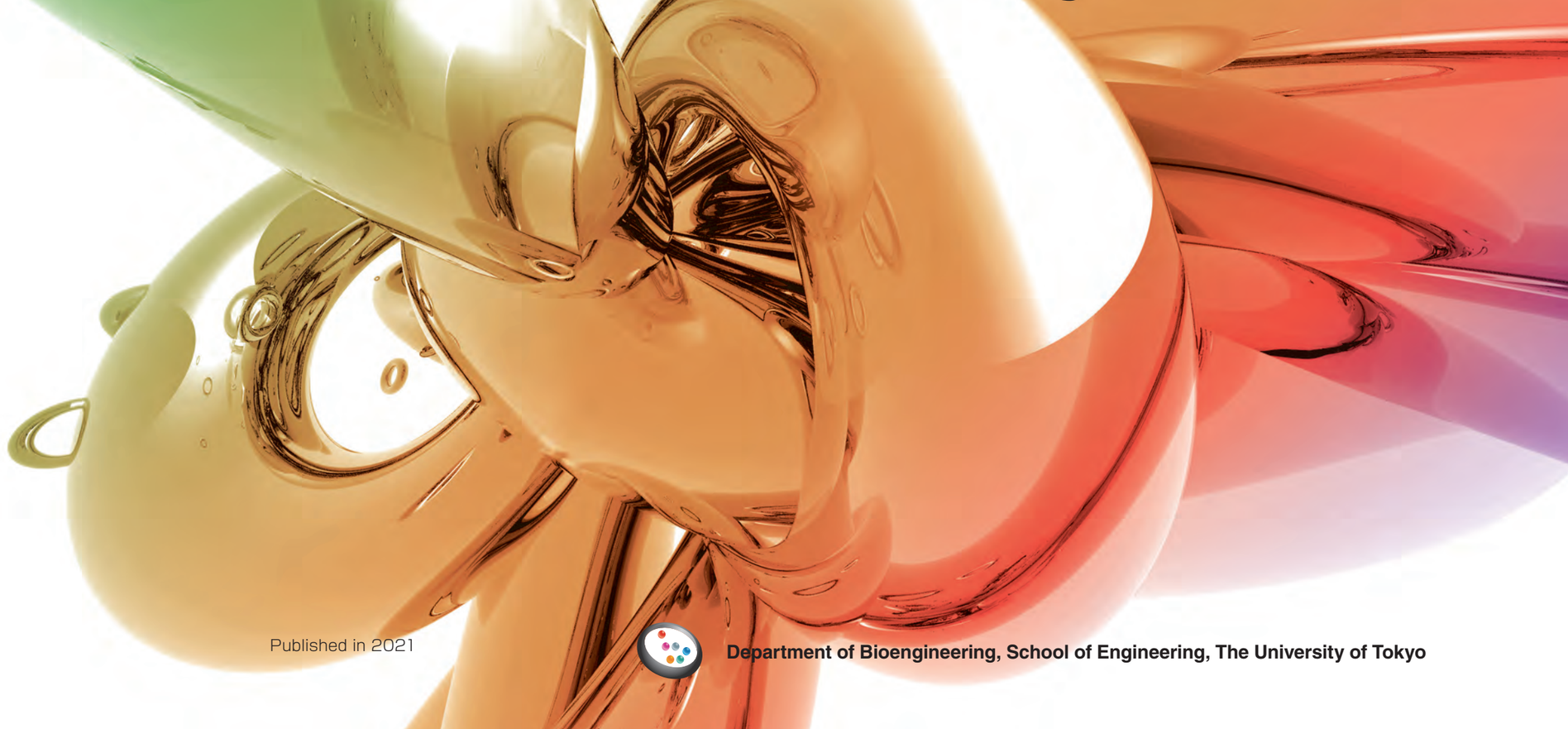
Bioengineering

# Bioengineering

Department of Bioengineering,
School of Engineering,
The University of Tokyo

# *Toward Innovative Medical Systems.*

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**School of Engineering, The University of Tokyo**

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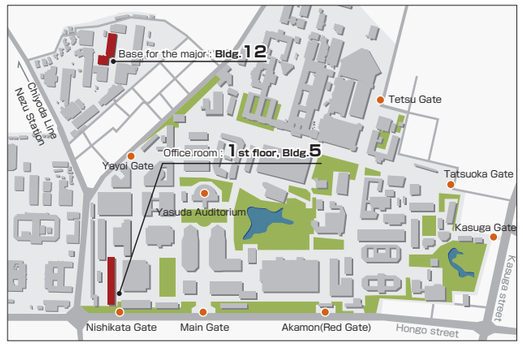




Published in 2021

**Department of Bioengineering, School of Engineering, The University of Tokyo**

# *INTEGRATION for INNOVATION*

## Connecting Engineering with Life Sciences and Medicine

**Bioengineering**





# *Development of innovative medical systems through elucidation and manipulation of the interactions of materials and systems with living bodies*

*Head of the Department of Bioengineering*
**Professor Hiroyuki TAKAHASHI**

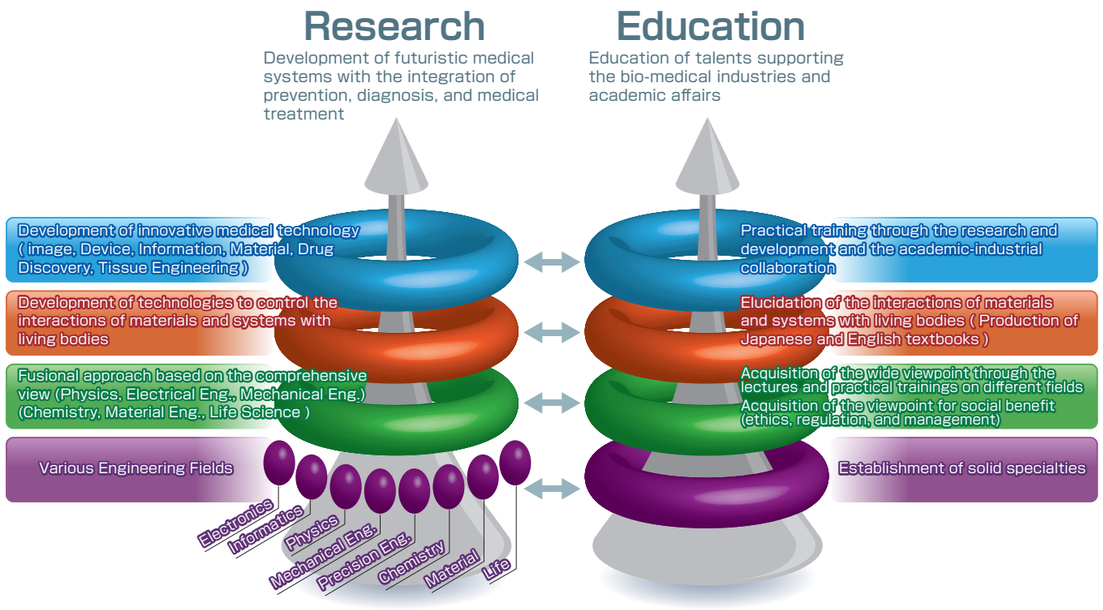
The Department of Bioengineering was established in 2006, the year Japan came to have the highest percentage of over-65s in the world combined with the lowest percentage of under-15s. It was also the year in which metabolic syndrome (denoting a collection of symptoms that can lead to diabetes and heart disease) became one of Japan's top ten buzzwords of the year. Against such a societal backdrop, the department came into being to meet the demands of the times. Its mission is to address the pressing challenges we face right now in terms of extreme population aging and a low birth rate, as well as presymptomatic disease and the need to extend healthy life expectancy.

Up to the undergraduate level, students learn the basics of the various engineering fields within their own disciplines. The Department of Bioengineering builds on that foundation, addressing the connections between bioscience and engineering from a broad perspective that includes the biomedical field. The department could be said to play a major role in the quest to establish the scientific principles behind such connections.

The Department of Bioengineering enables students to study and acquire knowledge across two intersecting dimensions simultaneously: the multidisciplinary dimension and the engineering technology dimension. The multidisciplinary dimension comprises the chemistry-related fields of life science, material engineering, and chemistry itself, as well as physics-related fields such as mechanical engineering and electrical engineering. The engineering technology dimension comprises devices and imaging. The department's key role in terms of bioscience makes it the focal point for medical-engineering collaboration, and therefore a valued part of the School of Engineering.

Specifically, as engineers who understand medicine, we focus on medical engineering to implement education programs predicated on interaction between the human body on the one hand, and materials and systems on the other. These educational activities enable us to contribute to society by turning out experts in medical engineering who can spearhead the creation of the world's most advanced medical systems into the future. At the same time, the department does not limit itself to fields closely connected to medical engineering, but also has the capacity to explore more elementary, fundamental scientific principles and basic science related to bioscience and engineering.

Having successfully completed its first decade, the Department of Bioengineering is targeting dramatic advancement in its second decade. Join us in forging the next generation, in an era requiring further international cooperation and collaboration, opening the door onto a new stage in history.




**Principles on research and education in Department of Bioengineering**

FIELDS

# *Multidisciplinary Engineering in Life Science and Medicine*

**6** FIELDS

"6 fields form the core of the Department of Bioengineering: Mechanobioengineering, Bioelectronics, Biodevices, Chemical Bioengineering, Biomaterials, and Bioimaging".

## Mechanobioengineering

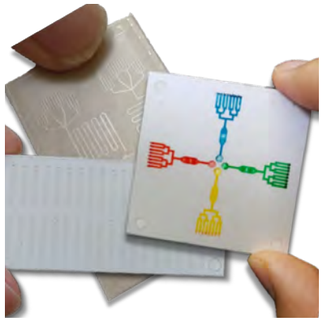
In this field, we research advanced medical support technologies that combine mechanical engineering and biotechnology. Specifically, the development of medical diagnostic and surgery support robots based on advanced information technologies and control technologies; contrast studies for malignancy imaging by applying fluids containing microelements - such as molecules and bubbles - to the phenomena of macro fluids; a noninvasive tumor therapy and lithotrity system using ultrasound; development of DNA handling technologies based on microfabrication, micro measurement technologies and nano/micro mechatronics; and the development of technologies for mechanical stress loading with high accuracy and 3D fabrication technology for organs.

## Bioelectronics

The field of bioelectronics investigates the mechanism of biological electric signal and information processing with the emphasis on distributed representation, parallel processing, and plasticity. Biologically-inspired (bio mimetic) devices, bio chips and nano pharmacologic sensors based on bimolecular and electronics have also been constructed. Bioelectronics fuses extraction/modeling of biological architecture with the implementation of electronic devices by top down (self organization system) and bottom up (semi conducting technology, for example) nanotechnology. Furthermore, bio nanotechnology supported by micro fabrication technique and nano-micro mechatronics is studied. Diagnosis, treatment and measurement system for bio-related materials and organisms are studied based on photonics and precision engineering. We are also performing researches of bio imaging with terahertz spectroscopy.

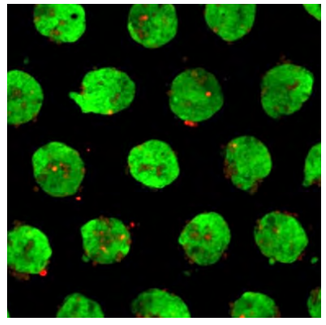
## Biodevices

In the field of medicine and life sciences, development of new analytical devices has brought a lot of discovery and innovation. In this field, based on the understanding of the interactions of materials and systems with living bodies, we study and develop a variety of devices for inspecting states of the living body, organs, cells, proteins and genes. Currently advanced microsystems for biology and medicine (referred to as biochips, micro total-analysis-systems, Lab-on-a-chips, Organ-on-a-chips) are being investigated intensively. Analytical chemistry, biomolecule manipulation and controlling, device fabrication technology and materials development, and so forth are the core technology of biodevices.



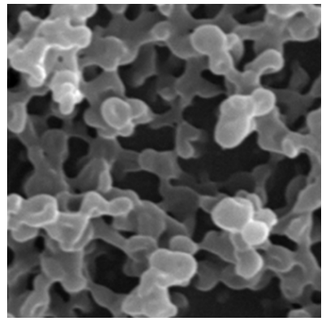
## Chemical Bioengineering

The behaviors of biosystems are well-regulated and controlled by the interactions among various functional molecules such as DNA, RNA and proteins in different hierarchies such as cells, tissues and organs. On the firm basis on chemistry, the research in the chemical bioengineering field is focused on the structure and functions of these biomolecules, and on the mechanisms for regulating and controlling the biosystems through such molecules. The research is also focused on the innovative technology development for design, synthesis and control of high performance cells, tissues and organs through artificial designing, alteration, modification and systematization of functional biomolecules. Finally, we aim at applying these technologies to the medical treatment field.



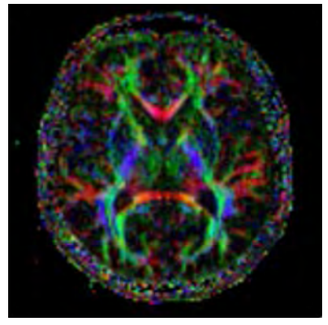
## Biomaterials

By controlling the interactions of materials with living bodies, we attempt to create high-performance innovative biomaterials that act directly on cells, tissues and organs to control their activities. By mimicking the structure and function of the natural viruses, we create delivery systems that contain drugs and genes and precisely convey them to the target tissues and lesions. By mimicking the structure and function of the biomembrane, we design coating materials that prevent non-specific adhesion of proteins and cells to surfaces. By precisely controlling the 3D shape on various scales, we develop structural biomaterials with extremely superior properties.



## Bioimaging

Aiming to achieve advanced medical treatments, we have been investigating and developing the imaging technologies for medical diagnosis, therapies, surgeries, and bio-function analysis. Our programs based on the disciplines of quantum physics, biological science and physics, system engineering and the information science of medical and cell imaging, and provides bio-imaging technologies for structural, functional, metabolic and molecular analyses, and also bio-simulating technologies.



NETWORK

# *Global Network for Cutting-edge Research*

The Department of Bioengineering, The University of Tokyo, promotes global education and research programs. Current programs include the China-Korean special program for the acceptance of Chinese and Korean students for doctoral course, an English-based master program from the Global 30 Project (International Bio-Engineering Program (IBP)) for outstanding students around the world, short-term study abroad programs between Western universities and research institutions (Global COE (Centers of Excellence), Center for Medical System Innovation (CMSI), etc.). In this way, the Department of Bioengineering aims to foster professionals who can contribute globally.

**Department of Bioengineering, School of Engineering, The University of Tokyo**

## Europe

- Imperial College London
- University of Gothenburg
- Swiss Federal Institute of Technology
- University of Cambridge
- Uppsala University
- Royal Institute of Technology
- University of Ulm
- Ludwig Maximilian University of Munich
- University of Lyon
- University of Twente
- Université de Rennes 1
- Karolinska Institutet
- Stockholms Universitet
- University of Technology of Compiègne

## Asia

- Seoul National University
- Yonsei University
- Tsinghua University
- National University of Singapore
- Indian Institutes of Technology
- Nanyang Technological University

## North America

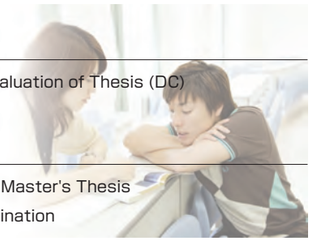
- Stanford University
- Harvard University
- The University of Texas at Austin
- Massachusetts Institute of Technology
- University of California, Los Angeles
- University of Toronto
- The University of Utah
- University of Rochester
- Duke University
- Clemson University
- University of Florida

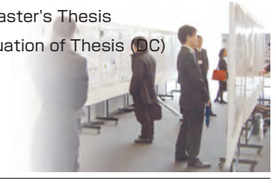
## South America

- Pontificia Universidad Católica de Chile
- Universidad Nacional Autonoma de Mexico
- Universidade Federal de Minas Gerais

# Campus Life

| | April Entrance | September Entrance |
|---|---|---|
| 4 Apr | Entrance Orientation<br>Start of Summer Semester<br>Entrance Ceremony | |
| 5 May | Examination Guidance for Graduate School<br>May Festival | Examination Guidance for Graduate School<br>May Festival |
| 6 Jun | | Submission of Doctoral Thesis |
| 7 Jul | Middle Term Evaluation of Thesis (MC) | Middle Term Evaluation of Thesis (DC) |
| 8 Aug | Entrance Examination | Submission on Master's Thesis<br>Entrance Examination |
| 9 Sep | | Graduation Ceremony |
| 10 Oct | Start of Winter Semester | Entrance Orientation<br>Start of Winter Semester<br>Entrance Ceremony |
| 11 Nov | | |
| 12 Dec | Submission of Doctoral Thesis<br>Open Meeting with Industrial Society | Open Meeting with Industrial Society |
| 1 Jan | | |
| 2 Feb | Submission on Master's Thesis<br>Middle Term Evaluation of Thesis (DC) | Middle Term Evaluation of Thesis (MC) |
| 3 Mar | Graduation Ceremony | |







# Message from International Students

## *Bioengineering combines biological science and traditional engineering to improve our life*

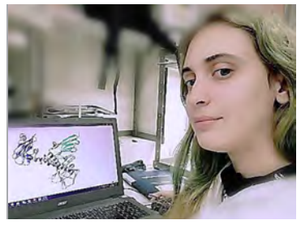
**GAO, Panpan**

- *Nationality:China*
- *Biodevices*
  *Miyake laboratory*
- *1st Year Doctor Student*

How amazing it will be if we can break the wall between life science and engineering, and how can we make it? Bioengineering should be the answer. Bioengineering is an interdisciplinary field that introduces engineering methods to biological science to develop new technologies for our daily life. When I was a master student in Miyake Lab, I was developing the microdevice to monitor the plant's physiological condition, which could be applied for smart farming in the future. Thanks to the great opportunities provided by the department, I could participate in many international conferences and visit other laboratories oversea to share my research works with researchers worldwide. And now as a Ph.D. student, I am working on a creative project for designing the wearable device for the healthcare system.

In Bioengineering, you will be exposed to many opportunities to join state-of-the-art researches and inspiring lectures. And with the help of the resources and platform offered by the department, your innovative idea can make a real contribution to our society.

## *The Department of Bioengineering teaches how to create innovative solutions*



**VALENCIANO BELLIDO, Sandra**

- *Nationality: Spain*
- *Chemicalbioengineering*
  *Tsumoto laboratory*
- *1st Year Doctor Student*

Bioengineering is the perfect combination of two different fields. The powerful tools of engineering applied with the broad knowledge of biology enables the creativity towards innovative solutions and the discovery of novel and revolutionary techniques and devices. By mixing together such different fields, it is possible to contrast diverse ideas and to see a problem from different perspectives, which is the key to successful solutions.

Bioengineering department offers the opportunity to learn from multidisciplinary fields, from device engineering to material science and protein engineering, which is the specialization of Tsumoto laboratory. However, our department provides much more. It presents a wide variety of lessons in English, facilitating the contribution of many international students. The array of different lessons from Engineering and Biology related disciplines together with the contribution of international students maximizes the possibilities of great collaborations. For me, this department has shown me to see the problems from different frames of mind and to be able to create original novel solutions. I have been able to create a network of multidisciplinary specialists to potentially collaborate with, and moreover, to create a group of friends. You are welcome to Bioengineering.

# Admission Capacity and Requirements for Completion

## Admission Capacity

**[Master's Course]** Admission Capacity: 24 / Master of Engineering
**[Doctoral Course]** Admission Capacity: 12 / Doctor of Engineering

## Requirements for Completion

**[Master's Course]** Students are requested to obtain over 30 credits to complete the program.
First, a minimum of 15 credits (7 lectures) must be acquired through the compulsory subjects.
Second, a minimum of 7 credits (4 lectures) must be acquired through the semi-compulsory subjects.
And third, a minimum of 7 credits must be acquired through the optional subjects.

**[Doctoral Course]** To obtain a minimum of 20 credits including the 20 credits for Bioengineering Seminar 2 (A), Bioengineering Seminar 2 (B), Advanced Experiments on Bioengineering 2, Advanced Research on Bioengineering 2.

# List of Course

**Master's Course: Compulsory Subject**

| |
|---|
| Bioengineering Seminar 1(A)・1(B) |
| Advanced Experiments on Bioengineering 1 |
| Advanced Research on Bioengineering 1 |
| Bioengineering exercise for social implementation 1 |
| Bioengineering Summer Experiments A |
| Basic Biology |

**Master's Course: Semi-Compulsory Subject**

| |
|---|
| Overview of Bioengineering 1 |
| Overview of Mechano Bioengineering 1 * |
| Overview of Mechano Bioengineering 2 |
| Basic Bioelectronics |
| Overview of Bioelectronics |
| Overview of Biodevices 1 * |
| Overview of Biodevices 2 |
| Overview of Chemical Bioengineering |
| Overview of Biomaterials 1 * |
| Overview of Biomaterials 2 |
| Overview of Bioimaging 1 * |
| Overview of Bioimaging 2 |

**Master's Course: Optional Subject**

| |
|---|
| Advanced Lectures on Regenerative Medicine * |
| Fundamental Technologies in Biodevices * |
| Protein Engineering * |
| Advanced Biomaterials |
| Advanced Biodevices |
| Biomanipulation Engineering * |
| Brain Electronics * |
| Advanced Bio-Electronics * |
| Medical Precision Engineering * |
| Applied Microfluidic Systems * |
| Tissue Engineering and Artificial Organs * |
| Advanced Lectures on Biomaterials * |
| Advanced Lectures on Bioimage Processing * |
| Advanced Course on Biosignal Processing * |
| Biological Reaction Engineering 1 |
| Radiation Biology |
| Overview of Biomedical Engineering * |
| Human Anatomy * |
| Human Physiology * |
| Human Pathology * |
| Overview on Clinical Medicine * |
| Presentation and writing in bioengineering |
| Medical radiation imaging |
| Multiscale Biosystems Engineering |
| Biofluid Mechanics * |

**Doctoral Course: Compulsory Subject**

| |
|---|
| Bioengineering Seminar 2(A)・2(B) |
| Advanced Experiments on Bioengineering 2 |
| Advanced Research on Bioengineering 2 |

**Doctoral Course: Optional Subject**

| |
|---|
| Bioengineering exercise for social implementation 2 |
| Overview of Bioengineering 2 |
| Bioengineering Summer Experiments B |
| Biological Reaction Engineering 2 |
| Radiation Biology |

*A Japanese lecture



# Graduate Careers

## Master

| Employing Companies |
|---|
| Accenture Japan Ltd. |
| Asahi Kasei Corporation |
| Ajinomoto Co., Inc. |
| Astellas Pharma Inc. |
| Amazon.com |
| Iwaki Seiyaku Co., Ltd. |
| USHIO INC. |
| Eisai Co., Ltd. |
| NTT DATA Corporation |
| LG Electronics Incorporated |
| Olympus Corporation |
| Kao Corporation |
| Canon Inc. |
| KYOCERA Corporation |
| KYOWA HAKKO BIO CO., LTD. |
| KONICA MINOLTA, INC. |
| GE Healthcare Japan Corporation |
| SYSMEX CORPORATION |
| Shiseido Company, Ltd |
| SHIMADZU CORPORATION |
| Johnson & Johnson K.K. |
| Sony Corporation |
| SoftBank Corp. |
| DAIICHI SANKYO COMPANY, LIMITED |
| Taisho Pharmaceutical Co., Ltd. |
| Takeda Pharmaceutical Company Limited. |
| CHUGAI PHARMACEUTICAL CO., LTD. |
| TEIJIN LIMITED |
| TERUMO CORPORATION |
| Tokyo Electron Limited |
| Tokyo Electric Power Company Holdings, Inc. |
| TOSHIBA CORPORATION |
| TORAY PEF PRODUCTS,INC. |
| Towa Pharmaceutical Co., Ltd. |
| TOYOTA MOTOR CORPORATION |
| NIKKISO CO., LTD. |
| NIPPON CARBIDE INDUSTRIES CO.,INC. |
| JAPAN TOBACCO INC. |
| PHC Holdings Corporation |
| HIKARI ALPHAX INC. |
| Hitachi, Ltd. |
| Hitachi Zosen Corporation |
| Hitachi High-Technologies Corporation |
| Pfizer Japan Inc. |
| Fujifilm Corporation |
| Brains Technology, Inc. |
| Mitsui E&S Machinery Co., Ltd. |
| Mitsubishi Heavy Industries, Ltd. |
| Murata Manufacturing Co., Ltd. |
| Ricoh Co., Ltd. |

····· and others

## Doctor

| Employing Companies |
|---|
| Pharmaceuticals and Medical Devices Agency |
| Kao Corporation |
| KANEKA CORPORATION |
| Center for iPS Cell Research and Application, Kyoto University |
| National Cerebral and Cardiovascular Center Hospital |
| GE Healthcare Japan |
| SYSMEX CORPORATION |
| Sichuan University |
| Mitsubishi Tanabe Pharma Corporation |
| CHUGAI PHARMACEUTICAL CO., LTD. |
| TEIJIN LIMITED |
| TERUMO CORPORATION |
| Tokyo Medical and Dental University |
| University of Tokyo |
| Tosoh Corporation |
| TORAY PEF PRODUCTS, INC. |
| Microsoft Japan Co., Ltd. |
| Panasonic Corporation |
| Hitachi, Ltd. |
| Pfizer Japan Inc. |
| HOGY MEDICAL CO.,LTD. |
| Institute of Physical and Chemical Research |
| Lily MedTech Inc. |
| Harvard Medical School, Boston Children Hospital |
| Stevanato Group |

····· and others

Mechanobioengineering

Professor
## Shu TAKAGI

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[**Subjects of Research**]
- Human Body Simulation using Supercomputers
- Blood Flow Simurations
- Medical Applications of Ultrasound and Microbubbles
- Multiscale Modeling of Biomembrane

[**Field of Study**]
Fluid Mechanics,
Medical Ultrasound,
Biomechanics,
Computational Science

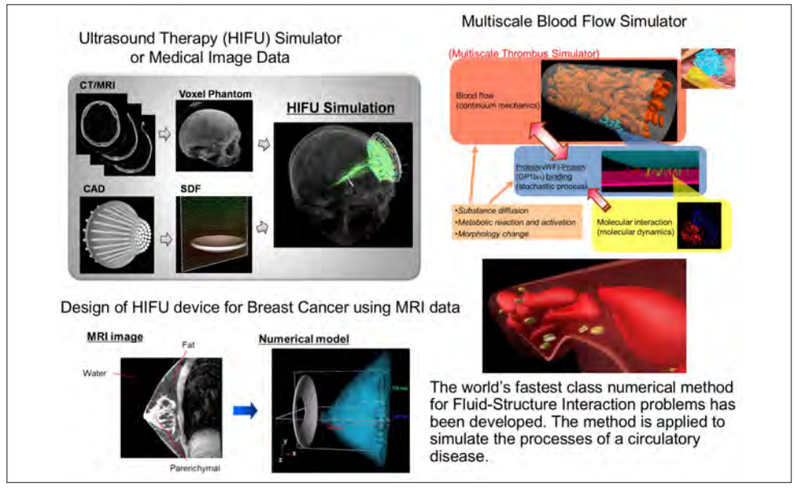
### Multiscale biomechanics for medical applications

## Toward the next generation medical treatment using the patient-specific image data

### Research Objective

Our objective is to contribute the medical treatment through the development of simulation tools for a new type of ultrasound diagnosis and therapy systems and also for the prediction of a circulatory disease using our own codes for the supercomputers. Both numerical and experi-mental studies have been conducted to achieve the actual feedback to medical applications.

### Summary




Mechanobioengineering

Professor
## Mamoru MITSUISHI

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[**Subjects of Research**]
- Neurosurgical system in the deep surgical field
- Computer-assisted knee arthroplasty system
- Remote minimally invasive surgical system
- Bone fracture reduction system
- Scaphoid fracture reduction system
- Remote ultrasound diagnosis system

[**Field of Study**]
Medical Robotics, Manufacturing System

### Computer-integrated surgical systems based on manufacturing technology

## Toward innovative medical systems

### Research Objective

Cutting-edge technology for medicine supported by mechanical engineering and bioengineering.
Surgical robotic systems; Computer-assisted knee surgical systems; Remote minimally invasive surgical systems; Medical Microrobots; Ultrasound treatment systems

### Summary




Mechanobioengineering

Associate Professor
## Kanako HARADA

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[**Subjects of Research**]
- Surgical robots for pediatric, eye and neurosurgery
- Automation of surgical robots
- Surgical skill assessment

[**Field of Study**]
Medical Robotics,
Computer Aided Surgery

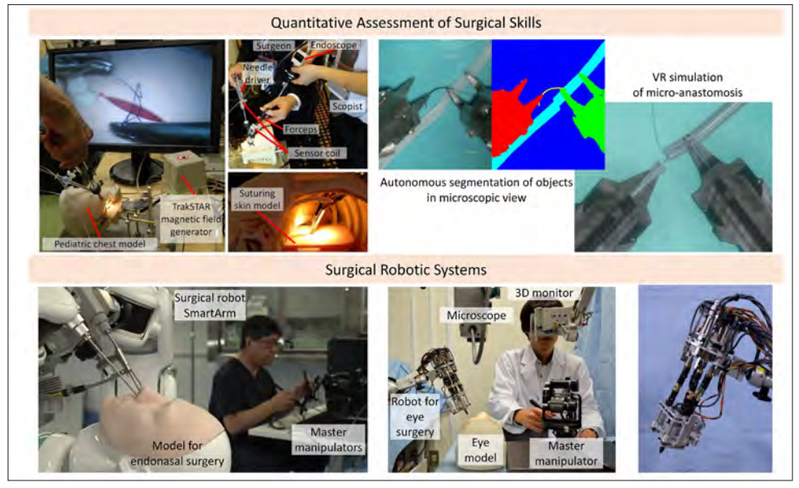
### Smart surgical robotic systems

## Toward skilled surgical robots

### Research Objective

We have been developing surgical robots for microsurgery, in particular, for pediatric, eye and neurosurgery using bioengineering technologies. We are also trying to automate the surgical robots considering surgical skills quantitatively assessed using high-fidelity patient/organ models equipped with sensors (named Bionic Humanoids) and virtual-reality simulators. Medicine-engineering collaboration is essential in this research domain, and basic knowledge of regulatory science is necessary.

### Summary




Mechanobioengineering

Associate Professor
## Katsuko FURUKAWA

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[**Subjects of Research**]
- Regenerative engineering of vascular blood vessel and cartilage tissue under mechanical stress
- 3D organ design with/without scaffolds
- Rapid prototyping technology for 3D scaffold design
- Real-time imaging of blood vessels under physiolosical stimulations

[**Field of Study**]
Mechanobioengineering, Regenerative Medicine, Biomaterials

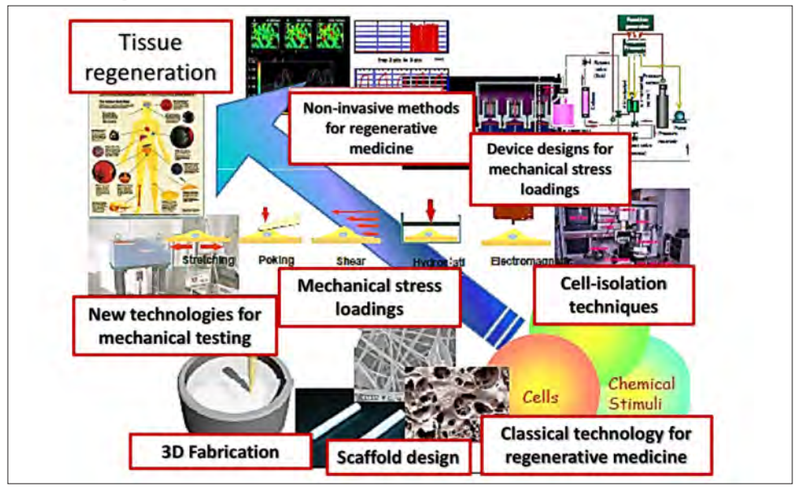
### Tissue engineering based on Mechanoengineering ~From tissue regeneration towards to organ regeneration~

## Let's enjoy cutting-edge researches for regenerative medicine based on engineering technologies!

### Research Objective

Furukawa Laboratory aims to develop fundamental technologies necessary for tissue engineering in terms of biomechanics. By designing devices for physical stimulation, we focus on enhancement of the functionality of tissue-engineered organs such as cartilage, blood vessel, and bone, with immature stem cells as cell sources. In particular, tissue-engineered cartilages produced at this lab have shown very promising results. Like such, we are actively developing new technologies for tissue-engineering with clinical feedbacks.

### Summary



Bioelectronics

Professor

## Hitoshi TABATA

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[Subjects of Research]
- Nano-bioelectronics・Photonics
- "Yuragi" electronics learned by bio mime tics
- Creation of new function by 3D programmable self organizing
- Nano scale molecule recognition by surface science technology
- Wearable healthcare sensors based on oxide semiconducting nano-devices

[Field of Study]
Nano Bio Electronics

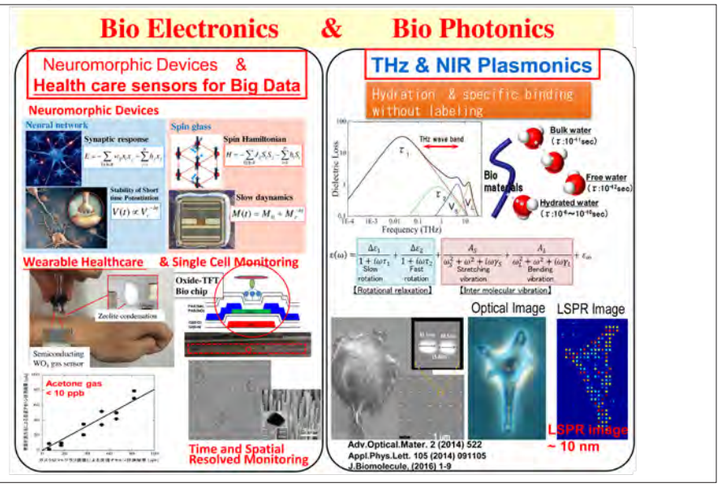
### Fusion Bioelectronics & Biophotonics by Nanoscience and Quantum Technology

## Nano structural control and Near IR and THz wave Technology for Bio-Medical Fields

### Research Objective

We study the interdisciplinary researches of bio-electronics and photonics by learning “from” and “about” organism. Nano-scale controlled devices using human friendly oxide semiconductors are the effective devices for low/non invasion and specific detection of pathological targets. A new method based on THz-spectroscopy is also studied for direct detection of cancer cells and/or hydration states of bio related materials. In addition, brain morphic and/or neuro morphic devices have been studied based on spin wave or spin fructuation.

### Summary




Bioelectronics

Project Professor

## Shinichi TOKUNO

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[Subjects of Research]
- Development of voice biomarkers (stress, depression, dementia, Parkinson's disease, etc.)
- Application of voice biomarkers (athlete mental care, etc.)

[Field of Study]
Medical engineering, Disaster medicine, Occupational health

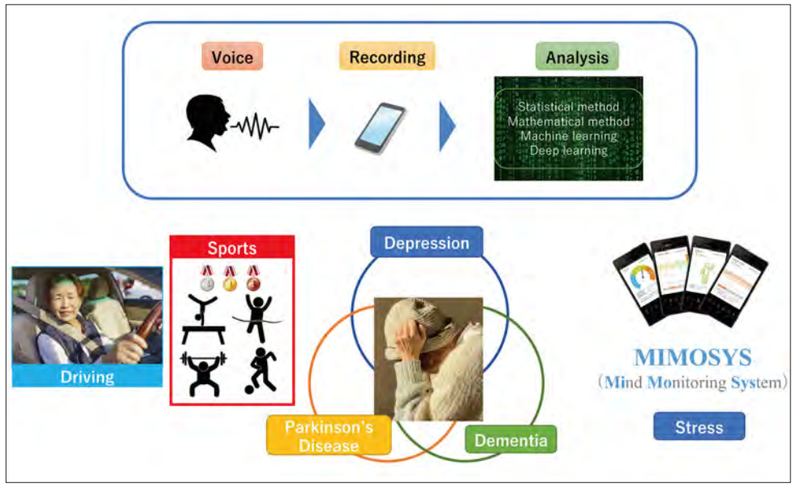
### Voice Analysis and Measurement of Pathophysiology : Technology to visualize disease by voice

## Hear a silent voice New medical engineering to analyze pathological condition from voice

### Research Objective

We are researching technology to detect minute changes in voice associated with disease and visualize the disease in a non-invasive manner. Voice stress assessment technology has already been developed and has been commercialized by several companies. It was also adopted as one of the ME-BYO Index promoted by Kanagawa Prefecture. Currently, we are conducting research on depression, dementia, and Parkinson's disease with a view to the aging society. Furthermore, we are looking for ways to utilize this technology in fields other than healthcare.

### Summary




Bioelectronics

Professor

## Akira HIROSE

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[Subjects of Research]
- Brain-like signal processing
- Adaptive wireless communications and imaging
- Intelligent ubiquitous electronics

[Field of Study]
Neural Networks, Adaptive Signal Processing

### Development of new framework and applications of intelligent wireless electronics

## Bioinstrumentation and Medical Front Applications of Brain-Inspired Wireless Electronics

### Research Objective

We construct a new field as the fusion of wireless electronics and brain-inspired adaptive information processing to realize novel bioinstrumentation to visualize invisibles and to develop systems useful and comfortable in the medical front.
(1) Active image acquisition systems based on coherent neural networks,
(2) Adaptive wireless communications workable under medical rigid restrictions, etc.

### Summary

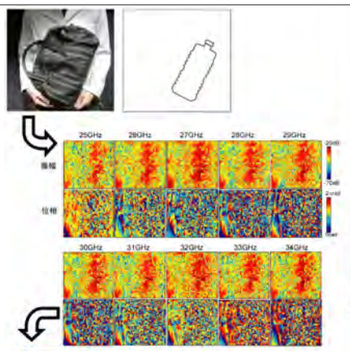

Fig.2 Ultra-wideband (UWB) and reconfigurable antenna for data communications with quite low interference to other equipment in the medical front. We design, simulate, fabricate and evaluate new antennas and embedded systems.

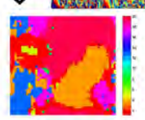

Fig.1 Active image acquisition utilizes coherence / phase information to realize highly functional medical and security imaging. Based on extended neural networks, we develop new imaging systems. From top to bottom, target optical photo and a sketch, raw millimeter-wave amplitude and phase images, and adaptively segmented image generated by a complex-valued neural network.

Bioelectronics

Associate Professor

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[Subjects of Research]
- High-sensitive biomolecular sensing for IoT/AI applications
- Optical detetions for biomechanical functions based on smart biomaterials
- Development of flexible bio-masure systems and stress sensing
- Engineering for biological defense
- Spectroscopic sensing for biological-related gases

[Field of Study]
Biological molecular (gas) sensing, Nanophotonics, Plasmonics and biomaterials

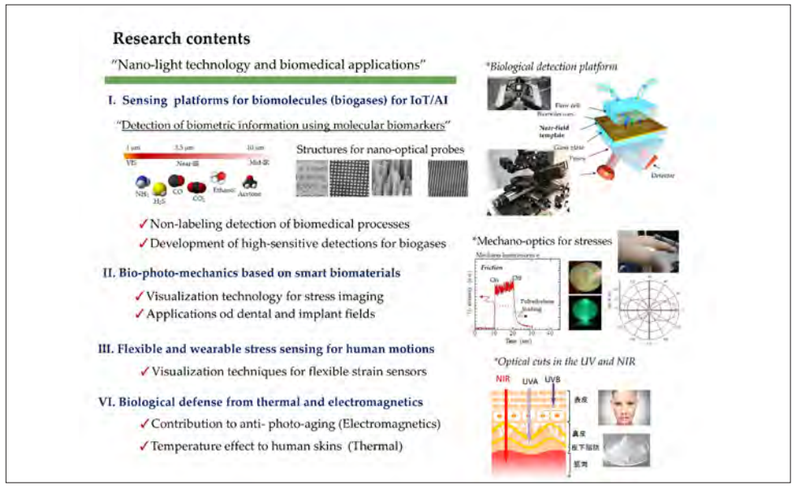
### Nano-optical techniques for biomedical applications

## Development of biomedical applications based on nano-optical techniques

### Research Objective

Our research group focuses on biomedical applications for biometric information sensing and biological defense technology. As typical studies, Development of surface detection techniques of biochemical information using nano-photonics based on nano-plasmonic materials and near-field lights. Visualization technology and stress detection in biological samples using stress-induced luminescent phenomena. In addition, Applications of biological defense, and beauty and health based on optical control in biomaterials.

### Summary



Bioelectronics

Project Associate Professor

## Shunji MITSUYOSHI

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[Subjects of Research]
- Artificial ego and morality-based behavioral control of robot using *the new operator*
- Fundamentals for development of Neumann and non Neumann computers using *the new operator*

[Field of Study]
Computer science, Voice emotion recognition, Pathophysiological Voice Analysis, Artificial intelligence

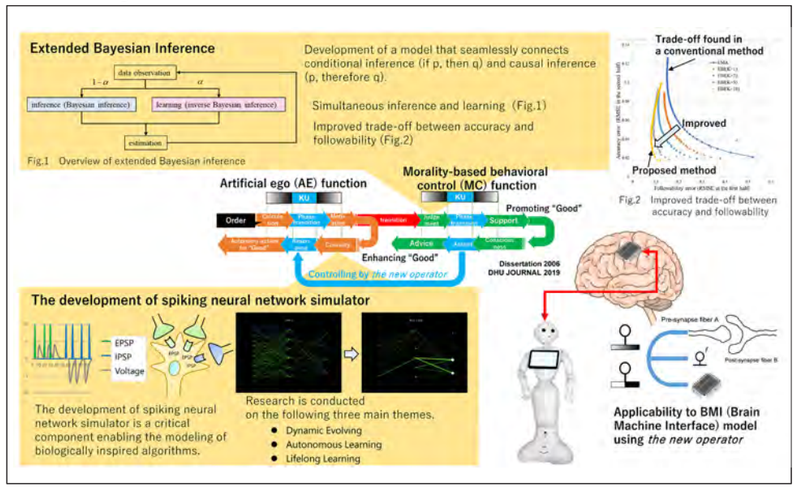
### "Artificial ego", quantification of human empathy, and control of morality-based behaviors of robots

## We devote ourselves to advancing mathematical models for numerically evaluating width of human empathy and the way how we control robots based on morality

### ● Research Objective

Mathematical Engineering of Morality Emotions aims to create both Neumann and non Neumann computers using *the new operator*, which enables phase transitions, computational emergence and autonomy.
We develop emulators to demonstrate Artificial ego (AE) equipped with *the motivation* using conventional computer systems.
Our final goal is to establish the way how we control robots using autonomy and morality derived from AE.

### ● Summary




Bioelectronics

Project Lecturer

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[Subjects of Research]
- Development of a flexible decision-making model integrating learning and inference and its application in non-stationary environments
- Mathematical modeling and application of inference with cognitive bias (causal inference)
- Measuring activation and empathy levels in meetings using multimodal information
- Measuring the severity of depression and arousal level using voice information
- Research on autonomous production systems that integrate on-site knowledge and machine learning

[Field of Study]
Medical systems, Intelligent informatics, Kansei informatics

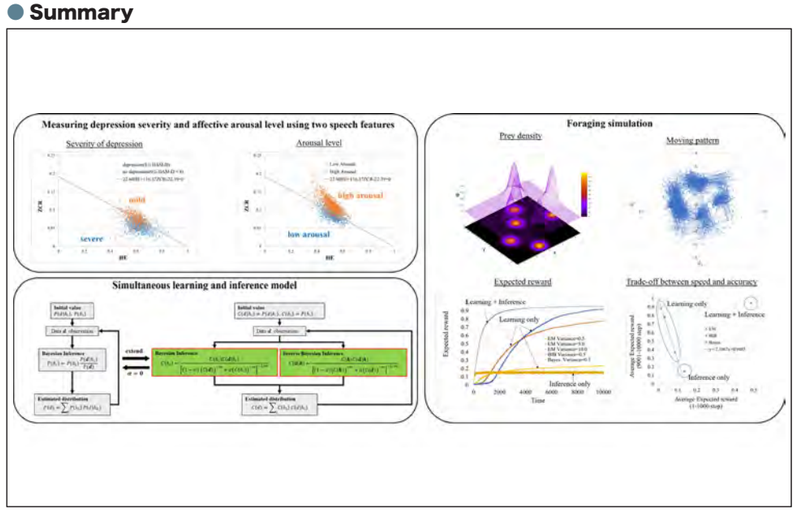
### Research on decision-making systems with human-like cognition, inference, and learning mechanisms

## A machine learning system that incorporates human knowledge, cognitive bias, and decision-making mechanisms

### ● Research Objective

To realize flexible decision-making systems that are equipped with human-specific cognitive biases and the ability to perform learning and inference simultaneously and seamlessly.

### ● Summary






Biodevices

Professor

## Takanori ICHIKI

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[Subjects of Research]
- Development of innovative nano/microfabrication technologies
- Microplasma technology
- High-speed molecular evolution systems

[Field of Study]
Nano and Micro Manufacturing, Biodevices, Plasma Process

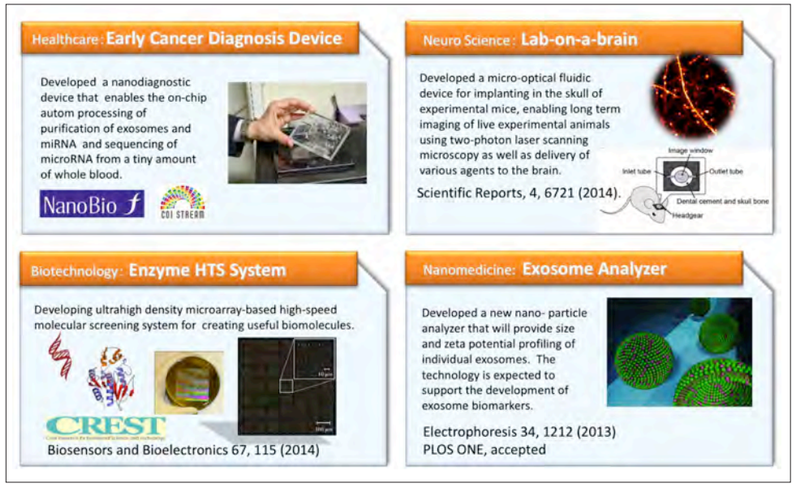
### Development of evolutional bio-sensing platforms based on nano-biodevice technology

## From nano/microprocess development to system integration

### ● Research Objective

To realize innovative systems for bioanalysis and biosynthesis, we are developing higher-order functional integrated bio-devices based on the advanced nano/microfabrication technologies and hetero-integration technologies of inorganic and organic materials.

### ● Summary




Biodevices

Professor

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[Subjects of Research]
- Development of biocompatible biointerfaces based on bioinspired materials for applications in biodevices
- Development of highly sensitive immunoassay and cell separation device by use of polymeric microfiber
- Development of block copolymers and hydrogels to investigate the cell-material interactions

[Field of Study]
Biointerface, Biomaterials, Biosensing

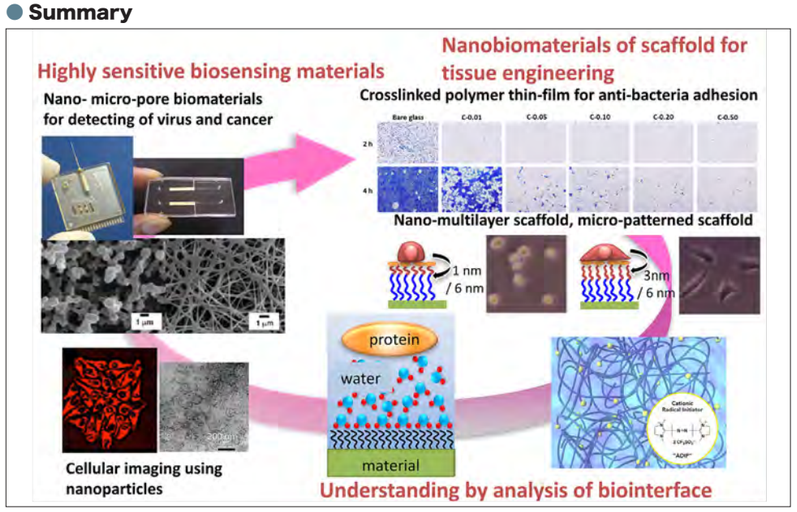
### Development of Highly Functional Medical Devices by Design of Biointerface

## Biointerface Science Pioneers the Future Medicine

### ● Research Objective

The biointerface is created when biomolecules, proteins, and viruses, or cells touches solid surfaces such as inorganic, synthetic polymer, or bio-inspired materials. The aim of our study on biointerface science is to understand and control the behavior of such biological objects on the surfaces. We are developing the highly functional medical devices for artificial organ, for medical diagnosis, for regeneration medicine by design of the biointerface.

### ● Summary



Biodevices

Professor

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[Subjects of Research]
- Single-molecule biophysics of rotary molecular motors
- Single-molecule digital bioassay with femtoliter reactor array
- High-throughput Enzyme screening with artificial reactor array
- Synthesis of autonomously self-replicating cell reactor

[Field of Study]
Single-molecule biophysics, Micro/Nano bioscience

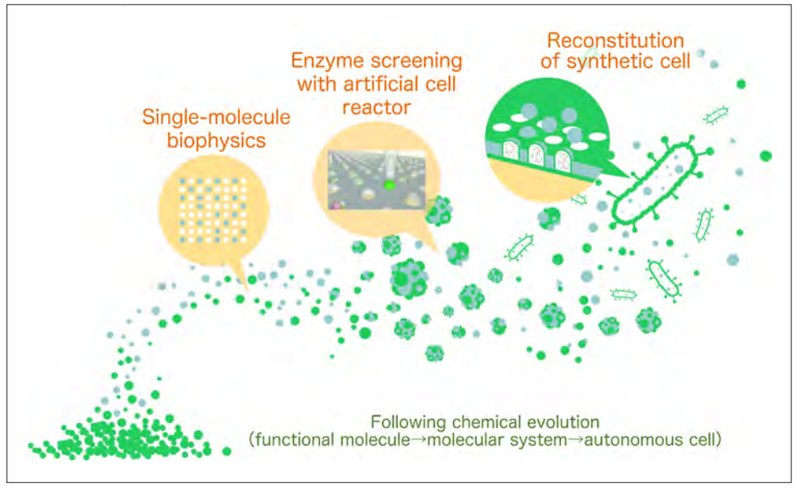
New Science and technology innovation by single-molecule and artificial cell reactor technologies

# Enjoy Science and create new technology

### Research Objective

For over two decades, we have been studying the molecular mechanism of ATP synthase by single molecule technology. Through our research, we have been creating novel and innovative technologies such as femtoliter reactor array, that is currently utilized in digital bioassays such as ELISA, and ratiometric fluorescent ATP sensor proteins. Development of these new technologies is motivated more by our own curiosity rather than the need of the society. These technologies are widely used now and have been further developed by other researchers or companies.

### Summary




Biodevices

Professor

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[Subjects of Research]
- Modelling of micro-fluid elements for biochemical operations
- Design tools for micro-fluid circuit
- Micro-analysis systems for biomedical diagnostics
- Compact water-quality monitors

[Field of Study]
Micro fluidics

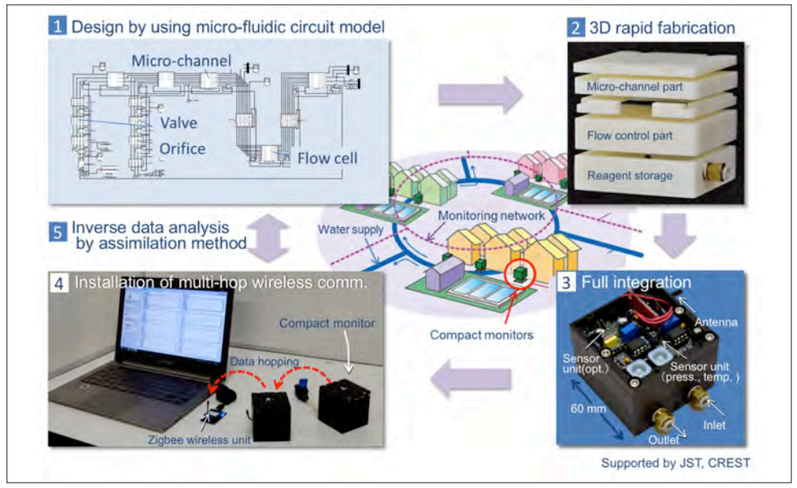
Development of design tool for micro-fluidic circuit

# Integration and installation technologies for monitoring network system of water-quality

### Research Objective

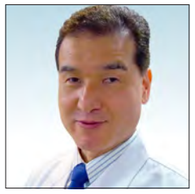
Modelling of micro-fluid elements, and development of design tools and manufacturing processes of micro-fluid systems for biomedical diagnostics, enviromental analysis and micro-chemical plants. Development of micro-fluid elements and modelling of the fluid behavior inside the elements, and a design tools of micro-fluid circuit by connecting those elements in series and by arraying them in parallel.

### Summary






Biodevices



Project Professor

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[Subjects of Research]
- Grafts fabricated as tissue and encapsulated by using bioMEMS
- Techniques to transplant grafts to animal model of disease
- Basic research to develop tissue transplantation for diabetes mellitus

[Field of Study]
Medical Engineering for Transplantation

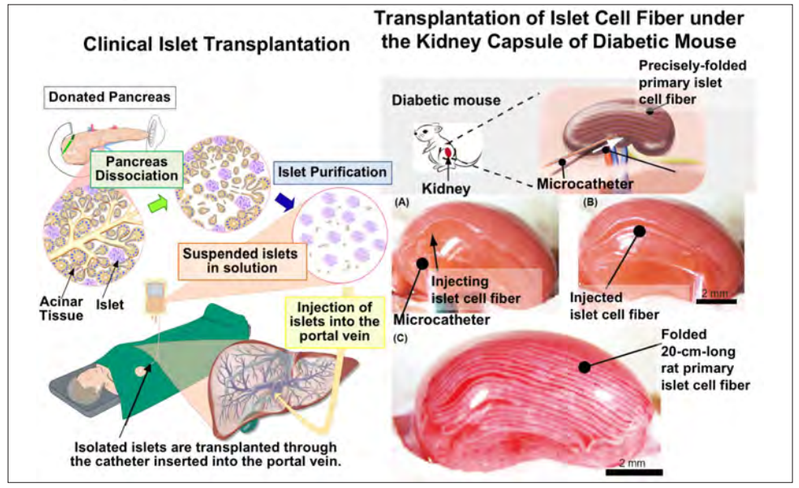
Development of next-generation technologies for tissue transplantation targeted at insulin dependent diabetes mellitus

# Developing smart grafts and techniques of tissue Tx for IDDM by applying BioMEMS

### Research Objective

Diabetes mellitus is currently recognized as a disease lacking in endogenous insulin secreted by pancreatic beta-cells. To treat insulin dependent diabetes mellitus (IDDM), clinical islet transplantation is performed, since the islet contains pancreatic beta-cells. IDDM is also considered to be one of the targets as the foothold of regenerative medicine or xenotransplantation, because replacement of the single type of cell is expected to cure IDDM. In this research, we are applying BioMEMS and developing new grafts and techniques to transplant pancreatic beta-cells for the treatment of IDDM patients through not only current clinical islet transplantation but also regenerative medicine or xenotransplantation.

### Summary




Biodevices

Associate Professor

## Yukiko MATSUNAGA

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[Subjects of Research]
- 3D tissue engineering using microfluidic technology
- Material synthesis and processing for biomedical micro devices

[Field of Study]
Micro tissue engineering, Biomaterials, Regenerative medicine, BioMEMS

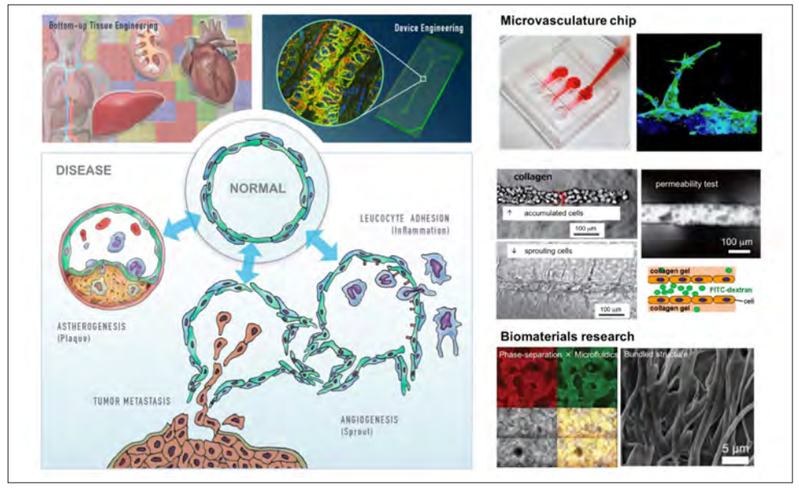
Visualization of Microenvironment of the Body

# Fabrication of 3D Living Tissues to Understand Disease Mechanisms

### Research Objective

We have been focusing on disease tissue engineering by combining biomaterial synthesis, microfabrication and cell biology. Our goal is to develop controllable in vitro models to “visualize” the microenvironment of tissues from normal to disease state at the cellular level. This approach is a powerful tool for mechanistic understanding of disease and drug discovery.

### Summary



Biodevices

Associate Professor
## Kazuma MAWATARI

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[Subjects of Research]
- Medicai diagnosis device and system
- Micro/nano fluidic device and fusion with electronics and information engineering
- Novel fluidic operations: aanovalve, single living cell sampling, concentration, etc.
- Ulstasensitive laser detection, electrochemical detection, and X-ray diffractometry in small space
- Solution chemistry and fluidics in nanospace
- Celluar space mimetic devices and the solution chemistry, fluidics, and lifescience

[Field of Study]
Micro/nano fluidic engineering, specgroscopy, analytical chemistry, optics

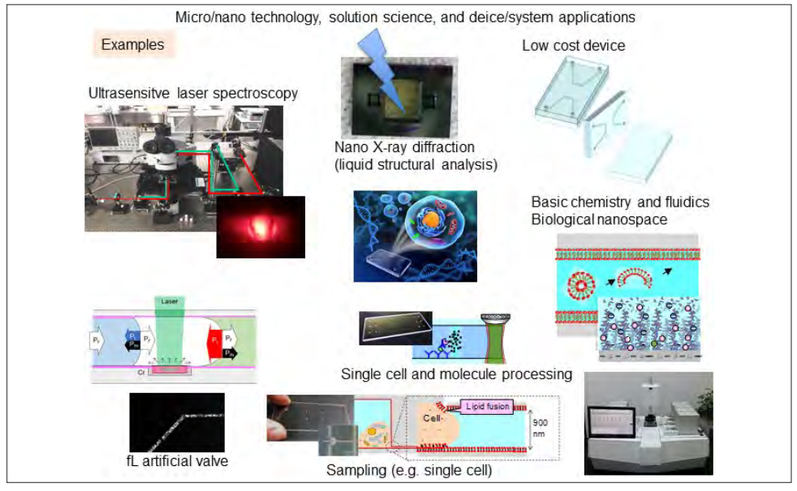
# Novel sensing by micro/nanofluidic engineering

## We develop originaltechnology for micro/nano space and clarify the science in the small space, which are applied to biology, medical, and environmental with novel devices and systems

### Research Objective

We develop our original technology using micro/nanofluidic devices, open new science with these tools: solution chemistry, chemical reaction, liquid structure in the ultrasmall liquid phase or inter/intracelluar nano space, which is quite difficult to investigate due to the small size and no experimental tool for them. Also, we contribute to novel sensing technologies in biology, medical, environmental, agriculture, and fishing industry by combining chemistry, physics, and information engineering. Collaboration with Vietnam, which is growing rapidlly, will be accelerated in both of education and research.

### Summary




Chemical bioengineering

Professor
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[Subjects of Research]
- Development of in situ cross-linkable hydrogels for medical uses
- Development of nano- and microparticles for medical uses
- Biodegradable sheets and films for medical uses
- Drug delivery, Tissue engineering, Minimally invasive treatment

[Field of Study]
Chemical Engineering,
MedicalEngineering, Biomaterials

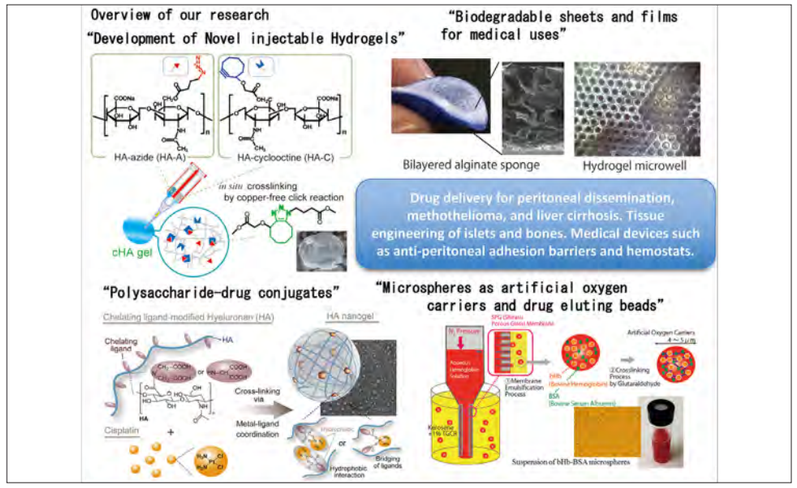
# Development of novel biomaterials and their applications for medical devices

## Development of novel biomaterials and their applications for medical devices

### Research Objective

We aim novel biomaterials and medical devices. We develop new injectable hydrogels, hydrogel beads, non-woven sheet and gel sponges composed of natural polymers such as hyaluronic acid, gelatin, and albumin or synthetic polymers such as dendritic polymers. We applied these materials to drug delivery for peritoneal dissemination, methothelioma, and liver cirrhosis, tissue engineering of islets and bones, and medical devices such as anti-peritoneal adhesion barriers and hemostats. Based on chemical engineering, material engineering, and biochemical engineering, we collaborate with medical doctors for future clinical applications.

### Summary






Chemical bioengineering

Professor
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[Subjects of Research]
- Progagation and differentiation of stem/progenitor cells in various scales
- Organization of vascularized tissues/ organs for regenerative medicine
- Development of physiological tissue/ organ models for efficacy/hazard evaluations and disease analyses
- Multi-scale numerical sumulations of human metabolisms

[Field of Study]
Organs and Biosystems Engineering

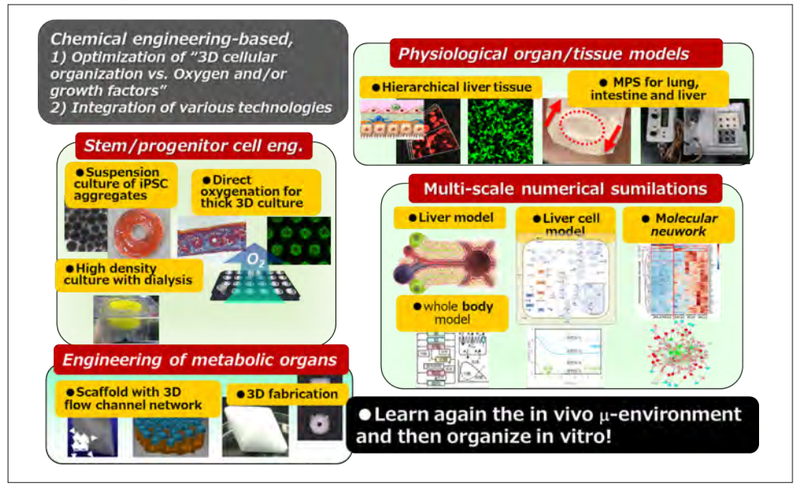
# Organs and Biosystems Engineering for regenerative medicine and cell-based assays

## Chemical system engineering-based applications of latest knowledge of biology and medicine

### Research Objective

The general goal of our lab is to culture and/or organization of stem and organ-derived cells in various scales for regenerative medicine and cell-based assays. Chemical system engineering methodologies and its point of view serve as the basis in achieving these goals, because it optimize mass transfers in 3D cell-based tissues or best integrate basic biology, medicine and engineering.

### Summary




Chemical bioengineering

Professor
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[Subjects of Research]
- Molecular Technologies for the analysis of biomolecules in vivo
- Synthetic molecules for regulation of cellular functions
- Rational design and high-throughput screening of synthetic molecules for drug discovery

[Field of Study]
Chemical Biology

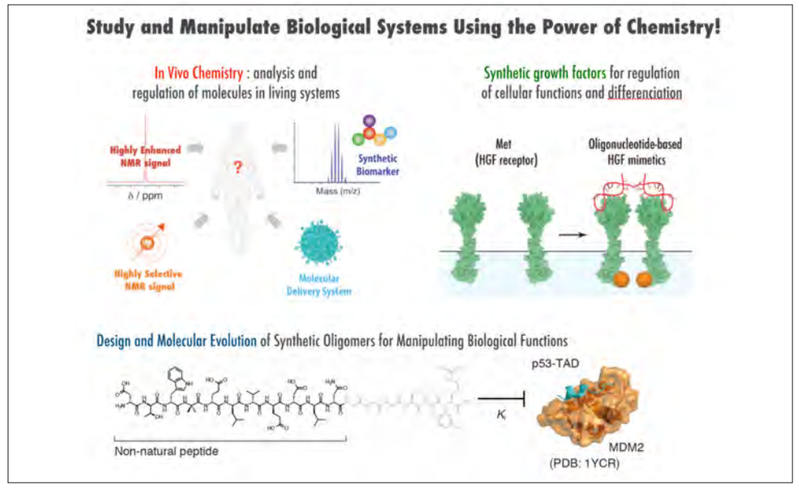
# Molecular Technology for Understanding of Living Systems and for Early Diagnosis and Therapy

## Study and Manipulate Biological Systems Using the Power of Chemistry

### Research Objective

Our body is composed of a variety of biomolecules. An unsolved principle of life must lay in the activities of such biomolecules and the abnormal molecular activities could cause various diseases such as metabolic disorder. Our group is conducting chemistry-based research for "understanding of living systems at the molecular level" and "developing new molecular technology contributing to early diagnosis and therapy". The research area ranges from leading edge sensing technology for non-invasive molecular diagnosis/analysis/sensing and functional molecule development for molecular therapy and regenerative therapy.

### Summary



Chemical bioengineering

Professor

## Tsutomu SUZUKI

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[**Subjects of Research**]
- RNA modifications associated with various biological functions
- Decoding of genetic information and protein synthesis
- Epitranscriptome and biological functions
- Molecular pathogenesis of RNA modopathy

[**Field of Study**]
Molecular biology, Biochamistry

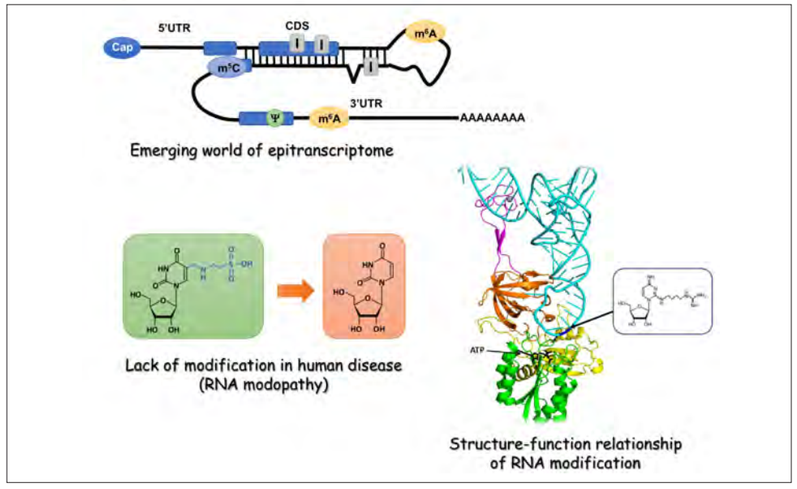
### RNA biology and molecular pathogenesis

## Epitranscriptome regulation of gene expression and higher-order biological process associated with RNA

### Research Objective

Higher-order biological processes, including development, differentiation and complex mental activity, are the result of sophisticated regulation of gene expression. Dysregulation of gene expression often causes a variety of human diseases. RNA molecules are deeply involved in regulation of gene expression at various steps of central dogma. We are tackling to elucidate various biological phenomena associated with RNA functions based on multidisciplinary approaches including molecular biology, biochemistry, genetics, analytical chemistry and cell biology.

### Summary




Chemical bioengineering

Associate Professor

## Seiichi OHTA

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[**Subjects of Research**]
- Fascile and sensitive detection of biomarkers using photofunctional nanoparticles
- One-pod detection of multiple biomarkers using photofunctional nanoparticles
- Constraction of a diagnostic model based on the expression profile of multiple biomarkers

[**Field of Study**]
Chemical Engineering,
Photofunctional nanoparticles

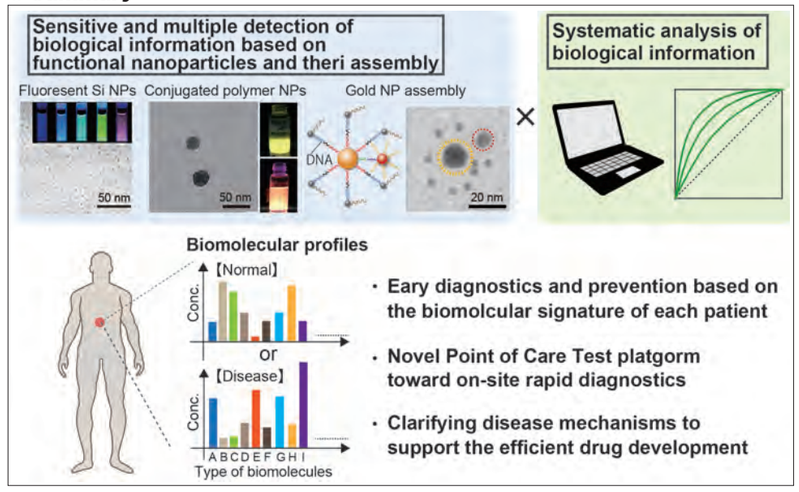
### Exploring systems diagnostics using functional nanoparticles

## Integrating sensitive and multiplle detection of biological information with systematic data analysis toward early diagnostics platform

### Research Objective

In our body, dynamic and complicated interactions of numerous biomolecules determine biological phenomena. Using functional nanoparticles as a tool, we develop a detection/ visualizing method of these interactions. Integrating with the data analysis that considers living body as a system, we aim to develop a novel diagnostic platform enabling early diagnostics, precision medicines, and efficient drug development. Chemical Engineering is a basic principle of our group, to which various medical or biological knowledge are integrated systematically.

### Summary




Chemical bioengineering

Professor

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[**Subjects of Research**]
- Antibody Engineering in the Era of Bio-Better
- Artificial Regulation of Biomolecular Interactions
- Focus on Disease-related Molecular Systems
- Protein Engineering in Bio-Material Design

[**Field of Study**]
Protein Engineering,
Physical Biochemistry

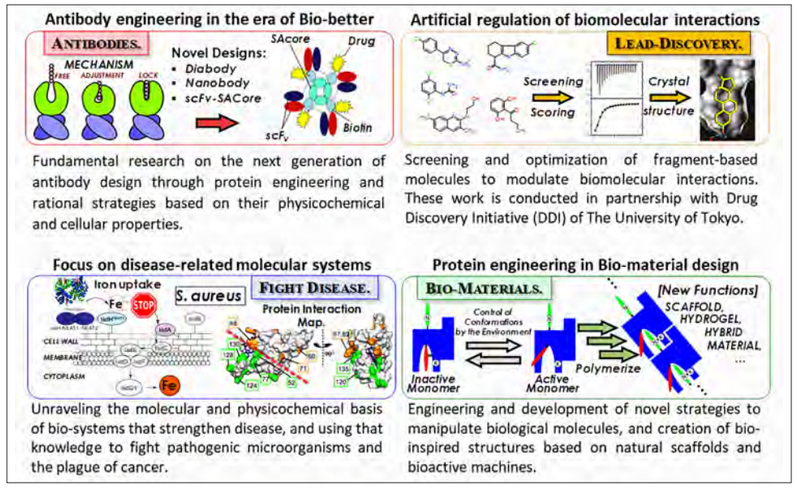
### Biophysical analyses, design, and manipulation of biomolecular Interactions

## Analyses, design, and manipulation of protein interactions

### Research Objective

Biological phenomena are based on highly organized and specific molecular interactions. We aim to dissect these biomolecular interactions using state-of-the-art methodologies, and to design ligands to control them. We also advance bio-medicine in the era of bio-better and bio-superior using multiple engineering approaches. Our methodologies are applied to the study of disease-related biological machineries and will stimulate the creation of safer and more efficient medications.

### Summary




Chemical bioengineering

Associate Professor

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[**Subjects of Research**]
- Roles of organelle interactions
- Investigation of neuronal ultrastructures
- Adult neurogenesis

[**Field of Study**]
Molecular Biology and Cell Biology

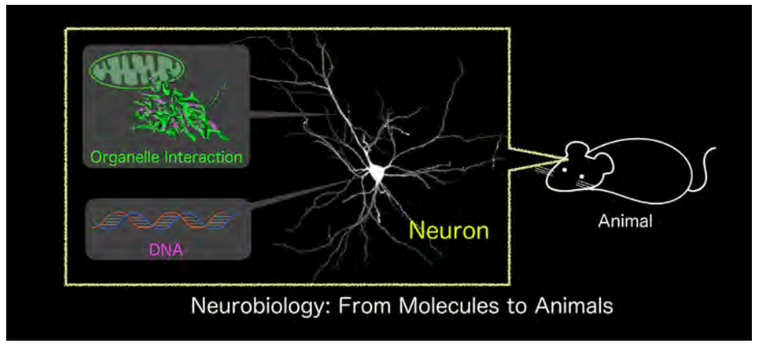
### Neurobiology

## From Molecules to Animals

### Research Objective

The nervous system regulates our mind and behavior. Precise regulation of each neuron and connections between neurons are required for proper functioning of the brain. Therefore, elucidating the mechanisms regulating brain function facilitates developing therapies for neurodevelopmental and neurodegenerative diseases such as Parkinson' s and Alzheimer' s disease. We study how neurons, the connections between neurons, and adult neurogenesis contribute to the functions of the nervous system, from the perspective of cell biology.

### Summary



Chemical bioengineering

Associate Professor

## Hironori HOJO

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[**Subjects of Research**]

- Understanding of epigenetic and gene expression dynamics in development and tissue repair
- Development of human organ modeling using human pluripotent stem cells
- Identification of drug candidates for skeletal formation and its application for skeletal regeneration
- Development of novel biomaterials for tissue engineering

[**Field of Study**]
Skeletal development and regeneration

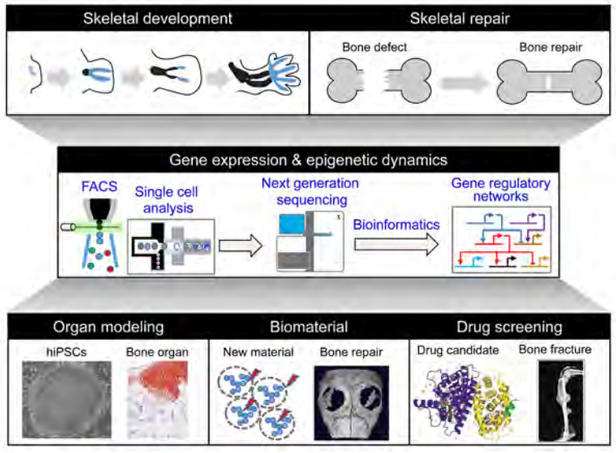
### Integrative studies of developmental biology, regenerative medicine and biomaterial

## Establishment of strategies for tissue engineering and disease therapy based on understanding of molecular mechanisms underlying skeletal development and repair

### Research Objective

We aim at identifying gene regulatory networks underlying skeletal development and repair by understanding those complex biological contexts from aspects of the cell lineage and epigenetic dynamics.
By utilizing the identified knowledge to integrate with modeling of human development and disease, novel biomaterials and drug screening system, we aim to establish strategies for skeletal tissue engineering and disease therapy.

### Summary




Chemical bioengineering

Project Associate Professor

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[**Subjects of Research**]

- Development of biophysical technology for antibody and small molecule drugs
- Design of high-potential biopharmaceuticals using in silico methodology

[**Field of Study**]
Medicinal Physicochemistry,
Protein Engineering,
Biochemistry

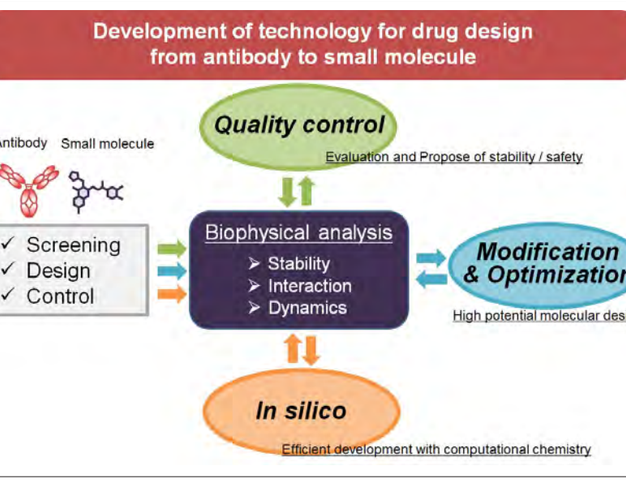
### Advanced Biopharmaceutical Science using Biophysical Technologies

## We propose and design the innovative biopharmaceuticals.

### Research Objective

Developments and improvements of technology for the discovery and optimization of high-potency antibodies have greatly increased to find the specific and stable antibody with desired biological properties. Biophysical analyses of therapeutic antibody, particularly those of protein interaction and stability, are recognized as one of the critical procedures in the development of biopharmaceuticals, which would be assessed as an essential step to develop next generation antibodies. We study biophysical analyses of various antibody to propose new strategy for development of the next generation antibody.

### Summary






Chemical bioengineering

Lecturer

## Daisuke KURODA

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[**Subjects of Research**]

- Computer-aided molecular design
- Development of information processing technologies for high-throughput experiments
- Computational protein engineering
- Immunoinformatics

[**Field of Study**]
Molecular design, Informatics,
Computational chemistry, Biophysics

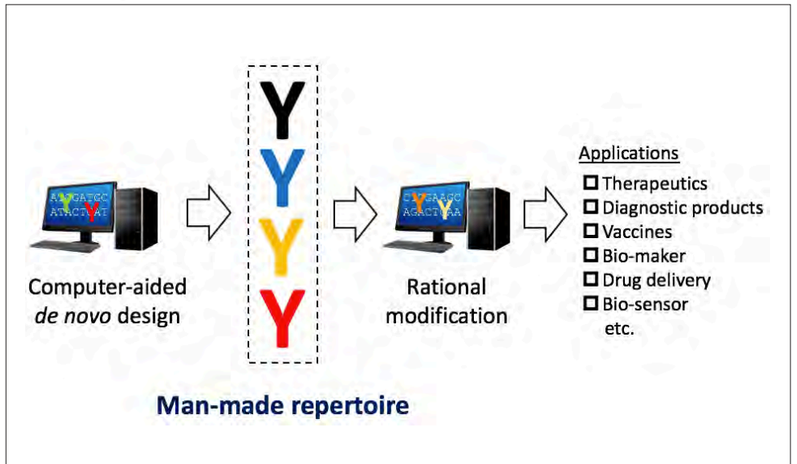
### Theory and practice of computer-aided molecular design

## Creating "real" molecules in computer

### Research Objective

Our main research interests are in computer-aided molecular design and its validation through wet-lab experiments. For design, we use molecular dynamics, Monte Carlo and quantum chemical methods to simulate structures and functions of macromolecules. For validation, we exploited protein engineering experiments, such as physicochemical measurements and X-ray crystallography. The experimental information will in turn lead to machine learning-based approaches for molecular design.

### Summary




Chemical bioengineering

Lecturer

## Makoto NAKAKIDO

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[**Subjects of Research**]

- Construction of a strategy to develop humanized single domain antibodies relying on in vitro selection
- Development of anti-bacterial therapeutics utilizing a variety of modality-based molecules
- Elucidation of the molecular mechanism by which extracellular tumor supressor proteins regulate signal transduction
- Elucidation and regulation of molecular transport system in brain relying on antibody engineering

[**Field of Study**]
Protein science,
Molecular medical engineering,
Molecular biological chemistry

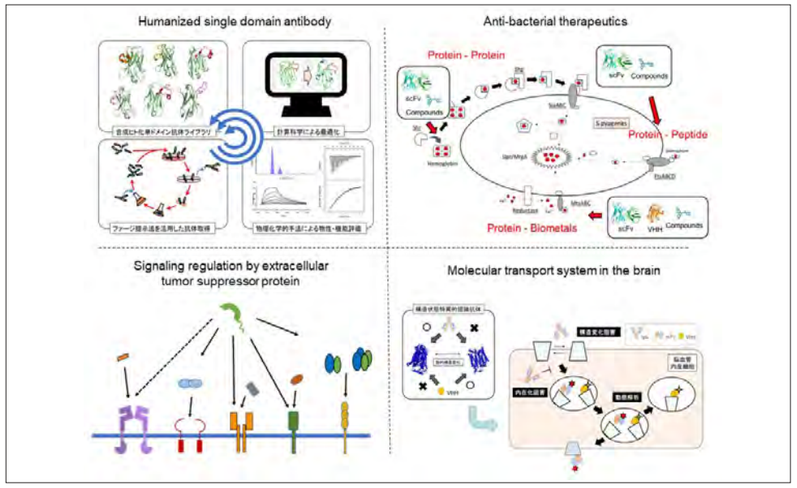
### Elucidation and regulation of biological system using a variety of modality-based molecules

## To elucidate and regulate biological systems and pathologies related to brain science using a variety of modality-based molecules

### Research Objective

Recently, modality-based drug discovery, which is based on appropriate selection of molecular species depending on molecular mechanisms of target diseases, have attracted increasing attention. Our research interests include development of novel stragtegy for modality-based drug discovery and elucidation of novel biology through understanding of molecular properties of target proteins. Our research is mainly relying on physicochemical approaches collaborating with other biological disciplines such as bacteriology, and aim to solve a variety of challenges in medicinal and / or biological research field.

### Summary



Biomaterials

Professor

## Takamasa SAKAI

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[**Subjects of Research**]

- Understanding of structure-property relationship of polymer gels
- Design of structural biomaterials using hydrogels
- Hydrogel scaffold for regenerative medicine

[**Field of Study**]
Biomaterials

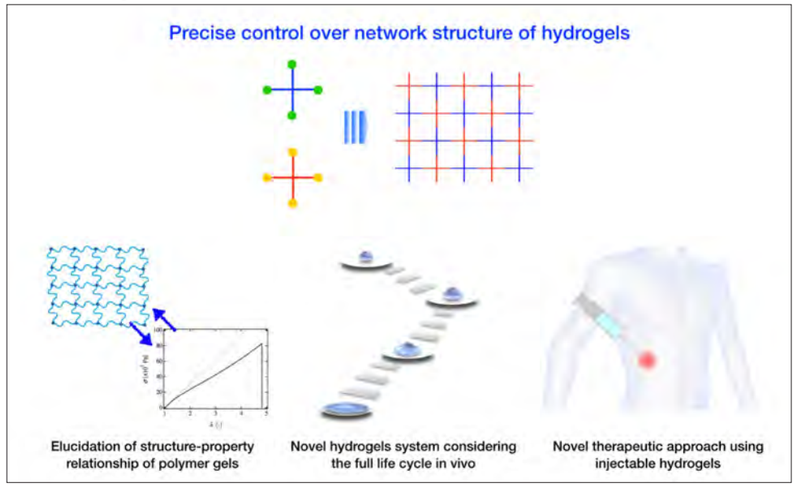
### Design and Fabrication of Hydrogels for Biomedical Application

## Next-generation hydrogels based on fundamental understanding

### ● Research Objective

Hydrogels are water-filled materials which have similar composition with that of living body. Owing to the similarity, hydrogels are promising candidates for biomaterials. We design and fabricate hydrogels with precisely controlled network structures, and attempt to develop novel hydrogels for biomedical application.

### ● Summary




Biomaterials

Professor

## Yuichi TEI/Ung-il CHUNG

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[**Subjects of Research**]

- Development of methods precisely controlling 3D shape of biomaterials
- Optimization of regenerative signals with novel monitoring systems and screening of signaling factors
- Integration of biomaterials with signaling factors for high performance

[**Field of Study**]
Biomaterials, Regenerative Medicine/
Tissue Engineering, Skeletal Biology

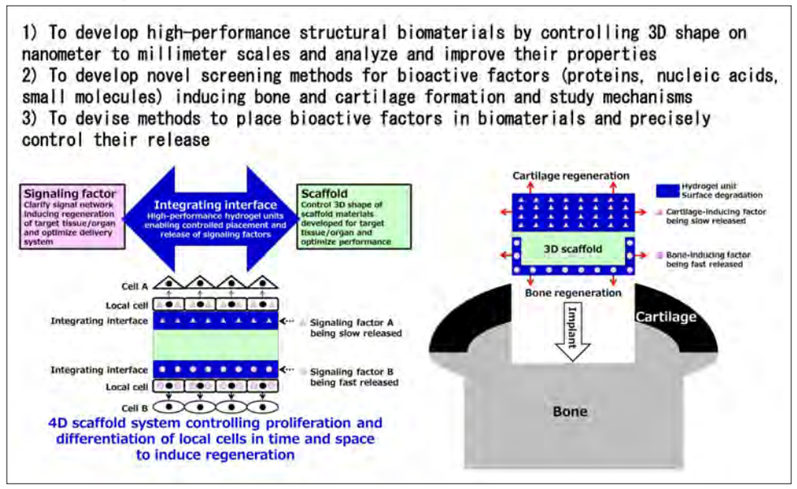
### Creation of innovative regenerative device integrating scaffolds and signaling factors

## Integration of life science and materials science

### ● Research Objective

Among the three pillars of tissue engineering/regenerative medicine, we focus on signals and scaffolds and try to integrate the two to create innovative implant devices, which locally act on host cells to induce regeneration.

### ● Summary






Biomaterials

Associate Professor

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[**Subjects of Research**]

- Polymeric micelles as drug delivery systems of anticancer drugs
- Tumor imaging and diagnosis
- Effect of cancer biology on nanomedicine

[**Field of Study**]
Nanomedicine

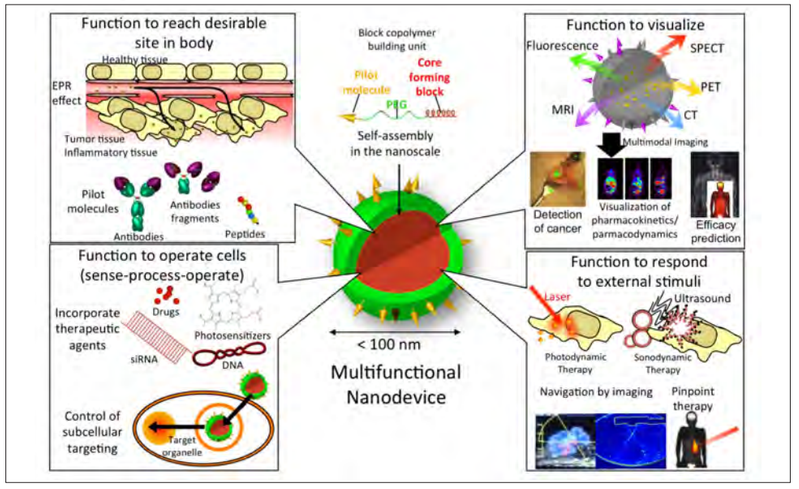
### Development of Multifunctional Nanodevices based on Functional Biomaterials for Safe and Effective Diagnosis and Therapies

## Nano-assembled structures toward safe and effective therapies

### ● Research Objective

For effective treatment of intractable diseases,drugs or genes need to be delivered to the aimed sites inside the body. Thus, it is essential to develop systems that performs diagnosis and treatments required when and where they are needed. By creating biocompatible multifunctional nanodevices based on the self-assembly of synthetic polymers, we are developing system capable of these functions.

### ● Summary




Biomaterials

Project Associate Professor

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[**Subjects of Research**]

- Development of functional self-assembly based on precise polymer synthesis technology
- Development of innovative therapeutic / diagnosis technology for intractable diseases

[**Field of Study**]
Drug Delivery System, Biomaterials,
Polymer Chemistry, Colloid and Interface
Science

### Development of innovative therapeutic / diagnostic technology for intractable diseases based on multifunctional polymer self-assembly

## Design and construction of smart materials for realizing the liberation from intractable disease

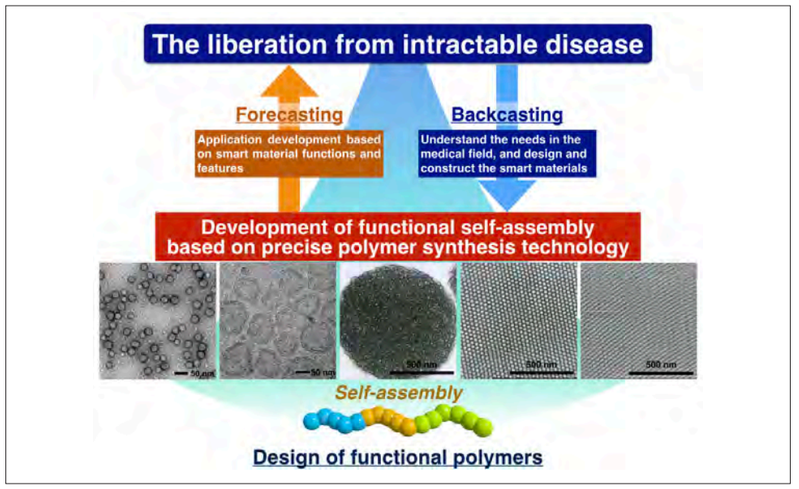
### ● Research Objective

In our research group, we designed a multifunctional polymer self-assembly whose building block is a polymer with secured safety in vivo, and for the therapies and early diagnosis of intractable diseases (such as Alzheimer's disease etc).We are researching with the following different approaches.

・Application development based on smart material functions and features (forecasting)

・Understand the needs in the medical field appropriately, and design and construct the smart materials (backcasting)

### ● Summary



Bioimaging

Professor

## Ichiro SAKUMA

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[**Subjects of Research**]
- Surgical Robotics
- Minimally Invasive Precision Guided Therapy
- Optical Mapping of Cardiac Excitation
- Cardiac Electrophysiology

[**Field of Study**]
Computer Aided Surgery, Bio-Instrumentation, Electrophysiology

# Integration of therapeutic and diagnostic system for safer and less invasive surgery

## Realize minimally invasive therapies by integration of treatment and diagnosis based on advanced engineering technologies

### Research Objective

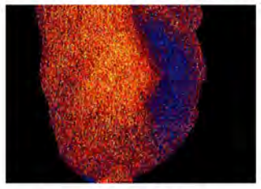
Our laboratory focuses on the biomedical applications, especially biomedical devices and systems based on mechatronics (a multidisciplinary field of electrical engineering and mechanical engineering). We are developing novel technologies such as a computer assisted surgical system for precision treatment, diagnostic method to visualize lesion, and navigation system for conducting advanced surgery. We are also doing basic research for investigating the response of biological cells, tissues and body by using precision measurements and manipulation techniques.

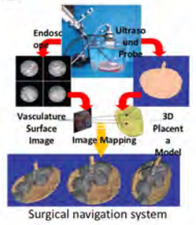
### Summary

***Purpose***

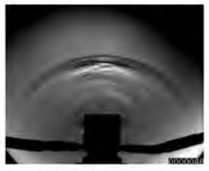
Our laboratory aims safer and less invasive surgery by novel surgical device, mechatronics for precise surgery, functional imaging of biological signals and surgical navigation systems.

Development of bone fracture model

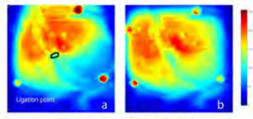

Analysis of arrhythmia by optical mapping system



Surgical navigation system


Application of shock wave


New actuator for minimally invasive surgery



Visualization of blood perfusion

Bioimaging

Professor

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[**Subjects of Research**]
- Quantum Radiation Imaging

[**Field of Study**]
Radiation Measurements and Imaging

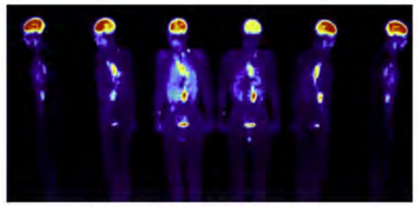
# Quantum Radiation Imaging for Biomedical Applications

## Function imaging with nuclear medicine and radiation imaging

### Research Objective

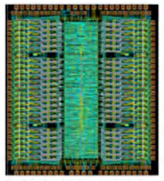
Positron emission tomography and other radiation imaging techniques provide biological functions and molecular information.
We are developing new sensor technologies and studying new imaging methods, which can be used for new cancer diagnostics and high resolution tracer imaging.

### Summary


Whole body PET imaging


FDG PET image


PET sensor and front-end electronics


ASIC design for PET applications


High-resolution PET



Bioimaging

Associate Professor

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[**Subjects of Research**]
- Development of the superconducting detector
- Pixel imaging using the superconducting electronics
- Micro fabricaion of electronics devices
- Radiation physics

[**Field of Study**]
Radiation Measurements, low temperature phsics, and micro fabrication

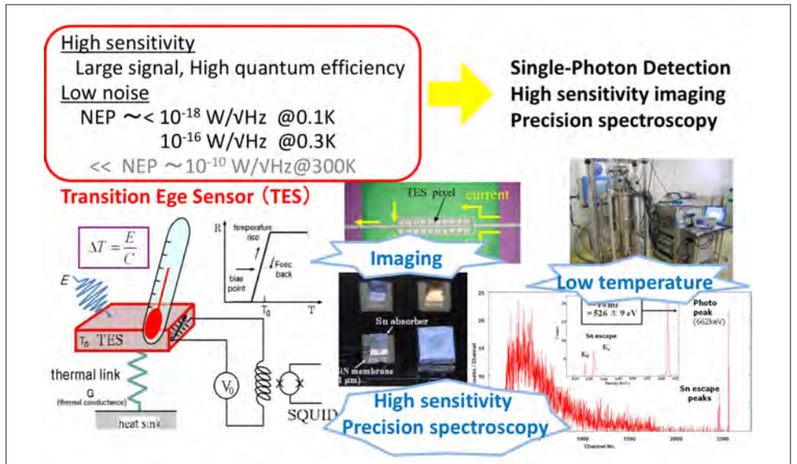
# Innovative superconducting detectors for Bio-imaging

## Innovative radiation / optical photon measurement method with ultra high sensitivity and high efficiency

### Research Objective

Superconducting device technology which uses the transition between the superconducting state and the normal state is expected as the very sensitive sensor and the low noise detector. Our goal is to realize a innovative high-energy-resolution spectroscopy for radiotherapy or material analysis, and also we will develop the ultra-high sensitive optical single photon sensor which can be applied to bio-imaging and bioanalysis.

### Summary




Bioimaging

Associate Professor

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[**Subjects of Research**]
- MRI measurement techniques for electrical properties and phenomena
- Magnetic stimulation of the brain
- Flexible thin-film devices for biosensing
- Magnetic prove for identifying sentinel lymph nodes

[**Field of Study**]
MRI, Magnetic Stimulation of the Brain, Biomagnetics, Applied Superconductivity

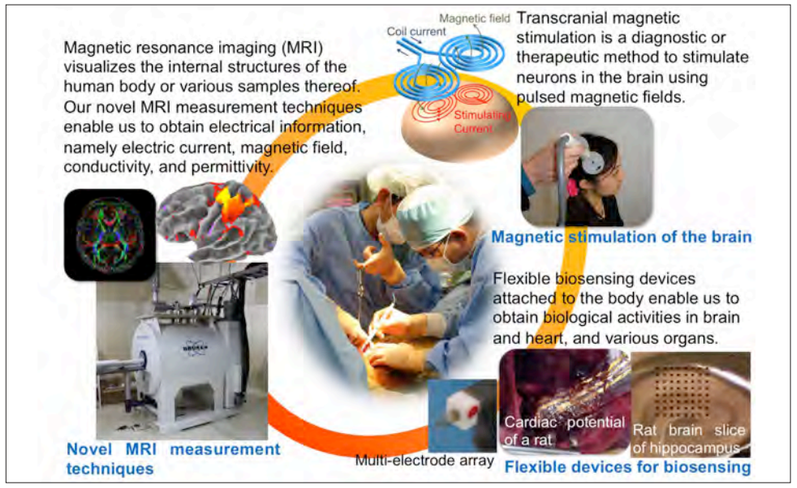
# Electromagnetic Imaging of Biological Bodies and Brain Stimulation

## Development of novel electromagnetic devices for medical applications

### Research Objective

Electromagnetic fields enable diagnosis of diseases at an early stage and non-invasive treatment of the diseases. Our group is developing compact and user-friendly medical equipment for use in patients' home, and flexible thin film devices which fit even the curved geometry of the brain surface.

### Summary



Bioimaging

Project Associate Professor
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**[Subjects of Research]**
- Biomedical functional molecular imaging in individuals
- Nuclear Medicine
- Medical Quantum Radiation imaging
- Detection technology and sensors for quantum radiation
- Research on integration of magnetic, RI and quantum technology

**[Field of Study]**
Quantum Imaging, Biomedical Imaging, Radiation Imaging

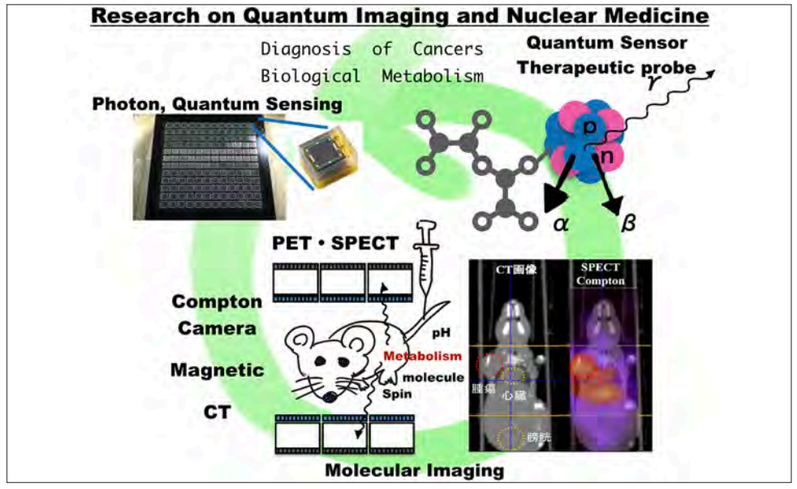
### Medical Quantum Radiation imaging to visualize molecular functions at individual level

## From quantum sensors to medical functional imaging

### ● Research Objective

CT (Computed Tomography), PET (Positron Emission Tomography) and SPECT (Single Photon Emission CT) are powerful medical quantum radiation imaging method providing precise morphological information and high-sensitive molecular functional information. Novel molecular/functional imaging technology at individual level are being developed for future accurate cancer diagnosis or prediction of diseases. New quantum sensors and combination with other modalities are also under development.

### ● Summary




Bioimaging

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**[Subjects of Research]**
- Dynamics of impulse propagation and rotational activity (rotor)
- Atrial Fibrillation and 3-Dimensional Scroll Wave
- Mechanisms of Ventricular Fibrillation (VF) and VF storm

**[Field of Study]**
Cardiac Electrophysiology, Cardiology

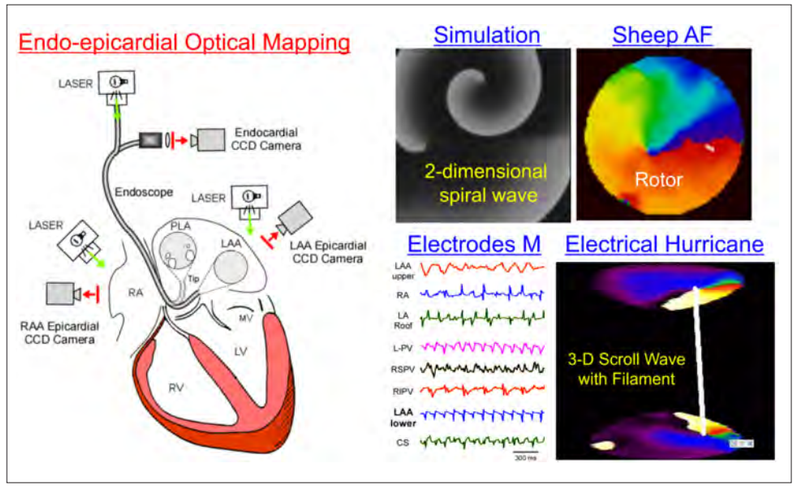
### Optical Mapping of Rotor as a Mechanism of Cardiac Fibrillation

## Establishment of a Novel Therapeutic Strategy for Cardiac Fibrillation

### ● Research Objective

Since about 100 years ago, many theoretical and experimental studies have suggested that rotor (a.k.a. 2-dimensional spiral wave reentry/3-d scroll wave) rotating around a functional obstacle, like hurricane and tornado, is the major mechanisms of cardiac fibrillation. Our objectives are first to explore spiral wave dynamics specifically in remodeled atria of chronic atrial fibrillation using high resolution optical mapping system and computer simulation; and second to examine how radio-frequency ablation of spiral wave effectively terminates and prevents cardiac fibrillation.

### ● Summary






Bioimaging

Lecturer
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**[Subjects of Research]**
- Development of photoacoustic techniques for treatment and diagnosis
- Visualization of acoustic interactions with cells and tissues
- Study on cellular response to fast mechanical stimulation
- Development of the world's fastest camera

**[Field of Study]**
Bioimaging,
Optical and Acoustical Engineering,
High-speed imaging

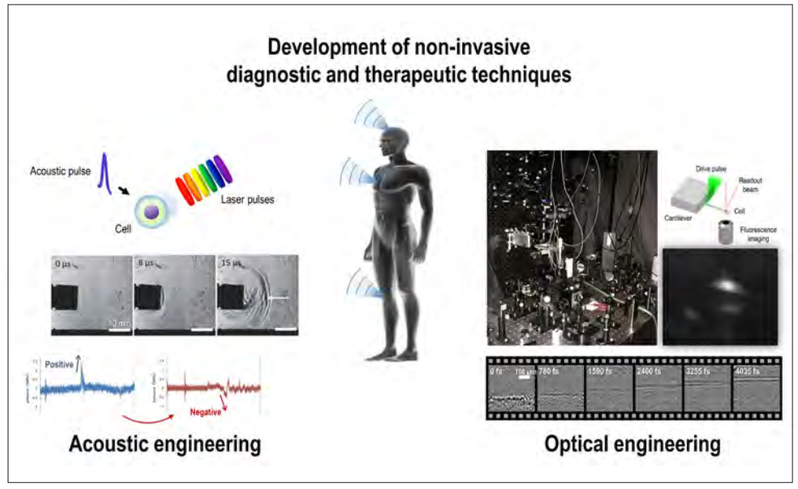
### Research on acoustic interactions within living bodies

## Open new avenues with innovative imaging technologies

### ● Research Objective

The main research interest in the Nakagawa group is to use acoustic wave as a tool to modulate the living body and cells. Based on acoustic engineering and optical engineering, we have proposed and demonstrated unique acoustic wave generators and wave modulators. We are also developing novel ultrafast imaging methods to reveal acoustic interactions with cells and tissues.

### ● Summary




Bioengineering

To all the students

# This Q & A describes frequently asked questions and answers.

## About admission

**Q** Do I have to possess the knowledge of basic subjects in biology such as molecular and cellular biology before taking the entrance examination?

**A** No, you don't. You can choose the subjects in the examination. Details are available in the guidelines of the entrance examination. You can learn research-related knowledge in the laboratory or from lectures after you enroll in the Department of Bioengineering.

**A** Since you can select the subjects to be tested, you can choose the questions which are related to your own research area. There will be more opportunities for you to learn the basic knowledge of biology after you enroll in the department. It won't be too late if you start then.

**Q** Is there any limitation or disadvantage if I am an examinee from another university or another department?

**A** No, your previous affiliation has no influence on admission.

**Q** Where can I find detailed information about each laboratory?

**A** You can find an introduction of professors online.
If you have any questions you can directly contact your prospective professor.

## About department and reseach

**Q** I've heard that one of the advantages of the Department of Bioengineering is the fusion of medicine and engineering. Is this accurate?

**A** Nowadays, it is necessary to solve problems considering both medical and engineering aspects in state-of-the-art medicine. Bioengineering is a discipline which integrates both subjects. See page 2.

**Q** Is it possible to study abroad while being a student here? Is there any support for that?

**A** Yes, but you have to follow necessary procedures.
You may apply at the office of the department after consulting with your supervisor about the study plan.
You can find information on exchange programs at the OICE.

**A** I have studied abroad for a short term through an exchange program.
I got sufficient financial support from the school, so I could focus on my research when studying abroad.

**Q** Are there any examples of joint research between industry and university?

**A** In the Department of Bioengineering, we are now promoting academic-industry collaboration. There is a lot of ongoing collaborative research with companies, including the following:

**Mathematical Engineering of Morality Emotions**
**Next Generation Medical Radiation Imaging**
**Voice Analysis and Measurement of Pathophysiology**

Besides, you can learn about the efforts we made to put our research into practical use and industrialization.

## About careers after graduation

**Q** What companies do students mainly work for after graduation?

**A** See page 10.

**Q** Is there any support or recommendation from the department for job hunting?

**A** You can obtain recommendations from the department. The details will be explained at the department's career guidance. Documents on recruitment information are also available in the department office, and you can browse them at any time. In addition, you can consult with the Career Support Office about your job hunting activities and career plans.