Invitation to Life Science and Technology

Tokyo Institute of Technology
School of Life Science and Technology

http://educ.titech.ac.jp/bio/eng/
Greetings from the Dean

Professor Hisakazu MIHARA, Dean

Invitation to the School of Life Science and Technology

The School of Life Science and Technology was founded in April 2016 by integrating the undergraduate and graduate schools and is dedicated to the study of bioscience and biotechnology. Our School encompasses approximately 70 research fields and 120 faculty members. Through our education program, which covers a wide spectrum of specialized fields of knowledge related to life science and technology, we aim to develop scientists and engineers who are capable of driving forward world-class research and development and innovative contributions to science and technology. At the undergraduate level, students are taught a broad foundational knowledge in specialized subjects, namely biology, chemistry, and physics. Students also prepare themselves to participate in cutting-edge research by completing independent research projects (graduation research). At the graduate level, two majors are offered: The Life Science and Technology Graduate Major focuses on study and research in advanced areas of the discipline. The interdisciplinary Human Centered Science and Biomedical Engineering Graduate Major integrates the life sciences with chemical science and engineering, materials science and engineering, mechanical engineering, electrical and electronic engineering, and information and communications engineering. In this globalized age, intercultural skills are key to forging a successful career, and we encourage our students to study abroad and acquire these skills.

Tokyo Tech was the first university in Japan to create schools dedicated to life sciences and technology. During their two decades of operation, the former undergraduate and graduate schools set precedents in both education and research. Graduates have established successful careers in various sectors and professions, with many graduates working as distinguished researchers and assuming leadership positions.

In accordance with Institute-wide efforts to globalize as a participating member of MEXT’s Top Global University Project, the School intends to raise its international standing and develop individuals who are capable of finding success in the world. Furthermore, the School will continue to admit outstanding international students through its International Graduate Programs, including its integrated master’s and doctoral course.

Finally, considerable research that focuses on the next generation of life sciences and technology has been and will continue to be conducted with outstanding results. The School launched the Life Science and Technology Open Innovation Hub (LiHub), which serves a hub of knowledge for innovation in the life sciences and integration with society and industry. We also closely cooperate with the Cell Biology Center, which is led by Honorary Professor Yoshinori Ohsumi (2016 Nobel Prize Laureate in Physiology or Medicine), to pursue education and research initiatives. The School is committed to leading the way in educational and research initiatives in the life sciences and technology.
Blending Life Science and Technology to Create Infinite Possibilities

Can you imagine how our society will change in the coming years? We can foresee the future as life science and technology progress together. Extensive research is being conducted at the School of Life Science and Technology, from exploring the principles of life to technological applications. Collective knowledge and skills in life science and technology offer infinite possibilities for our future society.

History of the School

1929 Foundation of the Tokyo Institute of Technology
June 1990 Foundation of the School of Bioscience and Biotechnology
April 1992 Foundation of the Graduate School of Bioscience and Biotechnology
Autumn 1993 Establishment of the Gene Research Center
March 1997 Establishment of the Research Center for Experimental Biology
1999 Reorganization of the Graduate School

Three new departments were opened in the graduate school: Department of Life Science, Department of Biological Information, and Department of Biomolecular Engineering. The undergraduate school was restructured into two departments: Department of Bioscience and Department of Biotechnology.

2000 The Department of Bioscience and the Department of Biotechnology in the graduate school were reorganized and renamed as the Department of Biological Sciences and the Department of Bioengineering, respectively.

2001 Construction of the Radiosotope Research Center
2003 Three research centers were merged to create the Center for Biological Resources and Informatics.
2016 Reorganization of the undergraduate and graduate schools as the School of Life Science and Technology
Roots of the School

Tokyo Tech successfully created vitamin B2 by hand for the first time, thereby making industrial production possible. In addition, a drug for improving liver function, Urso, and an antiviral drug, Arasena, were also synthesized at Tokyo Tech. Furthermore, a group of Tokyo Tech researchers discovered alkaline enzymes, which led to the development of enzyme-containing detergents. Based on this pioneering research, Tokyo Tech established the School of Bioscience and Biotechnology, which was Japan’s first interdisciplinary school of life science and technology.

The School of Life Science and Technology is advancing world-class research, developing various fields related to the life sciences, and delivering excellent results.

A Message from Yoshinori Ohsumi, Honorary Professor and 2016 Nobel Laureate in Physiology or Medicine

Science is a human activity that is built on a body of knowledge obtained over many generations. Therefore, it is impossible to separate scientists from the age in which they live. I am an example of this, having drawn inspiration from the scientific developments of my time and my own personal experiences to undertake my work on autophagy in yeast. While our understanding of the natural world continues to expand at a rapid pace, many mysteries remain unsolved. Many answers are in fact only the start of new questions. Rather than being captivated by the products of science and technology, I believe that the philosophy and broad perspective of science are more important than ever for the future of humanity.

My message for today’s young people is to always keep an eye on the future. To perceive great authority before you merely indicates academic stagnation. Progress is realized by preparing young people to challenge accepted norms and surpass their predecessors. Do not be intimidated by others, and have the courage to embrace and develop your interests without being distracted by the relentless volume of information that is characteristic of our age. Make sure you live a life you are happy with, and find your own way with passion and resilience.
Overview of Our Researches

School of Life Science and Technology

The School is actively engaged in a wide spectrum of research that covers the life sciences from the micro to the macro and from the basics to cutting-edge applications.

The School is composed of two majors, Life Science and Technology and Human Centered Science and Biomedical Engineering.
### Faculty Members List

#### Life Science and Technology

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<td>Kazushi Kinbara</td>
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<td>Hisakazu Mihara</td>
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<td>Satoshi Murakami</td>
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<td>Minoru Sakurai</td>
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<td>Hideya Yuasa</td>
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**Research Field**
- M: Molecule
- C: Cell
- T: Tissue, Organism

#### Human Centered Science and Biomedical Engineering

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<td>Susumu Kajiwara</td>
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<td>Kan Tanaka</td>
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<td>Hiroshi Ueda</td>
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<td>Naoyuki Yamamoto</td>
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**Associate Professor**
- Hiroyuki Akama      | T     | W9-614   | 23   |
- Sousuke Imamura    | T     | R1-816   | 23   |
- Shun-ichi Ishiuchi | M     | R1-316   | 20   |
- Tetsuya Kitaguchi  | C     | R1-616   | 22   |
- Eizo Miyashita     | T     | G3-1114  | 23   |
- Toshiaki Mori      | M     | B2-1121  | 21   |
- Shun-icho Ogura    | M     | B1-702   | 21   |
- Ken-ichi Watabayashi| C   | R1A-215  | 22   |

**Assistant Professor**
- Tetsuya Kadonosono | M     | B2-421A  | 21   |

### Facility Name
- **Suzukakedai Campus**
  - B1 Bldg.
  - B2 Bldg.
  - B-A (B1-B2 Annex A)
  - B-B (B1-B2 Annex B)
  - B-C (B1-B2 Annex C)
  - J2 Bldg.
  - J3 Bldg.
  - G1 Bldg.
  - G3 Bldg.
  - R1 Bldg.
  - R1A Bldg.
  - R2 Bldg.
  - S2 Bldg.

- **Ookayama Campus**
  - West Bldg. 3
  - West Bldg. 9

- **Suzukakedai Sta.**
- **Ookayama Sta.**
- **Midorigaoka Sta.**
- **Midorigaoka Area**
Faculty Members and Researches

Professor Yoshitaka Ishii
Structural biology of amyloid and molecular mechanism of Alzheimer’s
Our team is revealing functions and structures of misfolded amyloid proteins associated with Alzheimer’s and other diseases by solid-state NMR (SSNMR). Our research scope also includes NMR-based analysis of advanced nanomaterials such as modified graphenes.

Professor Kazushi Kinbara
Developing functional molecules inspired by biological systems
Inspired by the sophisticated biological systems, we are developing synthetic functional molecules which mimic or control biomacromolecules.

Professor Akio Kitao
Observing Biological Phenomena by Computer
We investigate molecular mechanisms of biological systems (proteins, nucleic acids, membrane, etc.) by cutting-edge computer simulation.

Professor Eiry Kobatake
Construction of super biofunctional protein materials
We have created various super biofunctional protein materials for controlling cellular functions and biosensing.

Professor Yuichi Kobayashi
Organic synthesis toward biologically active compounds
We study efficient synthesis of biologically active compounds. We are also focusing on developing new C-C bond forming reactions.
**Design of bio-functional and bio-conjugate materials**

Our research interests involve design of biofunctional materials capable of enhancing function of biopolymers and cells for nanomedicines, tissue engineering and diagnosis.

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**Peptide engineering and chemical biology**

We design and construct supramolecular systems composed of peptides, glycosides and proteins using peptide engineering techniques for chemical biology research.

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**Structure and molecular mechanism of membrane protein complex**

We seek to understand the molecular mechanism of key biological processes on the cell membrane and membrane proteins at the level of protein structure, dynamics and molecular biology.

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**Biophysical elucidation of biomolecular functions**

Theoretical and experimental elucidation of the structure-function relationships of biomolecules from the first principles of physical chemistry.

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**Elucidation of molecular mechanisms of chaperone and prion/amyloid**

We are studying molecular mechanism of chaperones and protein aggregates such as yeast prions/amyloids.
Faculty Members and Researches

Professor Takafumi Ueno
Development of artificial enzymes and biosupramolecular materials
Our interests are chemistry of protein assembly based on synthetic chemistry and structural biology to elucidate chemical reactions in living cells and develop biomaterials.

Professor Hirokazu Urabe
Organic chemistry – The area leading biosciences
Our projects are the development of new, economical, or environmentally benign organic reactions and their applications to the synthesis of bioactive compounds and pharmaceuticals.

Professor Hideya Yuasa
Photostimulants and photodynamic therapy of cancer
We are studying photodynamic therapy of cancer using up-conversion nanoparticles and photosensitizers we developed on our own.

Associate Professor Noriyuki Asakura
Bioelectrochemistry of proteins and hydrogen generation by photoinduced biological electron transfer
We are interested in understanding details of the important biological electron transfer. This provides precise control over enzyme reactions in direct electrochemical and photochemical studies.

Associate Professor Shinichiro Fuse
Natural product synthesis & micro-flow synthesis for drug discovery
We develop efficient synthetic methodology of bioactive natural products using micro-flow technology toward drug discovery.
Associate Professor
Takeshi Hata

Synthesis of bioactive compounds by sustainable molecular transformation

We are developing new sustainable synthetic methods for manipulation of organic molecules and also making natural products and pharmaceuticals by those methods.

Associate Professor
Nobuhiro Hayashi

Elucidation of something unknown of the life through high performance proteomics

Using original high sensitive and high throughput 2D-PAGE methodology, we are studying various basic, engineering or clinical researches.

Associate Professor
Tomoko Matsuda

Organic synthesis by enzymes

We have been using enzymes as a catalyst and CO₂ as a solvent for organic synthesis to promote green chemistry.

Associate Professor
Masayasu Mie

Development of biomolecular tools

We are trying to develop molecular tools consisting of biomolecules such as proteins and DNA for bioimaging, biosensing and regulation of cellular functions.

Associate Professor
Akihiro Ohkubo

Development of new nucleic acid drugs for gene therapy

We develop new bioactive molecules including nucleic acids drugs for accurate regulation of biochemical reactions (transcription, splicing, translation) based on organic chemistry.
Faculty Members and Researches

### Associate Professor Kohji Seio

**Keywords:** organic chemistry of nucleic acids, transcription regulation, nucleic acid drugs

**Nucleic acids chemistry for regulation of genetic information**

We are trying to establish novel methodologies to regulate nucleic acids related phenomenon, using organic chemistry, physical chemistry, biochemistry, and computational chemistry.

### Associate Professor Hiroshi Tatsuumi

**Keywords:** fluorescent probe, bioimaging, supramolecular chemistry, cell environment chemistry

**Control and Analysis of Cell Environment based on Chemical Biology**

We design and chemically synthesize supramolecular hydrogels and various fluorescent probes to control and analyze cellular function and cell environment.

### Professor Toshiaki Fukui

**Keywords:** bacteria/archaea, metabolic engineering, hyperthermophiles, bioplastic-producing bacteria

**Analyses and engineering of microbes for production of useful compounds**

Our lab is studying on analyses and metabolic engineering of microbes (especially hyperthermophiles, bioplastic-producing bacteria, and methylotrophs) aiming efficient production of useful compounds.

### Professor Takehiko Itoh

**Keywords:** genome informatics, chromosome dynamics

**Elucidation of biological phenomenon using NGS and bioinformatics**

We are studying biological phenomenon, using next generation sequencer and various computational bioinformatics techniques.

### Professor Hiroshi Iwasaki

**Keywords:** chromosome biology, homologous recombination, DNA repair, genome integrity

**Temporospatial regulation of chromosome dynamics**

We are studying the molecular basis that underlies temporospatial regulation of chromosome dynamics through various techniques. In particular, we focus on the process of homologous recombination and mating type switching in fission yeast.
**Professor Hiroshi Kimura**

**Assistant Professor Hidenori Nishihara**

**Yuko Sato**

**In vivo regulation of epigenetic dynamics**

To understand the mechanism of gene expression, we are investigating histone modification dynamics in living cells and organisms.

**Keywords:** epigenetics, cell nucleus, transcription, live cell imaging

**Chromatin, Gene expression**

![Localization of various histone modifications](image)

**Professor Masayuki Komada**

**Assistant Professor Toshiaki Fukushima**

**Regulation of cell proliferation by growth factor receptor downregulation**

We study how cell proliferation is regulated by growth factor receptor downregulation and how its impairment leads to tumorigenesis, with a focus on pituitary tumor causing Cushing’s disease.

**Keywords:** cancer, tumor, growth factor receptor, ubiquitin

**Cellular function**

![USP8 mutation in pituitary tumor in Cushing’s disease](image)

**Professor Satoshi Nakamura**

**Assistant Professor Kazuhioko Miyana**

**Extremophiles and extremozymes have limitless possibilities!**

We are doing researches on protein engineering of extremozymes (enzymes produced by extremophiles) and metabolic engineering of extremophiles for production of useful materials.

**Keywords:** protein engineering, metabolic engineering, extremophiles, extremozymes

**Microbiology**

![3D-structure of extremozymes](image)

**Professor Yasunori Tanji**

**Assistant Professor Kazuhioko Miyana**

**Characterization of bacteriophage and its application**

Bacteriophage is a virus specific to bacteria. We are investigating molecular mechanism of phage infection and its application for controlling pathogens.

**Keywords:** bacteriophage, microbiological corrosion, wastewater treatment

**Microbiology**

![Bacteriophage specific to S. aureus](image)

**Professor Makio Tokunaga**

**Assistant Professor Yuma Ito**

**Visualization and quantitation of cellular mechanisms**

Our goal is the understanding of cellular spatio-temporal dynamics and mechanisms, based on development of techniques in molecular imaging and quantification.

**Keywords:** single molecule, imaging and quantification, super-resolution, chromatin

**Cellular function**

![Three-dimensional multi-color imaging of signaling and transcription factor molecules in the cell nucleus](image)
Faculty Members and Researches

**Professor Masaaki Wachi**  
**Assistant Professor Noritaka Iwai**  
**Keywords**:  
*E. coli*, cell division, metabolism, antibiotics, *Corynebacterium glutamicum*  
**SEM image of C. glutamicum cells**  
**Microbiology**  
Regulatory mechanism of bacterial cell growth and metabolism  
We want to know how bacterial cells perform cellular metabolism, grow, and reproduce. Screening of new antibiotics is also carried out.

**Professor Yuki Yamaguchi**  
**Assistant Professor Satoshi Sakamoto**  
**Keywords**: gene expression, genome, drug development, chemical biology  
**Chromatin, Gene expression**  
Understanding and applying the machinery of life  
We are promoting both basic and applied research, focusing on control mechanisms of genome expression and chemical biology using small molecules.

**Associate Professor Yasunori Aizawa**  
**Keywords**: gene, human genome, microprotein, new proteome technologies  
**Genomics**  
Elucidation of sequence-function relationship in the human genome  
We apply various approaches of molecular and synthetic biology to elucidate significance of (1) polycistronic translation of human mRNAs and (2) introns and retroelements in the human genomic functions.

**Associate Professor Takashi Hirasawa**  
**Keywords**: applied microbiology, metabolic engineering, microbial cell factories, bioproduction  
**Microbiology**  
Metabolic engineering toward bioproduction of useful materials  
We are studying metabolic engineering of microorganisms for development of key technologies on rational design of microbial cell factories for production of useful materials.

**Associate Professor Masaki Kajikawa**  
**Keywords**: transposable element, retrotransposon, genome evolution, epigenetics  
**Chromatin, Gene expression**  
Are transposable elements alive?  
There are a huge number of transposable elements (TEs) in the genome of organisms. Our aim is to elucidate the amplification mechanism of TEs.
**Associate Professor Toshiaki Kamachi**

**Elucidation and application of metal ions in biological system**

We are studying transduction of light energy into chemical energy by metalloenzyme and elucidation of oxygen dynamics inside a single cell.

**Keywords** metalloenzyme, oxygen imaging, energy transduction

**Microbiology**

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**Associate Professor Fumi Kano**

**Cell-editing technology based on cell-resealing technique**

Kano lab is devoted to the development of “Cell-editing technology” to design functions and fate of cells by using “cell-resealing technique”, a novel method to introduce molecules into cells.

**Keywords** cell-resealing technique, cell editing/image analysis/human iPScells

**Cellular function**

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**Associate Professor Akira Kato**

**Epithelial mechanisms responsible for environmental adaptation**

We compare expressions and functions of transporters in various epithelial cell types (kidney, intestine, etc.) among freshwater fishes, seawater fishes, and terrestrial animals.

**Keywords** electrophysiology, molecular physiology, cell biology, comparative genomics

**Cellular function**

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**Associate Professor Shinji Masuda**

**Elucidation of regulatory mechanisms of photosynthesis, chloroplast, and photoreceptor functions**

We are studying molecular mechanisms of how photosynthetic organisms sense and respond to light quality and quantity to control photosynthesis.

**Keywords** photoreceptor, chloroplast, photosynthesis, photo-oxidative stress

**Photobiology**

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**Associate Professor Nobuhiro Nakamura**

**Regulatory mechanism of cell and tissue shape and function**

Our research is focusing on the signaling mediators, such as receptors, that regulate the cell and tissue architecture and function and the pathogenesis of related diseases.

**Keywords** receptor, signal transduction, knockout mice, ubiquitin

**Cellular function**

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Faculty Members and Researches

Associate Professor
Hitoshi Nakatogawa

Elucidation of molecular mechanisms and physiological roles of autophagy
We are studying molecular basis and physiological functions of autophagy (self-eating), an intracellular bulk degradation/recycling system, using various techniques.

Keywords: yeast, organelles, membrane dynamics, starvation/stress response
Cellular function: Electron and fluorescence microscopy of yeast cells

Associate Professor
Nobuaki Shiraki

Elucidation of the role of amino acid metabolism in stem cell differentiation
We are studying the role of amino acid metabolism in maintenance and differentiation of stem cells and its application for ES/IPS cell endoderm differentiation.

Keywords: ES cells, IPS cells, amino acid metabolism, cell differentiation
Cellular function: Methionine deprivation induced cell death only in undifferentiated cells (Green: undifferentiated stem cells, Red: endoderm cells)

Associate Professor
Takuji Yamada

Big data for human gut microbiome
We are studying molecular basis and metabolic functions of human gut or skin microbiome, using genomics, metagenomics and bioinformatics.

Keywords: gut microbiome, metagenome, metabolic pathway, bioinformatics
Bioinformatics, Synthetic biology: Data for human gut microbiomes

Associate Professor
Rie Yatsunami

Extremophiles and extreomozymes have limitless possibilities!
We are doing researches on metabolic engineering of extremely halophilic archaeon *Haloarcula japonica* for production of useful materials.

Keywords: protein engineering, metabolic engineering, extremophiles, extremozymes
Microbiology: AFM image of triangular disk-shaped halophilic archaeon

Professor
Yuichi Hongoh
Assistant Professor
Hirokazu Kuwahara

Molecular ecology and genome evolution of symbiotic systems
We are aiming to decipher symbiotic mechanisms between microbes and animals such as termites, and among the microbes. We use interdisciplinary approaches: from filed studies to single-cell genomics.

Keywords: symbiosis, insect gut microbes, single-cell genomics
Microbial Ecology: Termite-gut protists and their symbiotic bacteria
Professor Hiroshi Ichinose
Assistant Professor Satoshi Hara

Patho-physiology of neuro-psychiatric disorders in relation to monoamines

We are studying the regulatory mechanism of brain function by monoamines and by tetrahydrobiopterin in order to develop novel drugs and diagnostic tools.

Keywords: dopamine, Parkinson’s disease, developmental disorders

Conditional knock-out of the tyrosine hydroxylase gene by AAV-Cre

Professor Shoen Kume
Assistant Professor Daisuke Sakano

Modeling organ development and homeostasis using human iPS cells

We are using human iPS cells to study the mechanism underlying organ development, differentiation, homeostasis, aiming for drug development and regenerative medicine.

Keywords: stem cell, development & differentiation, drug development, regeneration

ES/iPS cell-derived differentiated cells of the pancreatic, hepatic and intestinal cells

Professor Hiroyuki Ohta
Assistant Professor Koichi Hori

Stress responses and oil production in microalgae, Plant colonization of land

We are studying mechanism of stress responses of microalgae, particularly focusing on oil accumulation under nutrient starvation. We are also studying primary mechanisms for adaptation of plants on terrestrial condition, utilizing a chyrophytic alga, Klebsormidium flaccidum as a model organism.

Keywords: microalgae, plants, stress response, oil, bioenergy

Oleaginous alga Nannochloropsis

Studies on colonization of land by plants How plant colonized land?

Associate Professor Junji Hirot a
Assistant Professor Ayumi Nagashima

Molecular neuroscience of a sense of smell

Our laboratory studies on molecular mechanisms underlying the fate determination of olfactory sensory neurons, using mouse genetics and imaging techniques.

Keywords: olfaction, chemical sense, neuronal differentiation, genome engineering

Visualization of neurons in the main olfactory epithelium

Artificial chromosome & genome editing

Associate Professor Atsushi Kawakami

Cellular and molecular mechanism of tissue regeneration

Multi-cellular organisms maintain their lives by regenerating damaged cells and tissues. In particular, fish retain high regeneration ability and regenerate fins, heart muscles, many internal organs, and even brain. We are tackling the mystery of tissues regeneration and homeostasis using zebrafish as a model.

Keywords: regenerative biology, zebrafish, stem cell, tissue homeostasis

Analyses by transgenic imaging, cell lineage tracing, manipulation of molecular signals

Neurology

Life Science and Technology

Molecule

Cell

Tissue

Organism
### Associate Professor Masato Nikaido
**Understanding the molecular mechanism of adaptive and parallel evolution**

We are comparing the genomes of various animals to understand molecular mechanisms that generate biological diversity. We mainly focus on cichlids, ancient fish and hedgehogs.

**Keywords**: evolutionary biology, pheromone, cichlids, mammals

**Evolution, Ecology**

![Parallel evolution from hairs to spines (hedgehogs and tenrecs)](image)

**Enlarged lip (cichlids)**

### Associate Professor Toshiya Osada
**Development of olfactory receptors based chemical sensor**

We have developed a chemical sensor using olfactory receptors that are expressed in fission yeast through the endogenous GPCR pathway.

**Keywords**: olfactory receptor, pheromone, fission yeast, sensor

**Neuroscience**

![The ligand assay](image)

### Associate Professor Mie Shimojima
**Physiological role of lipid remodeling in plants**

We are studying molecular mechanism and physiological function of plant lipid remodeling (membrane lipids, storage lipids, and surface lipids) in response to environmental stress.

**Keywords**: plant, lipid, oil, stress response

**Plant**

![Lack of phosphate (Pi) starvation-induced lipid remodeling increases tolerance to drought stress](image)

### Associate Professor Takashi Suzuki
**Neuronal circuit formation and its plasticity**

Our research goal is to elucidate the molecular mechanisms underlying neuronal circuit formation and function by means of molecular genetics.

**Keywords**: brain, neuron, activity dependent plasticity, cell-cell communication

**Neuroscience**

![Fluorescence microscopy of the Drosophila visual system](image)

### Associate Professor Kazunori Tachibana
**Elucidation of molecular mechanisms of spawning in jellyfish**

We are studying molecular basis and physiological regulations of jellyfish spawning in laboratory and field.

**Keywords**: jellyfish, spawning, photoperiodism

**Chronobiology**

![Jellyfish (Cladonema pacificum) and its polyp](image)
Associate Professor
Yoh-ichi Tagawa

*in vitro* living models for animal experiment alternatives and pre-clinical studies

We are developing culture systems of ES/IPS cell-derived tissues/organs on micro-fluidic devices closing livings (mouse or human).

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Associate Professor
Mikiko Tanaka

Evolutionary developmental biology

Developmental basis of the evolution of vertebrate morphology

We are exploring the developmental and molecular mechanisms of how morphology of vertebrates have evolved.
Faculty Members and Researches

Professor
Masaaki Fujii
Assistant Professor
Mitsuhiko Miyazaki

Structure and dynamics of molecules and clusters studied by advanced multicolor laser spectroscopy

We are developing new multi-color laser spectroscopy and studying molecular recognition mechanism of neurotransmitters and revealing chemical reaction mechanism in solvated clusters.

Professor
Hiroyuki Nakamura
Assistant Professor
Shinichi Sato

Elucidation of biological functions and drug development by organic synthesis

We are developing new drugs for cancer therapy and new methodology for chemical biology based on synthetic organic chemistry.

Professor
Nobuhiro Nishiyama
Assistant Professor
Hiroyasu Takemoto
Takahiro Nomoto

Development of smart nanomedicine based on polymer nanotechnology

We are developing synthetic polymer-based nanomedicines towards realization of future medicine such as treatment of intractable diseases including cancers and diagnostic imaging.

Professor
Hiroshi Ueda
Assistant Professor
Yuki Ohmuro-Matsuyama

Creation of novel biosystems by antibody/enzyme engineering

We are trying to create superior detection/diagnosis/therapy systems by transforming natural functional proteins to better ones for human beings.

Associate Professor
Shun-ichi Ishiiuchi

Novel structural analysis method for biomolecules by combining mass and laser spectroscopy

We are developing a new spectroscopic technique to interrogate the molecular structures associated with molecular recognitions of small drug molecules.
Associate Professor
Toshiaki Mori

Interaction analyses of glycoconjugate on cell surface and its application for medical engineering

We investigate the interaction analyses of glycoconjugates on cell surface at single molecule level and aim at the preparation of biomedical materials.

Associate Professor
Shun-ichi Ogura

Development of new biochemistry for medical applications

We develop the new biochemistry based on the analysis of metabolite from human and aim for the medical applications including cancer.

Assistant Professor
Tetsuya Kadonosono

Novel biopharmaceuticals for molecular target therapy of cancer

We are establishing a novel technology for creating high-performance biopharmaceuticals for cancer therapy. We are also aiming to identify novel cancer therapeutic targets.

Professor
Toru Hisabori

Elucidation of energy conversion and redox regulation mechanisms of photosynthetic organisms

We are focusing on bioenergetics and redox-regulation mechanism of photosynthetic organisms, and the development of application using these basic knowledges.

Professor
Susumu Kajiwara

Molecular mechanisms of microbial infection, development of antimicrobial drugs & design of resource recycle system

We study about applied biochemistry and molecular microbiology for medical care and environmental conservation (notably, infection, drug resistance, host response, renewal resources).
Faculty Members and Researches

Professor Kan Tanaka
Assistant Professor Yuki Kobayashi

From understanding to design of cell systems

Our researches focus on fundamental architects of both prokaryotic and eukaryotic cells, destined for remodeling and design of cell systems.

Keywords: photosynthesis, metabolism, gene expression, symbiosis/evolution

Researches on unicellular model microorganisms

Professor Naoyuki Yamamoto

Sensing molecules and these roles in host-bacterial communications

We are trying to find novel molecules displayed on gut surface which can sense to intestinal bacteria and elucidate the role in host response.

Keywords: microflora, host-bacterial communication, host response, sensing

Host-bacterial communication

Associate Professor Tetsuya Kitaguchi

Development of genetically-encoded biosensors

We are developing tools for an optical microscope to visualize the dynamics of intracellular molecules in living cells, tissues and whole animal bodies.

Keywords: GFP, bioimaging, cell signaling

Cellular function

Associate Professor Ken-ichi Wakabayashi

Mechanisms of flagellar motility and photomovement of green algae

We are studying regulatory mechanisms of eukaryotic flagellar motility, through the analyses of photomovement of green algae (Chlamydomonas and Volvox).

Keywords: flagella, cilia, photomovement, green alga

Cellular function

Cross-section of flagellum ("9+2" structure)

Professor Shinae Kondoh
Assistant Professor Takahiro Kuchimaru


We are aiming at developing novel drugs and diagnostic agents for hypoxic cancers. We are also establishing a novel technology for creating highly target-specific peptide drugs.

Keywords: tumor hypoxia, HIF, in vivo optical imaging, drug development

Innovative biopharmaceuticals development

Cancer treatment, Imaging

Visualization of cancers with an optical imaging probe
Associate Professor
Hiroyuki Akama

Elucidation of the neural system of human brain by MRI
We are exploring the neural system of human brain by using techniques of fMRI with machine learning (Multi-voxel pattern analysis) and graph-theoretical analysis.

Keywords: brain imaging (fMRI), machine learning (MVPA), complex networks

Distributed neural patterns
MVPA Accuracy functions

Associate Professor
Sousuke Imamura

Elucidation of molecular mechanisms of plant environmental adaptation
We are studying fundamental molecular mechanisms of environmental responses of plants, especially nutrient signaling pathway, using microalgae.

Keywords: environmental response, microalgae, nitrogen metabolism, biomass production, TOR kinase

TOR-inactivation results in oil accumulation (right picture)
(Green: neutral lipid)

Microalgal culture

Associate Professor
Eizo Miyashita

Explore the brain to understand adaptive control mechanisms of the arm
Repeating a verification experiment based on a working hypothesis, we are trying to understand the brain that is called the last frontier around us. Experimental data are collected in multiple levels from behavior to neurons.

Keywords: brain science, neuroscience, motor learning, brain machine interface

Measuring brain activity during task performance

BMI as a medical application

(Other Professor)
Masayuki Yamamura: Computational modeling collective function and morphogenesis
Yasuko Yanagida: Device innovation by MEMS and biotechnology

(Assistant Professors)
Kimitoshi Denda: Molecular physiology of cell growth and development during embryogenesis
Hiroshi Ikeda: Biomimetic materials science
Keiji Inohaya: Bone formation and development
Shuji Kanamaru: Structural study of assembly and infection of phages
Shinya Kaneko: Nobel genome technology, Fruiting-body formation of mushroom
Eiichi Okumura: Cell cycle control and signal transduction
Takao Sato: Protein structure analysis and elucidation of mechanism
Masaki Tamori: Physiology and morphology of echinoderms
Toshiaki Tanaka: Regulatory mechanisms of cell proliferation via ECM
The Center for Biological Resources and Informatics (Bio-Center) was established in 2003 as a facility for performing genetic and animal experiments by merging the Gene Research Center (established in 1989), Research Center for Experimental Biology (established in 1994), and Radioisotope Research Center (established in 2001). In 2011, the Radioisotope Division was separated from the Bio-Center and renamed as the Radiation Research and Management Center. The new Bio-Center consists of 5 sections: Gene Experiments, Experimental Biology, Protein Informatics, Genome Informatics, and RNA Informatics. The Gene Experiments and Experimental Biology sections mainly 1) provide education, training, and safety management on recombinant DNA and experimental animals, 2) provide technical support and maintenance of the core equipment, and 3) maintain the animal and plant facilities. The main mission of the sections of Protein Informatics, Genome Informatics, and RNA Informatics is to perform leading-edge bioinformatics research on proteins, DNA, and RNA in the post-sequencing era.

Animal Facilities
1) Maintain and manage animal facilities
2) Provide equipment for animal experiments
3) Facilitate higher research and education

Rabbit, guinea pig, mouse, rat
Freshwater organisms (zebrafish, medaka, Xenopus frog, etc.)
Seawater organisms (puffer fish, starfish etc.)
Provide services for mouse germ cell operations
(in vitro fertilization, embryo/spERM freezing, transplantation)

Safety Management
1) Provides safety management and education for recombinant DNA experiments at the Tokyo Institute of Technology
2) Provides equipment for molecular biology experiments
3) Provides innovative technologies for genetic research
4) Provides research and education of proteins and genes using computer simulation

Core Equipment Service
- Microscope systems (confocal microscopes, light microscopes, zoom microscopes etc.)
- Electron microscope
- Scanning electron microscope
- Cryostat
- Spectrophotofluorometer etc.

Shinji Masuda, Associate Professor
Junji Hirotaka, Associate Professor
Minoru Sakurai, Professor
Kazunori Tachibana, Associate Professor
Akira Kato, Associate Professor
Center for Cell Biology

Led by Honorary Professor Yoshinori Ohsumi, the 2016 Nobel Prize laureate in Physiology or Medicine, the Cell Biology Center is a new consortium that will unite a diverse range of investigators from basic to applied science backgrounds. This center aims to investigate the structure and function of cells—the basic units of life—by observing molecular mechanisms and by manipulating cells with cell editing and cytoarchitectural techniques. The findings will be used to create cells with unique functions. Through these interdependent investigations, the center will elucidate the fundamental principles of cells through world-class research and state-of-the-art techniques and ultimately contribute to next generation of cell engineering, human health, and disease treatment.

Location: Suzukakedai Campus, S2 Building


**Honorary Professor**

**Yoshinori Ohsumi**

**Keywords**

yeast, autophagy, vacuole, starvation, growth control

**Comprehensive studies of physiological roles of autophagy in yeast**

We try to understand the induction mechanism and various modes of autophagy under various conditions. By biochemical analysis we have been studying degradation process of protein and RNA via autophagy and selective targets of autophagy.

**Cellular Function**

Autophagosome by microscopy

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**Life Science and Technology Open Innovation Hub (LiHub)**

The Life Science and Technology Open Innovation Hub (LiHub) was established in 2016 with the goal of building up a new academic style for Open Innovation by accelerating collaborations between our faculty members and industrial communities. Our School is one of the largest academic organizations in life science and technology field in Japan, including 75 research laboratories, which covers a wide range of bio-related disciplines.

By taking this strong advantage, LiHub serves as interfaces for companies and/or public sectors that need expertise of life science and biotechnology for their business and social activities. LiHub arranges communication, discussion and collaborations with faculty members who meet requests from companies and/or public sectors. In LiHub, there are 11 research groups that have already created communities for smooth academia-industry interactions, each of which is composed of 6-12 members of our faculties and specialized by one particular cutting-edge field such as healthcare industry, biomaterial, brain-environment interface, drug development, and synthetic biology. New more LiHub research groups will be created upon companies and/or public sectors’ requests.

For more information, visit the LiHub website (or search with the keyword, "LiHub"): http://www1.bio.titech.ac.jp/lihub/index.html

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**Open Research Facilities for Life Science and Technology**

Our school operates the Open Research Facilities for Life Science and Technology, which consists of the Shimadzu Corporation Precision Analytical Instruments Room, cell and protein analysis facility, ultracentrifuge facility, cold room, bioimaging facility, aquatic animal laboratory, biomolecular analysis facility, microbial culture room, and shared laboratory and office spaces. These facilities and spaces are provided to support research and education in the life sciences and technology at Tokyo Tech. We envision that these facilities will provide opportunities for active collaboration among scientists, students, and technical staff members.

In a collaboration between Tokyo Tech and the Shimadzu Corporation, The Shimadzu Corporation Precision Analytical Instruments Room was established in 2017. This is a unique attempt to enhance research activities at Tokyo Tech by using the instruments and knowledge of the Shimadzu Corporation. This room contains advanced bioanalytical instruments, including mass spectrometry and microchip electrophoresis systems, that were donated by or purchased from the Shimadzu Corporation. We often hold orientation sessions for new users, as well as open workshops and demonstrations for new instruments.

**The Shimadzu Corporation Precision Analytical Instruments Room**
Fostering Global Leaders

Interdisciplinary Interactions Encompassing Science, Engineering, Pharmacology, Agriculture, Medical Science, Computer Science, and Systems Engineering

The School of Life Science and Technology offers a fulfilling curriculum that encourages students to become leaders in a variety of fields. The curriculum enables students to systematically acquire the foundational knowledge and expertise in life science and technology. Furthermore, students can obtain an advanced education in a cutting-edge research environment. Our variety of international programs and internships is also emphasized.

Undergraduate study

The largest education and research organization for life science and technology in Japan

The School of Life Science and Technology is one of the largest undergraduate life science programs in Japan. Students can study the life sciences from polyphenic perspectives, including science, engineering, pharmacology, medicine, and agriculture.

Creative experiences from the first year

In their first year, students take part in a challenging active learning program in which they create educational materials related to the life sciences. Critical thinking and problem-solving skills are developed through collaborative work.

Study abroad and internship opportunities

A set of well-established international exchange programs and short-term study programs are available, and undergraduate students are encouraged to use these programs to study overseas. Internships at companies are also encouraged, and credit is given for these activities.

Early enrollment in graduate-level classes

Because most students continue their studies at the graduate level, the School allows students to take graduate-level classes while they are undergraduates. Talented eligible students can also graduate early.
Graduate study

Cutting-edge research extends to chemistry, physics, materials science, and computer science

A wide range of cutting-edge research is led by approximately 70 professors and associate professors. The research fields are not limited to biology but also extend to other fields related to chemistry, physics, materials science, and computer science.

Research in an international environment

We welcome many outstanding researchers from abroad to visit and participate in research initiatives and seminars. Many of our laboratories have international students. There is an international atmosphere across the campus. Students are encouraged to attend conferences and internships abroad using the school’s study abroad programs. Credit is also given for these activities.

Broad and diverse studies lead to employment in a variety of fields

Studies at the School of Life Science and Technology are related not only to scientific fields such as biology, chemistry, and physics but also engineering fields such as applied chemistry, materials, mechanical engineering, and computer science. Our alumni work in a variety of companies in different fields.
Pursuing New Forms of

Our new curriculum allows smooth transitions between degree programs. At the undergraduate level, students acquire basic knowledge in life science and technology by their third year and prepare themselves to participate in cutting-edge research by conducting the Independent Research Project (graduation research) in their final year.
Learning

-Quarter system

Our curriculum uses a quarter system in which each year is divided into quarters. The system allows flexible course planning and makes it easier for students to study abroad and complete internships.

<table>
<thead>
<tr>
<th>5th Year</th>
<th>6th Year</th>
<th>7th Year</th>
<th>8th Year</th>
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<td>Master's Major Courses</td>
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<tr>
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<td>Human Centered Science and Biomedical Engineering Graduate Major</td>
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Master's Degree Program

Perform in-depth research in laboratories with a wide research scope
Develop presentation skills by participating in international conferences
★ Progress is measured by the student’s level of achievement. Those who have attained a sufficiently high level may take more-advanced courses.

Doctoral Degree Program

Completion of a doctorate opens up a wide range of opportunities and allows graduates to take on leadership roles in variety of fields

Master's Degree Program

Learn by engaging in cutting-edge research

By joining a laboratory and conducting cutting-edge research, students gain a deeper understanding of their field and develop scientific skills.

Doctoral Degree Program

Make an impact in the future of the life sciences

Advanced doctoral research provides opportunities for students to take an active part in the fields of life science and technology both inside and outside of Japan.

For additional details of the support options available to students at Tokyo Tech (tuition fee exemptions, scholarships, dormitory options, employment opportunities, etc.), please visit our website at http://www.bio.titech.ac.jp/outline/disclosure/stu_support.pdf
Student Work and Activities

The fast-growing fields of life science and biotechnology seek internationally active individuals who are able to open up a new era. By creating an independent study environment, the School of Life Science and Technology supports a variety of activities in which students take initiative and proactively communicate with other students and researchers around the world.

Team Tokyo Tech wins another gold medal at iGEM

Approximately 200 teams of students from around the world participate in International Genetically Engineered Machine (iGEM), an international competition in synthesis biology. Team Tokyo Tech, which mainly consisted of students from the School of Life Science and Technology, extended its record by winning its 11th consecutive gold medal.

Tokyo Tech BioCon

First-year students at the School of Life Science and Technology develop educational materials that are used to teach elementary school students biotechnology-related topics. At the end of the course, they present their materials at BioCon, the Institute’s contest where students showcase the teaching materials that they have developed.

Looking to the future of life science with world-famous researchers

With the hope of becoming world-class investigators, undergraduate and graduate students as well as young researchers can enrich their perspectives through participation in Bioscience and Biotechnology International Symposia and Top Leaders Forums where they can meet superb academics from home and abroad.

Join workshops and training seminars abroad

Tokyo Tech offers students the opportunity to attend overseas workshops and training seminars in order to foster global leadership.
Exposure to cross-cultural environments while studying abroad

International internships are among the many ways in which students have the opportunity to visit universities and research institutes abroad. These programs aim to develop human resources in the field of life science and individuals capable of playing an active role in the world.

News

Students talk about their life in the lab

Shinya Suzuki  doctoral student

Tokyo Tech is a place abound with opportunities, where students can take small but definite steps in pursuit of possibilities. In my case, these steps involved competing at an international competition with my peers, advancing my studies through research, and reassessing myself in the world of research by studying abroad. I encourage everyone who wants to make a difference to come and study here.

Chika Nishimori  master’s student

I came to Tokyo Tech to study developmental biology, and I am currently involved in research at Professor Mikiko Tanaka’s laboratory, where the area of focus is the evolution of limb development. My research environment is superb—I receive solid guidance from my supervisor, I am surrounded by excellent researchers, and I have access to extensive facilities. I also value my time spent attending courses and research presentations because I get to meet faculty members and students outside of my laboratory who inspire me with fresh ideas and perspectives.

Ayaka Muramatsu  undergraduate student

My research is concerned with the metabolism in microorganisms that thrive in temperatures that are far too high for humans. There are plenty of times when my research does not go according to plan. But, I find the process of making slow but steady progress with my colleagues and the support of our faculty to be richly rewarding. I would recommend that incoming students join clubs, study abroad, and take part in whatever else that sparks their interest. The diverse range of experiences that they gain will surely broaden their perspectives.
International Graduate Program (IGP)

http://www.titech.ac.jp/english/graduate_school/international/index.html

International Graduate Program for Bioscience and Biotechnology

Since 2007, the School of Life Science and Technology (formerly the Graduate School of Bioscience and Biotechnology) has administered an international graduate course for foreign students, especially excellent students from East Asian countries.

In 2013, to further advance this graduate course, we launched a new international education program that includes master, doctoral, and integrated master’s and doctoral education curricula designed to help students cultivate their creativity, learn practical working skills, and improve their English- and Japanese-language skills. In this graduate program, we foster international leaders who are able to develop leading-edge research and innovations in science and technology as bridge between Japan and other nations.

Currently, our school has two Graduate Majors, Life Science and Technology and Human Centered Science and Biomedical Engineering. A student selects one of these majors after discussion with his or her supervisor.

Snap shot of new members in this program in 2016

Tokyo Institute of Technology – Tsinghua University Joint Graduate School Program

http://www.ipo.titech.ac.jp/tsinghua/

Tokyo Tech and Tsinghua University have a Joint Graduate School Program of master’s and doctoral courses. The main objective of this strategic program is to train personnel who can use three languages—Japanese, Chinese, and English—and are versed in these cultures. The Bio-course (Bioscience and Biotechnology course) has historically played a central role among three courses: Bio-course, Nano-course (Nanotechnology course), and Decision Science & Technology course. Staff, students, and industry representatives deepen their mutual understanding of each other by taking part in two symposia held every year in Beijing and Tokyo. This program provides an ideal opportunity to improve international relationships and educate a young generation who will contribute to the industrial and cultural development of both countries.
The Education Academy of Computational Life Sciences (ACLS) has provided an educational program since 2012 with the goal of training potential leaders from the fields of life sciences and computer science to take active, international roles in multiple fields. The program is an integrated master’s and doctoral education program in which students from both the School of Life Science and Technology and the School of Computing participate in a close environment. Students can enroll in the program without leaving their main curriculum courses. Students who complete the program will receive a doctoral degree with a statement on their degree certificate that confirms that they have completed all the requirements of the Education Academy of Computational Life Sciences.

Previously, both life sciences and computer science evolved independently leading to a lack of mutual understanding and impeding attempts to collaboratively resolve issues. Flexible collaboration between these two fields is in high demand because it will inevitably drive research in life sciences and health care, which should significantly advance science and technology in the 21st century.

For these reasons, the program is focused on fostering potential leaders with fundamental knowledge of both life sciences and computer science, as well as collaborative skills, who will ultimately excel in a global environment.

This program defines and nurtures I’(Gamma)-type specialists who are 1) distinguished life sciences specialists with the ability to use cutting-edge computer science technology; or 2) distinguished computer science specialists with the ability to comprehend life sciences methodology and concepts.

The program was carried out from 2011 to March 2018 with the financial support from MEXT as “Program for Leading Graduate Schools”. Tokyo Tech will continue the program independently from April 2018.
Working Globally

90% of the undergraduate students will proceed to the graduate school of Tokyo Tech.

Places of the employment

- **Pharmacy**
  - Astellas Pharma, Asubio Pharma, Chugai Pharmaceutical, Daiichi Sankyo Healthcare, Japan Blood Products Organization, Kobayashi Pharmaceutical, Kyowa Hakko Kirin, Medical and Biological Laboratories, Mitsubishi Tanabe Pharma, Mochida Pharmaceutical, Pfizer Japan, Nihon Generics, Sumitomo Dainippon Pharma, Taisho Pharmaceutical, Takeda Pharmaceutical, etc.

- **Chemistry**
  - Asahi Kasei, Du Pont, Fujifilm, Idemitsu Kosan, JSR, Kao, Kuraray, Lion, Mitsubishi Chemical, Mitsui Chemicals, Nippon Shokubai, Sekisui Chemical, Shin-Etsu Chemical, Shiseido Japan, Sumitomo Chemical, Teijin, Toray Industries, etc.

- **Foods**
  - Ajinomoto, Asahi Breweries, Calpis, Ezaki Glico, Itoham Foods, Kagome, Kewpie, Kirin, Lotte, Megumilk Snow Brand, Meiji, Morinaga, Nissui, Sapporo Breweries, Suntory Holdings, Yakult, etc.

- **Other Manufacturing Industries**
  - Canon, Dai Nippon Printing, Daikin Industries, Fujitsu, Hitachi, Japan IBM, JGC, Kobe Steel, Konica Minolta, Kyocera, Mazda Motor, Panasonic, Shimadzu, Showa Denko, Tokyo Gas, Toppan Printing, Toshiba, Toyota Motor, etc.

- **Trading, Finance, IT**

- **Teacher, Government Official**

- **Others**
  - Dentsu, Hukuhodo, Mori Building, East Japan Railway, Z-kai, etc.
Schedule for Admission

For details and newest information, see http://admissions.titech.ac.jp/admission/

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For Applicants

Graduate School

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<tr>
<td>Doctor : 52</td>
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</table>

For details of information for Doctor course, please visit.
https://www.titech.ac.jp/english/graduate_school/admissions/doctrical.html
Access

Ookayama Campus

The Main Gate is a 1-minute walk from Ookayama Station on the Tokyu Oimachi and Tokyu Meguro Lines.

Suzukakedai Campus

The Suzukakedai Campus is a 5-minute walk from Suzukakedai Station on the Tokyo Den’entoshi Line.

Latest Information

Official site
http://educ.titech.ac.jp/bio/eng/

Inquiries

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TEL 045-924-5940 (9:00 - 17:15)  E-mail  suz.sei@jim.titech.ac.jp

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