required under the Kyoto Accord. This is to be established alongside small scale carbonization systems applicable and appropriate to the developing world.

The technique can also help boost rural economies. The project seeks to develop a method for introducing biomass carbon as a function of agricultural land into the domestic voluntary CO_2 market as carbon credits, establishing a sustainable money refunding system that channels funds from urban to rural areas. Agricultural crops will also play a part in the circular urban-rural flow of economy. Cool Vegetable farming crops are sold to environmentally conscious consumers, thereby boosting the rural economy in a manner similar to concepts of local production for

local consumption and local waste for local use, while helping raise consumer environmental awareness in urban areas. Some test-marketing of crops to urban consumers have begun and a study to measure consumer willingness to pay for Cool Vegetable crops been launched, in collaboration with Co-op Kobe, a major cooperative.

We also need to verify the techniques and effectiveness of Cool Vegetables farming. We are taking actual measurements of the net carbon sequestrated amount in the biomass carbides application experiments conducted in Kameoka City in order to identify the effects on emission reduction. We have also performed verification experiments on crop quality improvement, including life cycle assessment, and confirmed a relatively high yieldability in terms of agricultural output. Further research is needed to establish how long-term stability in persistent soil carbon storage can be realized. R

College and School of Policy Science
Professor HIDEHIKO KANEGAE (Ph.D.)

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About Ritsumeikan

Suzaku Campus (Kyoto)

Established in September 2006 as a local and global center of knowledge, Suzaku Campus hosts several high level professional graduate schools as well as the Ritsumeikan Academy headquarters.
The School of Law aims to cultivate internationally-minded legal professionals equipped to meet present-day challenges. The Graduate School of Management produces management professionals with an acute sense of strategic purpose and a high level of practical skill. The innovative Graduate School of Public Policy trains capable professionals with the skills that will be indispensable for the changes in 21st century industrial structure that will be brought about by globalization, computerization, the declining birthrate, and an aging population.

School
- School of Law

Graduate Schools
- Graduate School of Management
- Graduate School of Public Policy

Research Organization
- Ritsumeikan Global Innovation Research Organization (R-GIRO)
- Kinugasa Research Organization
- BKC Research Organization of Social Sciences
- Research Organization of Science and Engineering

Kinugasa Campus (Kyoto)

Kyoto is a city of learning, culture and the arts. Kinugasa Campus is surrounded by the historic temples of Kinkakuji, Ryoanji, Ninnaji, and Tojiin, providing a serene environment for research and education. At Kinugasa Campus, we are actively pursuing a fusion of social sciences and humanities. Kinugasa Campus is home to six colleges - the Colleges of Law, Social Sciences, International Relations, Policy Science, Letters and Image Arts and Sciences - as well as research facilities including the Art Research Center, making it an integrated education and research center for humanities and social sciences. The Kyoto Studies Program and the Language Communication Program were founded by the College of Letters in 2009, and efforts are being made to enrich the content of education and research by fully utilizing the geographical advantages of the Kyoto area.

Colleges
- College of Law
- College of Social Sciences
- College of International Relations
- College of Policy Science
- College of Letters
- College of Image Arts and Sciences

Graduate Schools
- Graduate School of Law
- Graduate School of Sociology
- Graduate School of International Relations
- Graduate School of Policy Science
- Graduate School of Letters
- Graduate School of Science for Human Services
- Graduate School of Language Education & Information Science
- Graduate School of Core Ethics & Frontier Sciences

Biwako-Kusatsu Campus (BKC) (Kusatsu, Shiga Pref.)

Biwako-Kusatsu Campus (BKC) was established as an education and research center in April of 1994 with the aim of creating a world-class campus which integrates the humanities and sciences. To this end, faculty, staff and students at BKC are making efforts towards the development of new education and research systems. They are actively pursuing research and the creation of new industries through industry-government-academia collaboration and community involvement. Faculty and staff at BKC are combining cutting-edge science with social sciences and constructing a diverse educational system that goes beyond existing academic fields. The Colleges of Life Sciences and Pharmaceutical Sciences were established in April 2008. In 2010, the College and Graduate School of Sport and Health Science opened with a comprehensive and interdisciplinary approach to sports and health.

Colleges
- College of Economics
- College of Business Administration
- College of Science & Engineering
- College of Information Science & Engineering
- College of Life Sciences
- College of Pharmaceutical Sciences (6-year track)
- College of Sport and Health Science

Graduate Schools
- Graduate School of Economics
- Graduate School of Business Administration
- Graduate School of Science & Engineering
- Graduate School of Sport and Health Science
- Graduate School of Technology Management