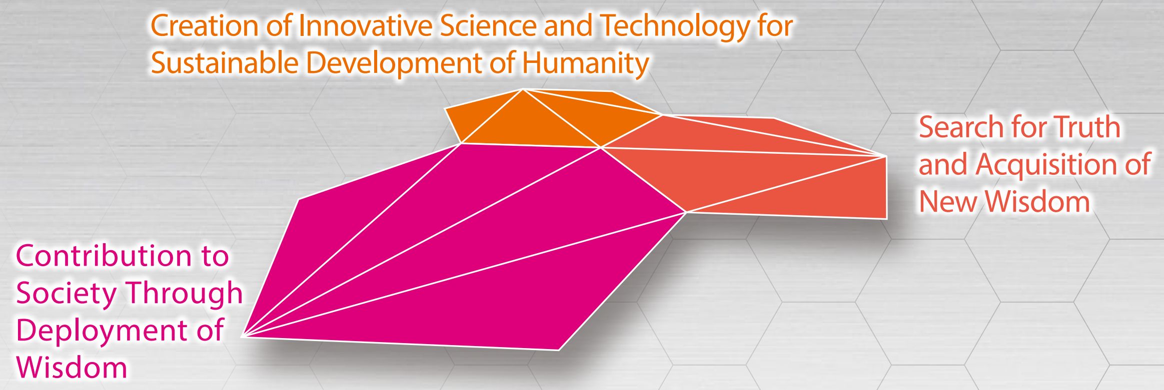
TOKYO TECH RESEARCH 2021-2022

東京工業大学
Tokyo Institute of Technology

Research at Tokyo Tech

Since its founding in 1881, Tokyo Tech has stood at the front line of research as one of the world's leading universities in science and engineering. Building upon the Institute's long-standing philosophy of *monotsukuri*, or technical ingenuity and innovation, Tokyo Tech consistently produces high-impact research across numerous science and technology fields, including physics, chemistry, mechanical engineering, materials science, environmental engineering, and life sciences.

Three Crucial Engagements in Research



From President Masu

As a national designated university corporation engaging in the world's highest levels of education and research, Tokyo Tech seeks new potential in science and technology and aspires to pioneer a new era in discourse with society. Focusing on the work of our researchers, this pamphlet describes the progress of our institution in creating innovative science and technology; searching for truth and acquiring new knowledge; and deploying that knowledge in society. I would be pleased, if the reader gains a sense of the future from the many research efforts at Tokyo Tech, a lens from which new alliances between industry and academia could emerge. The diversity groomed in a university setting provides opportunities to conduct exciting and intriguing research under fast-paced decision-making and execution. As we challenge ourselves to pursue research that will contribute to society, I ask you to look forward to the research prowess at Tokyo Tech.

President
Kazuya MASU

Staff/Students

Faculty
1,529 (International: 176)

% International
11.5%

Research Staff
287

Administrative Staff
598 (Female: 268)

% Female
44.8%

Students
10,448 (Female: 1,695) (International: 1,721)
% Female: 16.2%
% International: 16.4%

Bachelor's
4,922 (Female: 634) (International: 283)

Master's
4,052 (Female: 773) (International: 848)

Doctoral
1,474 (Female: 288) (International: 590)

Awards

Nobel Prize **Yoshinori Ohsumi, Honorary Professor, 2016 Nobel Prize in Physiology or Medicine**
"Elucidating the Molecular Mechanisms and Physiological Significance of Autophagy, a Cellular Adaptive System to Environment"
Hideki Shirakawa, PhD, 2000 Nobel Prize in Chemistry
"For the Discovery and Development of Conductive Polymers"

Japan Prize **Hideo Hosono, Honorary Professor, 2016**
"Creation of Unconventional Inorganic Materials with Novel Electronic Functions based on Nano-Structure Engineering"
Yasuharu Suematsu, Honorary Professor, 2014
"Pioneering Research on Semiconductor Lasers for High-Capacity Long-Distance Optical Fiber Communication"

Publications

Total
13,030

Top 1%
179

% International Co-Authorships
42.0%

Industry Collaboration

Patent Income
93 million yen(2019)

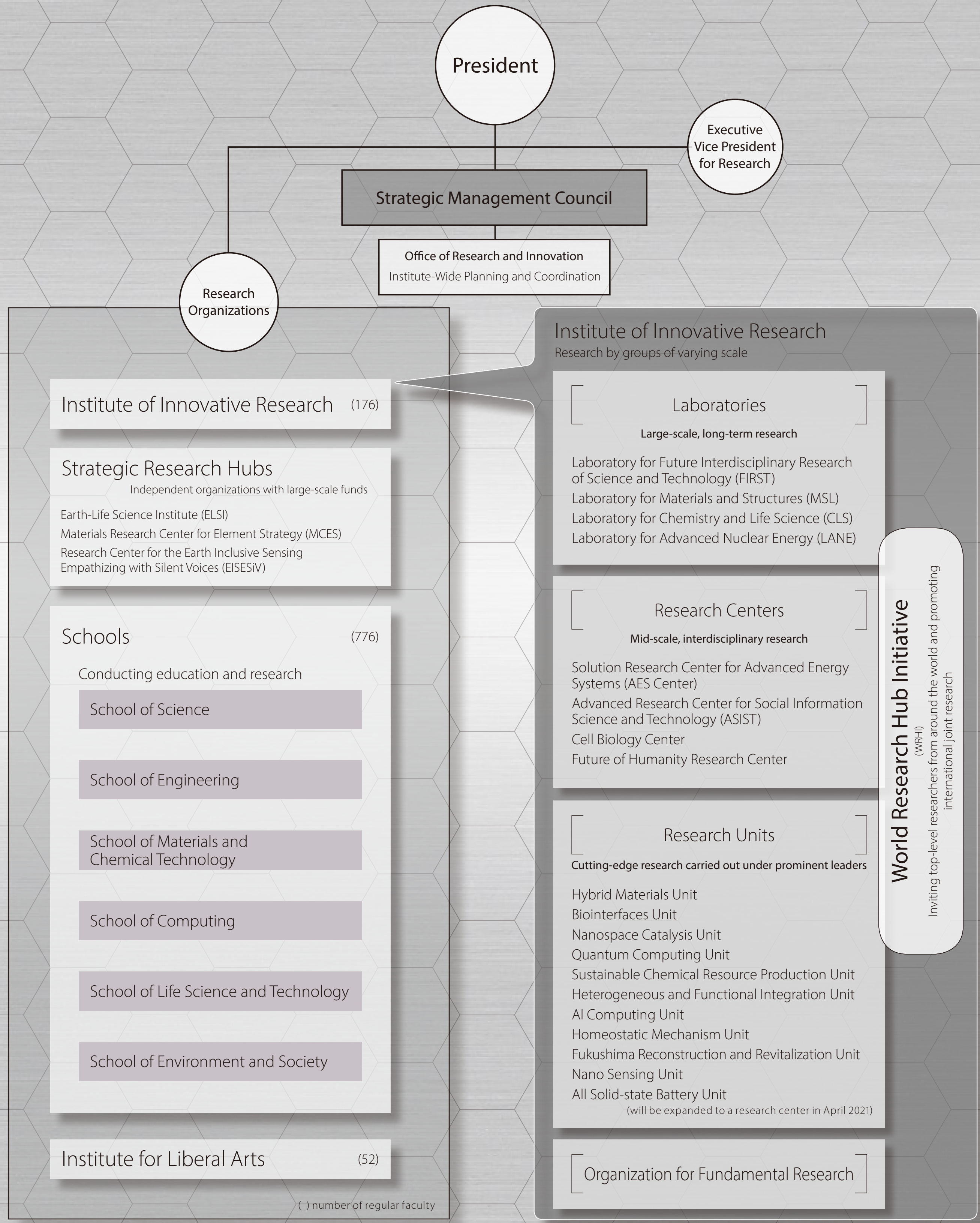
Tokyo Tech Ventures
118 companies (As of August 2020)

Income/Expenses

50.38 billion yen

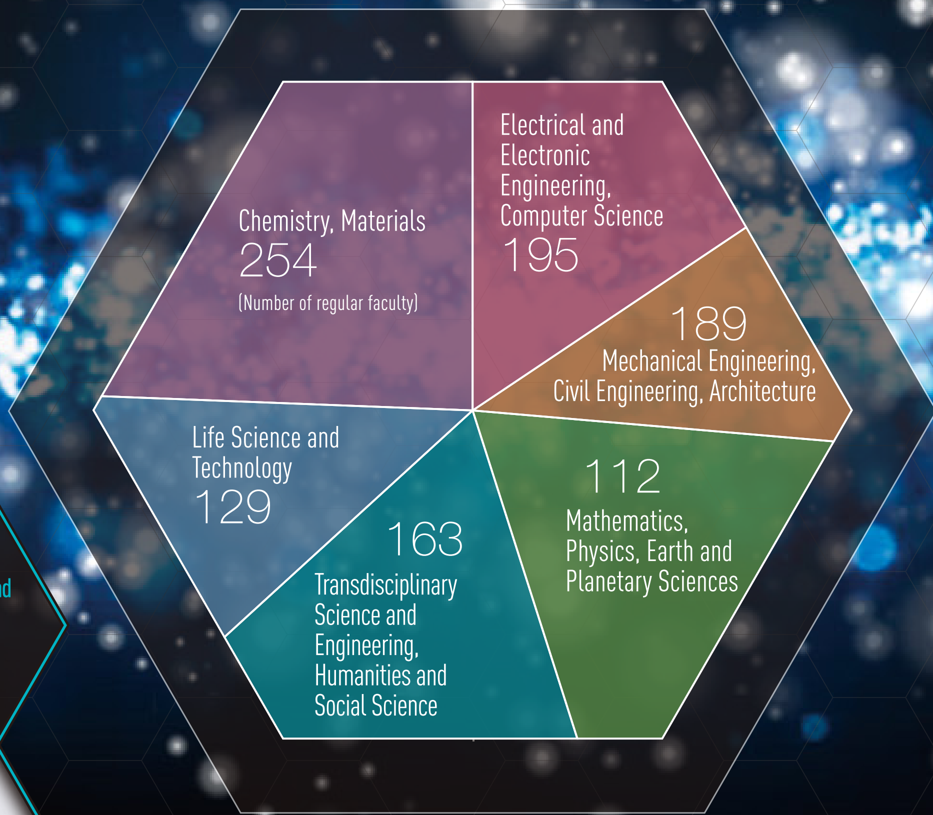
(Personnel data as of May 2020; Publications, Top 1%; 2015-2019, 5-year span, Web of Science; International Co-Authorship; 2019, Web of Science; Income/Expenses; estimated for fiscal year 2020)

Research Structure



CONTENTS

TOKYO TECH RESEARCH MAP 2021-2022



Creating new materials by combining metallic elements
Kimihisa Yamamoto
Institute of Innovative Research

Making all solid-state batteries universally available
Ryoji Kanno
Institute of Innovative Research

Development of high performance severe environment resistant ceramics
Katsumi Yoshida
Institute of Innovative Research

Development of photo-induced phase transition systems for realizing ultrafast quantum phase tuning
Shinya Koshihara
School of Science

Atomistic to real scale for high-temperature alloy design
Masao Takeyama
School of Materials and Chemical Technology

Environmentally benign heterogeneous catalysts
Michikazu Hara
Institute of Innovative Research

Organic synthesis driven by visible light (sunlight)
Munetaka Akita
Institute of Innovative Research

Creation of novel functional materials from a unique perspective
Hideo Hosono
Materials Research Center for Element Strategy

Systems control incorporating advances in information and communication
Hideaki Ishii
School of Computing

Diamond quantum sensors for healthcare and environmental energy fields
Mutsuko Hatano
School of Engineering

Ultra high-speed optical communications and 3D optical sensing with surface emitting lasers
Fumio Koyama
Institute of Innovative Research

Reconstruction of brain functions on computers
Yasuharu Koike
Institute of Innovative Research

Exploiting big data to model socio- and econophysics
Misako Takayasu
Institute of Innovative Research

Boosting lithium-ion batteries and fuel-cell efficiency
Shuichiro Hirai
School of Engineering

Achieving a low carbon society through solutions research
Takao Kashiwagi
Institute of Innovative Research

Soft robots that exploit artificial muscles
Koichi Suzumori
School of Engineering

Creative management of water use and environment
Chihiro Yoshimura
School of Environment and Society

Control of large-scale complex network systems and its applications
Jun-ichi Imura
School of Engineering

Functional-continuity buildings and cities that withstand earthquakes
Shoichi Kishiki
Institute of Innovative Research

Exosome in disease etiology and detection
Ayuko Hoshino
School of Life Science and Technology

Understanding the gene expression mechanism in living cells
Hiroshi Kimura
Institute of Innovative Research

Elucidating the molecular mechanisms of autophagy, an intracellular degradation system
Yoshinori Osumi
Institute of Innovative Research

Polymer design for future diagnostic and therapeutic medicine
Nobuhiro Nishiyama
Institute of Innovative Research

How energy organizes chemistry into life
Shawn McGlynn
Earth-Life Science Institute

Photo: N. Escanlar, ELSI

Nuclear energy systems with safe and less waste
Toru Obara
Institute of Innovative Research

Differentiation of iPS cells to digestive organs and application to drug discovery
Shoen Kume
School of Life Science and Technology

Studying methods of changing attitudes and behavior through interaction design
Katie Seaborn
School of Engineering

How mathematical science can optimize corporate activities
Shinji Mizuno
School of Engineering

Human studies
Eisuke Wakamatsu
Institute of Innovative Research /Institute for Liberal Arts

Leveraging innovations to build a sustainable society
Yuya Kajikawa
School of Environment and Society

Analyze human motion and support human performance using biomechanics
Takeo Maruyama
Tokyo Tech Academy for Leadership / Institute for Liberal Arts

Geometric analysis on minimal submanifold and mean curvature flow
Yoshihiro Tonegawa
School of Science

Evolution of the universe through ultimate elementary particles
Masahiro Kuze
School of Science

Quantum sensor technologies for ultra-precise inertial navigation
Mikio Kozuma
School of Science

Theory of planet formation and evolution
Shigeru Ida
Earth-Life Science Institute

Emerging Researcher Profiles 2021-2022

Chemistry, Materials

Solar energy conversion using solid photocatalysts
Kazuhiko Maeda School of Science

Our group has been studying heterogeneous photocatalysis for water splitting and CO_2 fixation toward solar to chemical energy conversion. Through the use of artificial solids and molecules that can be obtained under controlled conditions, we are creating an efficient photocatalyst that is active for desired reactions.

Rotaxane-based supramolecular mechanophores
Yoshimitsu Sagara School of Materials and Chemical Technology

We are working on the development of supramolecular mechanophores utilizing rotaxanes, which have been well investigated in supramolecular chemistry. The mechanophores can visualize tiny mechanical forces.

Developments of sensors with controlled Bio-Nano interfaces
Yuhei Hayamizu School of Materials and Chemical Technology

We are researching new nanobiotechnology to connect biology and electronics. By using designed proteins with graphene, a promising new electronic material, we are developing new interfaces to convert biological information into electronic information in a controlled manner.

Conversion of carbon dioxide into chemicals on alloys
Tomoaki Takayama School of Science

Using nanoparticulate alloys consisting of metals and half-metals of the d- or p-block elements as catalysts, carbon dioxide is converted into useful chemicals under mild conditions utilizing renewable energy and waste thermal energy.

Aromatic polymers and carbons for catalysis
Yuta Nabae School of Materials and Chemical Technology

I am working to develop a solid catalyst using organic materials based on keywords such as non-platinum catalysts, fuel cells, polyimides, hyperbranched polymers, organometallic complexes, and carbon materials. The goal is to realize a low-carbon society by developing a catalyst capable of efficiently promoting various reactions.

Development of new catalytic reactions by heterogeneous catalysts
Yusuke Kita Institute of Innovative Research

Promotion of the use of renewable resources is required to build a sustainable society. I am focusing on heterogeneous catalysts that synthesize high value-added compounds from non-edible biomass such as corn stalks that do not compete with food issues.

Signal-amplification sensing with smart chemosensors
Gaku Fukuhara School of Science

We have so far proposed a new amplification sensing methodology defined as "supramolecular allosteric signal-amplification sensing (SASS)", enabling to sense various analytes that are difficult to discriminate in a complex mixture.

High mobility semiconducting polymers
Tsuyoshi Michinobu
School of Materials and Chemical Technology

Crystalline organic semiconducting polymer thin films are capable of carrying electricity by properly controlling the intermolecular interactions and carrier generation. I aim to create a new organic semiconducting polymer by using precise molecular design and an efficient synthesis method, and to realize high-performance solar cells and transistors.

Microstructure control for improving mechanical properties of metallic materials
Nobuo Nakada School of Materials and Chemical Technology

The characteristics of metallic materials can be dramatically improved by properly controlling their microstructure. In our group, we are researching the relationship between the microstructure and mechanical properties, and optimal thermomechanical treatment processes aiming for creating ideal microstructures capable of innovatively improving the strength and toughness of metallic structural materials such as ferrous materials.

Rational nanospace design and its functions
Masahiro Yamashina School of Science

We are constructing molecular assemblies with nanospaces and exploring their spatial functions, by strategically combining various chemical bonds and organic molecules. Recently, we have succeeded in constructing a caged molecule based on an anti-aromatic molecule and elucidating its properties. In the future, we will explore for undiscovered molecules and chemical reactions that can only be observed in the nanospace.

Development of materials informatics technique and its application
Yu Kumagai Institute of Innovative Research

I am working on developing an advanced auto-calculation program for calculating the various characteristics of materials along with its application. Also, through machine learning based on acquired big data, I am developing a technique for quickly predicting characteristics, and clarifying the origins of physical properties.

Search for novel compounds focusing on anion
Takafumi Yamamoto Institute of Innovative Research

By using anion as a parameter, I am synthesizing new solid state compounds with novel structure and properties, which cannot be accessed by conventional solid state reaction focusing on cation.

Development of novel catalysts for low-temperature ammonia synthesis
Masaaki Kitano Materials Research Center for Element Strategy

I am working to develop a novel ammonia synthesis catalyst that can work under much more mild conditions at lower temperature and pressure than existing industrial ammonia synthesis processes, which require high temperature and pressure. In particular, I am focusing on developing a novel catalyst material that utilizes abundant elements and uses as little precious metals as possible.

Development of metal oxide catalysts for selective chemical processes
Keigo Kamata Institute of Innovative Research

We investigate the rational design and synthesis of metal oxide catalysts with a wide variety of crystal structure based on both theoretical and experimental approaches. Through the development of novel nanostructure control methods, we create highly functionalized catalysts with much superior activity than previously-reported catalysts for various types of catalytic reactions such as selective oxidation, acid-base reaction, and biomass conversion.

Anion-engineering for novel electronic functional materials exploration
Satoru Matsuishi Materials Research Center for Element Strategy

Focusing on "mixed-anion compounds" containing multiple types of anions and "electrides" in which electrons behave as anions, we are searching for novel functional materials such as superconductors, and electron conductors whose properties are changed by photo-irradiation.

Heat resistant alloy design based on microstructure control
Satoru Kobayashi School of Materials and Chemical Technology

We are working on basic research on physical metallurgy such as phase diagram and microstructure control with a final goal to design high performance heat resistant metallic materials with high creep resistance and low thermal expansion coefficient etc for increased temperature of jet engines and high fluctuation load/temperature operation of power plants in future.

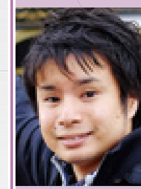
Advanced rare metal recycle technology using nanochemistry
Takehiko Tsukahara Institute of Innovative Research

We have developed a novel environmentally-friendly chemical system, which enables to separate/detect and recycle efficiency rare metal elements, by means of functional nanomaterials, nanospaces, and nanosensing technologies. This system can realize waste reduction, low environmental burden, and resource recycling of various wastes generated from chemical and nuclear engineering facilities.

Effective utilization of carbon resources by zeolite catalyst
Toshiyuki Yokoi Institute of Innovative Research

We aim to create innovative zeolite catalysts that can make efficient use of diverse resources and that can contribute to the development of green production of chemical feedstocks and value-added chemicals.

Precision self-assembly of crystallizable polymers
Tomoya Fukui Institute of Innovative Research



I investigate the precision self-assembly of functional polymers. I have succeeded in controlling the self-assembly of π-conjugated polymers by kinetic control, thereby yielding the nanofibers with controlled lengths from nano to micrometer.

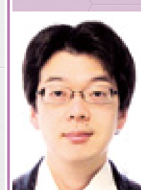
Search for solid electrolyte materials using machine learning
Kota Suzuki School of Materials and Chemical Technology

The novel lithium ion conductors could enable the development of all-solid-state lithium batteries; however, the efficiency of material discovery is slow. In this study, we are developing an efficient new materials search method by combining classical materials search and machine learning techniques.

Degradable polymers via precision polymerization
Tomohiro Kubo School of Materials and Chemical Technology

The development of on-demand degradable plastics for a circular economy is imperative as environmental concerns loom large. I aim to construct a guiding principle for degradable polymeric materials through unveiling novel synthetic strategies toward environmentally benign polymers.

Photocatalytic fine organic synthesis
Takashi Koike Institute of Innovative Research



Photocatalysis is an attractive tool that can realize thermodynamically unfavorable chemical reactions. Sunlight, LEDs, and fluorescent lights are recognized as common light sources. Using such readily available light sources, I am working on the development of novel and environmentally-friendly photocatalytic reaction systems that will contribute to the development of pharmaceuticals, agrochemicals, and organic functional materials.

Functional materials based on cyclic topology
Daisuke Aoki School of Materials and Chemical Technology

Cyclic topologies are ubiquitous in a variety of chemical compounds and the compounds with cyclic topology exhibit unique functionality derived from their topology. In this research, based on the effective method for synthesizing cyclic molecules, we aim for establishment of a guideline for new material design using cyclic molecules as a tool for developing functional materials.

Creation of aromatic nanospace as functional nano tools
Michito Yoshizawa Institute of Innovative Research

In nature, protein-based nanospaces demonstrate highly selective recognition and efficient reactions in water under mild conditions. Inspired by such biosystems, we have studied "aromatic nanospaces" as new nano tools usable in water. The tools provide unique functions for the development of novel molecular science.

Redox chemistry for molecular conversion technology
Shinsuke Inagi School of Materials and Chemical Technology

Focusing on the features of bipolar electrochemistry such as wireless nature, gradient potential and reduced electrolyte, novel molecular conversion technology based on redox chemistry is developed to produce useful and functional materials.

Life Science and Technology

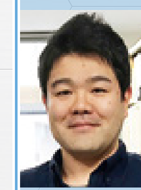
Exosome in disease etiology and detection
Ayuko Hoshino School of Life Science and Technology

Exosomes mediate cell-cell communication in physiology and disease. We aim to elucidate exosome driven disease pathology and develop novel treatments.

Elucidation of intestinal environment dynamics
Takuji Yamada School of Life Science and Technology

We have been engaged in elucidating the relationship between gut microbiome and diseases based on community structure analysis of the bacteria that live in the human intestines. In addition, we also focus on the research for the dynamics of the microbial community structure during the food fermentation process, data visualization of the metabolic pathway database, and a new analysis method.

Study on molecular mechanisms underlying autophagy
Hitoshi Nakatogawa School of Life Science and Technology



Autophagy, a major degradation system within cells, plays important roles in the maintenance and regulation of various biological functions, and its failure has been linked to different human diseases. We aim at clarifying mechanisms underlying autophagy at the molecular level.

Cell editing and cell design
Fumi Kano Institute of Innovative Research

I am creating a platform for editing and designing cells based on our two technologies: semi-intact cells system and cell-resealing technique for delivering molecules into cells, and image-based analytical method for creating the covariation network.

Nexus of nano, bio and electronics
Toshinori Fujie School of Life Science and Technology

Minimally invasive medicine is expected for human healthcare and biomedicine. Our group envisions the smart biodevice with integrated nano, bio, electronics.

Emerging Researcher Profiles 2021-2022

Life Science and Technology

How energy organizes chemistry into life

Shawn McGlynn Earth-Life Science Institute

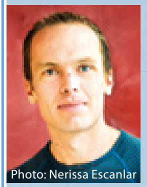
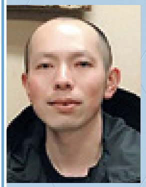


Photo: Nerissa Escanlar

In biology, material (molecules) are organized by energy flow. My lab works on multiple systems – from molecules in the lab to hot springs in the field- with the goal of understanding how organization is governed by energy transfer reactions.

Redox-based regulatory network for controlling plant functions

Keisuke Yoshida Institute of Innovative Research



Plants must control their own physiological functions in response to changes in environmental conditions. I focus on redox regulation as a key to control plant functions. I am trying to comprehensively understand its molecular basis and physiological significance.

Driven to discover: Polymer-drugs equipped with smart functionality

Yutaka Miura Institute of Innovative Research

Our areas of research features the development of polymer-drug discovery and biomaterials created through well-defined synthesis, control of stereochemistry, and nanotechnology for medical applications such as drug delivery and imaging.

Molecular design of thermoresponsive polymers for biomaterials

Naohiko Shimada School of Life Science and Technology

Polymers that change physicochemical properties in response to changes in temperature are referred to as thermoresponsive polymers. We have developed very rare thermoresponsive polymers that dissolve when heated under physiological conditions. The goal is to apply these to medicine and biotechnology.

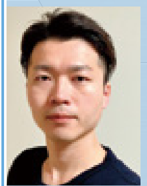
Engineering of *in cell* protein crystals

Satoshi Abe School of Life Science and Technology

I am focusing on protein crystallization reactions and am developing functional materials by complexation of various molecules and rapid structural analysis methods. In particular, I am pursuing the possibility of biofunctional materials that overturn conventional wisdom by using protein crystal engineering in living cells.

Drug delivery systems for photodynamic therapy and neutron capture therapy

Takahiro Nomoto Institute of Innovative Research



Photodynamic therapy and neutron capture therapy have attracted recent attention as promising techniques for treating intractable diseases including multiple and diffuse cancers. We develop light/neutron-responsive drug delivery systems to extend their application.

Analysis of human metabolism for medical applications

Shunichiro Ogura School of Life Science and Technology

Humans maintain their health through various metabolic processes. However, if these metabolic processes become abnormal, it can lead to disease. In our laboratory, such abnormalities with metabolic processes are being studied chemically in order to determine a methodology for normalizing metabolic processes.

Mechanical Engineering, Civil Engineering, Architecture

Advanced laser diagnostics and reactive fluid engineering

Masayasu Shimura School of Engineering

I am working to understand turbulence, turbulent heat transfer, and combustion phenomena using advanced laser measurements and numerical analysis targeting gas turbine engines and internal combustion engines used in aircraft and for power generation, and am also working on development of sensing and control techniques for reactive fluids that can contribute to improved safety with these.

Turbulent reacting flow modeling with supercomputing and machine learning

Yuki Minamoto School of Engineering

Direct numerical simulations of turbulent reacting flows and investigation to obtain physical insights. Data-oriented (AI) physical modelling for non-linear phenomena based on large-scale numerical simulation database. Development of machine learning platform for quantitative prediction of physical phenomena.

Development of innovative surgical robot systems

Kotaro Tadano Institute of Innovative Research

Based on robotics and control engineering, we are researching surgical robot systems and remote control for realizing effective work support for humans and advanced interactions between humans and machines.

Mechanism design and control of robotic and mechanical systems

Yusuke Sugahara School of Engineering

Based on the problem of consciousness, i.e., "how to design, what kind of robot system, to make the world better for living", I am pursuing the design and integration of various robots and mechanical systems. Specific research topics include: human-powered robotics, cable-driven parallel robots, locomotion mechanism, etc.

Establishing groundbreaking robotics through cutting–edge actuators

Hiroyuki Nabae School of Engineering

It can be difficult for general robot systems that use electromagnetic actuators to work properly in extreme environments such as confined spaces and where there is high load disturbance. We are working to create new robotics that can resolve such issues based on research into new actuators.

Systems and control theory for future energy management

Takayuki Ishizaki School of Engineering

Based on the foundation of systems and control theory, we challenge ourselves to advanced research topics for future smart energy management. In particular, we focus on developing modular design theory for large-scale decentralized control systems.

Surface reaction design in electrodes for carbon recycling

Hirotatu Watanabe School of Engineering

I am working on developing a fuel cell for carbon recycling. In this work, surface reaction design is developed through first-principle calculation and multi-scale visualization for reaction selectivity enhancement on an electrode.

Functional-continuity buildings and cities that withstand earthquakes

Shoichi Kishiki Institute of Innovative Research

While working on further development of existing passively vibration control and seismic isolation technology, I am working to establish a technique for reducing damage to partitions, ceilings, and equipment comprising indoor spaces in order to realize functional and business continuity of buildings and cities via a monitoring system.

Pursuing comfortable and healthy urban thermal environment

Takashi Asawa School of Environment and Society

The research fields of our lab are urban and built environmental engineering. Final goal of our research fields are realizing comfortable and healthy cities and buildings with less energy use. The research topics are urban remote sensing, thermal environment simulation, environmental effects of urban greening, and passive design.

Design method of high-rise building against huge earthquakes and typhoons

Daiki Sato Institute of Innovative Research

This laboratory aims to develop a design method that considers both seismic and wind loads for buildings with applied advanced vibration technologies such as passive control and base isolation systems by using observation data, experiments, and simulations. It also develops method for estimating performance of different dampers used in passive control and base-isolation systems.

New approach to architectural planning using big data and AI

Takuya Oki School of Environment and Society

We are developing new architectural planning methods to acquire knowledge from various big data, applying image processing, natural language processing, and spatiotemporal information processing methods based on AI. The data include building interior/exterior images from in-vehicle cameras and aerial photographs, real estate property information, SNSs, people's flows, eye tracks, and so on.

Challenge to wind and snow related issues for urban environment

Tsubasa Okaze School of Environment and Society

We are investigating the mechanisms of wind gust at pedestrian space, pollutant dispersion, snow drifting, and other problems caused by wind and its related diffusion phenomena within built-up environments, and proposing countermeasures with CFD (computational fluid dynamics), which can predict the flow fields with computer simulation.

Design and maintain the next generation infrastructure

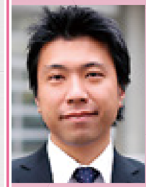
Nobuhiro Chijiwa School of Environment and Society

I am developing a method for properly evaluating the performance of existing infrastructures and for selecting optimal maintenance methods, and developing innovative infrastructure materials, designs, and maintenance methods through field fusion in order to realize a resilient and smart next-generation society.

Electrical and Electronic Engineering, Computer Science

World's fastest millimeter-wave transceiver

Kenichi Okada School of Engineering



I am working on research and development of millimeter-wave phased array transceivers for 5G and future wireless technologies through collaborative research with many companies. I am also studying terahertz and satellite communications, and circuit design techniques using CMOS integrated circuits.

Periodic nanostructures opening a new field of photonics

Tomohiro Amemiya Institute of Innovative Research

We are exploring the potential of "metamaterials" and "topological photonics" for opening a new field of photonics.

Diamond quantum technologies

Takayuki Iwasaki School of Engineering

Spin defects formed in diamond function as quantum sensors, and they are also expected to be used as solid-state quantum light sources for quantum network. I am proceeding with research on high-sensitivity magnetic and electric field sensors using NV centers, and studying new quantum light sources using Group IV elements.

High-efficiency solar cells and optical power converter for optical power transmission

Shinsuke Miyajima School of Engineering

A production process of silicon solar cells without explosive and toxic gases are investigated for low-cost silicon solar cells. Hybrid tandem solar cell using silicon and a perovskite material and blue-light optical power converter for optical power transmission system are also our important topics.

Ultralow power spintronic devices

Nam Hai Pham School of Engineering

We develop novel materials such as topological insulators, topological half metals, and ferromagnetic semiconductors to realize ultralow power spintronic devices, including magnetoresistive random access memory, racetrack memory, and spin transistor.

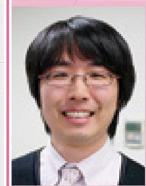
Custom computing machine for deep learning applications

Hiroki Nakahara School of Engineering

Custom computing machine for deep learning applications
I am researching the development of high-speed hardware exclusively for machine learning and AI processing including deep learning along with its applications.

Terahertz electronics and applications

Safumi Suzuki School of Engineering



The terahertz frequency band is expected to be used for various purposes such as next-generation wireless communication. In our laboratory, we will open up the future of terahertz technology by researching extreme semiconductor devices capable of terahertz operation, giving them various functionality, and applying them to the various terahertz applications and actually showing the operations.

Augmented reality using high speed vision and projection

Yoshihiro Watanabe School of Engineering

We explore the possibilities to invoke a new sense of reality based on the advanced technology centering on visual sensing and projection. The key is speed transcending the human capabilities. We believe the next reality is driven by the technological control of the unseen moment.

Semiconductor lasers and photonic circuits using heterogeneous integration technology

Nobuhiko Nishiyama School of Engineering

Using semiconductor lasers and photonic integrated circuits based on heterogeneous semiconductor integration and nanofabrication technologies, we aim to realize ultra-high-capacity optical communication transceivers and sensors. We also focus on ultra-low power photonic integrated circuits using semiconductor thin films to realize future photonic-electric convergence LSIs.

Computational neuroscience to understand neural mechanism of human motor control

Hiroyuki Kambara Institute of Innovative Research

To advance the knowledge about how our brain generates accurate and sophisticated motions, I am currently doing researches on the neural mechanisms underlying human motor control of a simple movement like reaching and a complex movement like juggling.

Emerging Researcher Profiles 2021-2022

Electrical and Electronic Engineering, Computer Science

Mathematics, Physics, Earth and Planetary Sciences

Hardware accelerators for AI applications

Van Thiem Chu Institute of Innovative Research

Many AI applications have a high demand for computing performance and efficiency, which conventional general-purpose processors cannot provide. My research aims to address this issue by developing novel domain-specific hardware accelerators.

Data-driven Intelligent Robotics

Asako Kanezaki School of Computing

We develop a robotic system that recognizes the real world and learns behavior. Robots collect data using various sensors and predict the optimal behavior through the knowledge they gather and interactions with humans. We are researching recognition technologies and machine learning methods for this purpose.

Exploration of new elementary particles unveiling the mystery of space-time

Hideyuki Oide School of Science

Although the Standard Model representing the state-of-the-art of our understanding of particle physics is known to be incomplete, it is experimentally unbroken so far. Discovery of un-predicted new particles would unveil the mystery of the Standard Model, and I am propelling new particle searches using the LHC accelerator realizing scrutiny of particle interactions at the ever highest energy scale.

Artificial intelligence for understanding and generating human language

Naoaki Okazaki School of Computing

Language is more than a communication tool. It is also a source for intellectual activities including thinking and logic. Incorporating linguistics, statistics, machine learning, and recent deep learning, I am working to achieve intelligent computers that can speak languages to communicate with others, as we human beings do.

Singular solutions of nonlinear parabolic partial differential equations

Jin Takahashi School of Computing

The main target of my research is parabolic partial differential equations such as diffusion equations based on the keyword "Singularity." More precisely, I am classifying and constructing solutions with singularities and high-dimensional singular sets, and analyzing the solvability of problems that include singular initial values and nonhomogeneous terms.

Probing the fundamental laws of nature with elementary particles

Yohei Yamaguchi School of Science

I am working to recreate the environment of the early universe using the world's highest energy LHC accelerator, and studying the nature of a vacuum filled with Higgs field. Elementary particles gained mass when the Higgs field symmetry was broken in the early universe. I am working to clarify the dynamics of the early universe by measuring the nature of the Higgs field.

Leverage math for sensing data processing and analysis

Shunsuke Ono School of Computing

We are developing signal processing algorithms for extracting and analyzing valuable information from noisy and degraded sensing data by leveraging sparse modeling and mathematical optimization. In addition, we are actively engaged in the application of these algorithms to remote sensing and biomedical engineering.

Mathematical optimization: theory and applications

Makoto Yamashita School of Computing

Mathematical optimization provides solutions using mathematical approaches for the optimal selection under many constraints, for example, numerical methods for train route searches and shift scheduling. We study theoretical aspects of mathematical optimization and apply numerical methods to various practical problems.

Out-of-equilibrium dynamics in isolated quantum many-body systems

Takato Yoshimura School of Science

I am interested in how quantum mechanical particles collectively behave when the system is far from equilibrium.

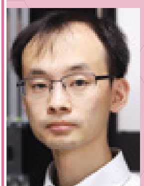
Vision augmentation by computation

Yuta Itoh School of Computing

How strong will the relationship between people and computers be in the future? Our aim is to extend the way people are in the computer society of the future. We thus research technologies to calculate and interfere interaction between people and the real world.

Improvement of usability of TSUBAME supercomputer

Akihiro Nomura Global Scientific Information and Computing Center



I am working to improve the job scheduling policy and software environment so that more researchers and students will be able to use Tokyo Tech's TSUBAME3.0 more efficiently and conveniently.

Ultraviolet Time-domain Astronomy with small satellites

Yoichi Yatsu School of Science

Time-domain Astronomy is a new category which focuses on transient celestial phenomena. We are surveying those transient events by making use of AI and unique small satellites. Currently we are developing a micro-satellite for the ultra-wide field UV transient explore mission to be launched in 2022.

Biophysics on DNA nanotechnology and artificial cells

Masahiro Takinoue School of Computing

Living systems are autonomous, intelligent, non-equilibrium material systems that exhibit behaviors such as replication and evolution, which are not found in other material systems. In addition to constructing intelligent DNA nanodevices and molecular robots, and artificial cells inspired by these systems, we are also trying to understand their physical mechanisms.

Cohomology in algebraic geometry

Shane Kelly School of Science

I research various mathematical concepts of space, specifically, cohomology theories in algebraic geometry. These describe in an abstract way the presence of data or "holes" in different dimensions in a "space". These theories are used in a wide catalogue of applications and areas of science, for example condensed matter theory, quantum gauge theories, string theory, cryptography and data analysis.

Macroscopic quantum physics with single nanoparticles in vacuum

Kiyotaka Aikawa School of Science

By using ultracold single nanoparticles laser-trapped in a vacuum, we investigate whether macroscopic objects follow quantum mechanics, which has been successful with microscopic particles such as electrons and atoms. We also aim at developing applications of our system in sensing.

Transdisciplinary Science and Engineering, Humanities and Social Science

Understanding solar system bodies via theory and exploration

Hidenori Genda Earth-Life Science Institute

I am studying how the characters of solar system bodies were formed mainly using logic and numerical simulations. I am also establishing future plans for solar system explorations. My ultimate goal is to understand the universality and specialities of our Earth by comparing the characters of planets.

Update current practices by designing human-technology interaction

Takumi Ohashi School of Environment and Society

I am trying to contribute to a sustainable society by designing interactions between humans and technology. Specifically, I involve and analyze events from various fields such as the livestock industry, caregiving, education, and drug discovery, and am working to reflect the results back to actual fields to co-design solutions for people in these fields.

Nationalism and religion found in contemporary politics

Takeshi Nakajima
Institute of Innovative Research/Institute for Liberal Arts

I am studying the relationship between politics and "mental" issues such as nationalism and religious faith. I am mainly looking at Japan and India. In both countries, a "rightward trend" that links religion and nationalism has been seen. Why are non-scientific phenomena expanding as science and technology are progressing? I am studying this mechanism.

Quest for exoplanets

Bunei Sato School of Science

I am attempting to discover extra-solar planets, which are planets that orbit stars other than the Sun, using ultra-high precision observations with a large telescope, and to clarify their characteristics. What kinds of planets exist in the universe? Is our solar system special? Are there other planets like Earth? I am working to answer such fundamental questions of humankind.

Environmental toxicology and plasma reforming technology

Shuo Cheng School of Environment and Society

My research investigates the uptake and effects of microfibers on the indoor aquatic microcosm system with three trophic levels. The research results can provide an essential basis for the environmental risk assessment of microplastics.

Analyzing visual culture of celebrity constructed by media

Kyohhei Kitamura Institute for Liberal Arts

In the 20th century, the appearance of celebrities such as movie stars and idols completely changed due to movies and television, and in the 21st century, new celebrities including YouTubers and VTubers appear over the internet. I am studying "celebrity" that is created through media and its visual culture.

Finding habitable worlds in the Solar System

Yasuhito Sekine Earth-Life Science Institute

Are there planetary bodies that support life in the universe? On Mars, the rover drives over mud that was once a lake. On the icy satellites of Jupiter and Saturn, seawater erupts from subsurface oceans into the space. Through experiments and models, I am studying the origin and the evolution of these planetary bodies, and the possibility of life.

Studying methods of changing attitudes and behavior through interaction design

Katie Seaborn School of Engineering

Interactive technology can be designed to influence, motivate, and provoke. I research the design and evaluation of interactive agents, interfaces, and experiences that use attitude and behavior change methods for personal and social good.

The relation of new technology and social and political issues

Ryosuke Nishida
Tokyo Tech Academy for Leadership / Institute for Liberal Arts

I handle the multifaceted relationship between new information technologies/services and politics (elections), institutions, and society through policy analysis, historical research, and quantitative analysis, etc. Recent research is on policy processes and the social impact of COVID-19 measures. A recent publication is "Sociology of the Corona Crisis" (2020, Asahi Shimbun Publications Inc.).

Adaptive and flexible coastal disaster mitigation

Hiroshi Takagi School of Environment and Society

I am engaged in a variety of integrated research, based on survey, experiment, and numerical analysis, in order to realize a living shoreline in urban coastal areas. This concept expects the synergistic effect of a hybrid structure composed of ecological and manmade elements for achieving a low-maintenance disaster countermeasure.

Mechanism of historical human capital formation

Kota Ogasawara School of Engineering

Ogasawara laboratory focuses on the mechanisms of human capital formation during industrialization. Utilizing unique long-term historical socioeconomic statistics with properly designed cliometrics, the lab studies how people accumulated human capital in the economic development process, especially from the economics viewpoint.

Research on educational practice, policy, and school reform

Yuta Suzuki Institute for Liberal Arts

I am engaged in educational research with the emphasis on learning from school sites and listening to school sites. In particular, I am interested in the learning of teachers, who are the change agent in reform of teaching and schooling."Formation and Development of Teachers' Professional Community: A Genealogy of Research on School Reform in the United States" (Keisoshobo, Tokyo, 2018).

Waste recycles promoted by additional value creation and psychological approaches

Fumitake Takahashi School of Environment and Society

My team studies waste management and recycles from generation to final landfill disposal. They include psychological analysis of waste sorting, design analysis for waste separation, value-added technology development for waste recycles, and geochemical conversion of landfilled wastes to soil.

Leveraging innovations to build a sustainable society

Yuya Kajikawa School of Environment and Society

I am developing and practicing methodologies for innovation. In particular, I am working on research and development management, planning for new businesses, analysis of business models and business ecosystems, extraction of social issues including potential issues, and designing and practicing evidence-based policies

Institute of Innovative Research (IIR)

Creating true innovation at the front line of science and technology
Contributing to solving future social and industrial problems by applying our knowledge of science and technology to create new value

DATA	As of May, 2020
Faculty/International	324/59
Research staff/International	110/39
Graduate Students/ International Graduate Students	992/282

The mission of the IIR is twofold — to promote active cooperation within and beyond the organization by providing an open research environment, and to continuously improve this environment so that researchers can focus fully on their work and make the most of their abilities. By accomplishing this mission, the IIR can create new research areas and technologies that address existing problems in society and lay the foundations of future industry. In the long run, the IIR aims to become a leading global innovation center.
IIR is committed to creating new research areas, promoting interdisciplinary research, solving the problems of human society, reinforcing its industry-academia alliance, and enhancing the industrial platform of the future, by applying the wisdom of science and technology to add new value and solving social and industrial issues, while training the personnel who will take charge of the academia and industry of the future.
IIR consists of multiple research labs, research centers, and research units that are spread across both the Suzukakedai and Ookayama campuses, where cutting-edge research covering a variety of fields including life sciences, materials, energy, electronic information, machinery, and disaster-prevention is progressing. We value the free-flowing ideas of our researchers, and by organic cooperation between and among research labs, centers, and units, we aim to contribute to society through new intellectual creations. As an organization engaged in science and technology creations, covering basic to applied technology, we conduct innovative research to produce results that contribute to society and plant the seeds of future industry in response to the increasingly sophisticated needs of society through the training of high-quality personnel and creative research activities.

Research Centers

Our aim is to make social contributions by enhancing our research capabilities and creating new knowledge through the maximum use of the various advantages inherited from the research units and by developing the organizations for our research base.

Solution Research Center for Advanced Energy Systems (AES Center)

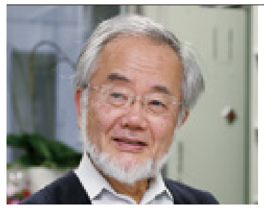
The AES Center and partner entities pursue development of fundamental next-generation energy technology. They aim to realize "smart communities" that fully incorporate renewable energy sources and energy-conservation, practices which are central to achieving a low-carbon society.

Center Director: Institute Professor Takao Kashiwagi

Advanced Research Center for Social Information Science and Technology (ASIST)

ASIST develops safe and secure social information distribution infrastructures that allow individuals to acquire, confirm, and utilize personal information managed by public administrations and medical institutions. They are also engaged in research and development of systems that provide one-stop service by public administrations and life-long individual health management.

Center Director: Institute Professor Nagaaki Ohyama



Cell Biology Center

The activities in this Center are oriented around understanding molecular mechanisms, from gene expression and editing, to synthesis, modification, and the resolution of proteins, and elucidating the dynamics of cellular functions with applications in next-generation cell engineering.

Center Director: Honorary Professor Yoshinori Ohsumi

Future of Humanity Research Center

Keeping in step with cutting-edge research of science and technology, this center deals with practical and essential questions regarding what humanity will be like in the decades or centuries to come, and explore the changes that technology will bring to humanity, the values to be protected, and the possibilities as viewed from various perspectives. Research results will be disseminated in various ways, including books, web articles, and radio.

Center Director: Associate Professor Asa Ito

Research Laboratories

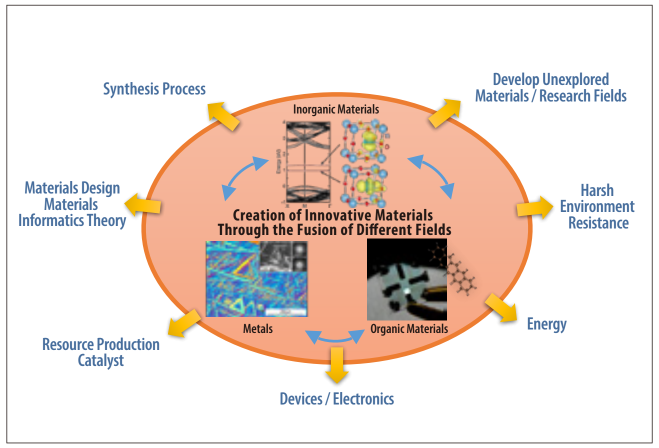
We are conducting front-line research in a wide range of fields. The aims of this research are as follows: to create new research areas; to promote interdisciplinary research; to solve problems found in human society; to strengthen industry–academia collaboration; and to foster a future industrial base. The research involves four research organizations in four different fields.

Laboratory for Future Interdisciplinary Research of Science and Technology (FIRST)

FIRST is dedicated to fostering human society's future development and prosperity by promoting technical progress in industry to meet the needs of the era. FIRST creates new industrial technologies through the fusion of mechanical engineering, electrical and electronic engineering, metallurgy, environmental engineering, disaster prevention engineering, social engineering, chemical engineering, and physical electronics. FIRST focuses on not only science and engineering, but also humanities and sociology, such as industrial sociology, as well as economics and law, to promote interdisciplinary research. The ultimate target is to conduct advanced science and engineering research that will lead to the creation of new industrial technologies to realize a prosperous future for the world.

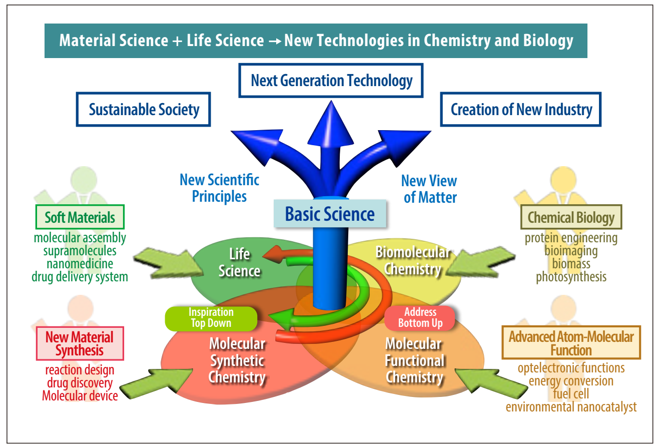
Laboratory for Materials and Structures (MSL)

MSL aims to create innovative materials with conspicuous properties and functions via interdisciplinary materials science based on inorganic materials extending to metals and organic materials. The ultimate goals of our lab include: a. Development of innovative materials based on novel concepts; b. Design of innovative materials in pursuit of novel guiding principles based on underlying materials science and theories in different scientific fields; c. Contribution to the solutions of social problems, including safety and environmental problems, through the application of innovative structures and materials.



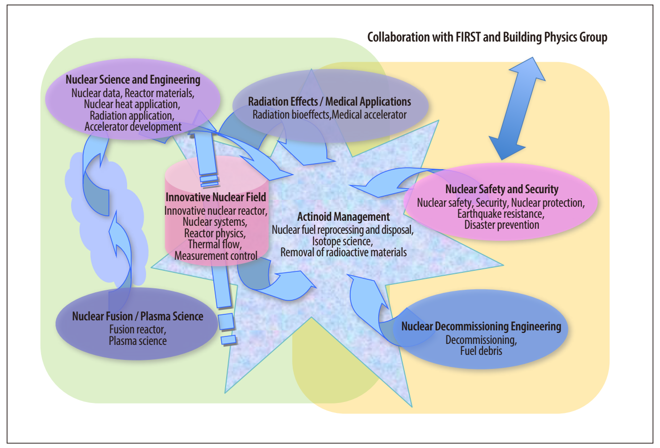
Laboratory for Chemistry and Life Science (CLS)

CLS, which consists of four major divisions - "molecular synthesis," "molecular assembly," "molecular functions," and "molecular bioscience" - carries out a wide range of research on molecular science, covering not only fundamental and applied chemistry, but also life science. By bringing domestic and international research activities together, CLS aims at creating new principles of molecular-based chemistry and bioscience, thereby making breakthroughs toward next-generation science and technology. The final goal of CLS is to contribute to the realization of the sustainable development of human society through front-line chemical research.



Laboratory for Advanced Nuclear Energy (LANE)

As one of the top laboratories leading in applied research as well as pursuing the scientific principles related to nuclear energy, LANE aims to contribute to the sustainable development of the world. The fundamental research of peaceful use of nuclear energy is of great significance to solve the global energy shortage and carbon dioxide emission problems. Innovative nuclear energy systems research, actinide management research, global nuclear security research, and advanced radiation medical research are promoted as mission-driven research objectives. The laboratory also studies some important issues Japanese society has to cope with – reactor decommissioning toward recovery from the Fukushima Daiichi nuclear power plant accident and environmental pollution recovery.



Research Units

The establishment of Research Units allows Tokyo Tech to select prominent research leaders and topics in fields where growth is expected in the future, and to provide funding, space, and human resources to individual projects. The system places priority on promoting cutting-edge research, and allows researchers at other universities, institutions, and companies to participate in joint projects.

Hybrid Materials Unit

Creates new materials based on the precision synthesis of sub-nano metal particles using original dendritic polymers; works to open up a frontier field of science for the next generation of functional materials.

Unit Leader: Professor Kimihisa Yamamoto

Heterogeneous and Functional Integration Unit

The development of large scale 3D integration technology for Tera-byte memory, ultra-small system module, bio-devices, and functional sensor to recognize thoughts of plant are being conducted by research platform in cooperation with industries, so-called WOW Alliance.

Unit Leader: Professor Takayuki Ohba

Biointerfaces Unit

Performs research to understand how the brain controls the body and develop devices that can be controlled by thought alone; also creates new methodologies and instruments to evaluate organ status for early detection of diseases.

Unit Leader: Professor Yasuharu Koike

AI Computing Unit

The unit focuses on hardware technologies for accelerating AI (Artificial Intelligence) workloads, such as deep neural networks, with the help of tight co-development with software technologies.

Unit Leader: Professor Masao Motomura

Nanospace Catalysis Unit

Creates nanospace catalysts and develops processes that make efficient use of carbon resources to contribute to the greening of chemical production.

Unit Leader: Associate Professor Toshiyuki Yokoi

Homeostatic Mechanism Unit

We have the ability to keep the internal environment as unchanged as possible.
This unit studies homeostatic mechanisms, especially neural mechanisms in mammals for the control of body fluid homeostasis, blood pressure, and obesity.

Unit Leader: Professor Masaharu Noda

Quantum Computing Unit

Basic theory of quantum annealing is our main topic of research. We have been leading the world in this field since our first proposal of quantum annealing in 1998.

Unit Leader: Professor Hidetoshi Nishimori

Fukushima Reconstruction and Revitalization Unit

We are developing fundamental technology for environmental restoration and for promoting the decommissioning of reactors, with the goal of early recovery for Fukushima following the unprecedented accident at the Fukushima-Daiichi nuclear power plant in 2011.

Unit Leader: Professor Kenji Takeshita

Sustainable Chemical Resource Production Unit

Seeks to establish sustainable production methods for indispensable chemical resources to human society without using petroleum resources, and to establish a new industry.

Unit Leader: Professor Michikazu Hara

Nano Sensing Unit

Our goal is to commercialize an ultrasensitive accelerometer system through integrated circuit technology and integrated MEMS technology, and to apply it to sustainable medical and food production by open innovation.

Unit Leader: Associate Professor Hiroyuki Ito

Research Unit for All Solid-state Battery Unit

We are working on the development of all solid-state batteries, an innovation expected to lead to the next-generation of energy storage. A key technology in this endeavor is our superionic conductors (solid electrolytes). We will contribute to the early adoption of solid-state batteries by establishing the basic technology through industry-academic collaboration.

Unit Leader: Professor Ryoji Kanno

The organization will be expanded to a research center in April 2021.

Strategic Research Hubs

Promotes cutting-edge global research supported by large-scale government funding

Earth-Life Science Institute (ELSI)

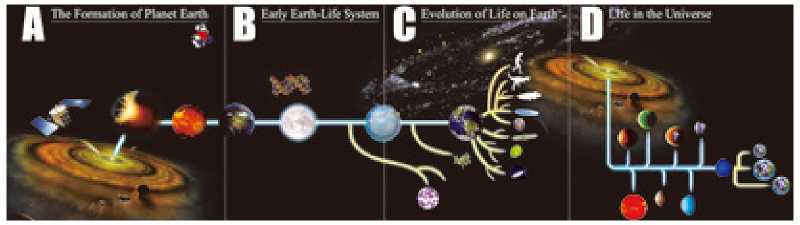
http://www.elsi.jp/en

Director: Kei Hirose

ELSI is a unique research institute that seeks to discover the "origins of the Earth and life" by bringing together world-class researchers in geoscience, life science, and planetary science from both Japan and overseas. With about half of its nearly 60 researchers coming from abroad, English is the official language of ELSI. The administration office has a dedicated staff to provide daily-life support for non-Japanese researchers. They also provide weekly Japanese classes. ELSI was selected by the MEXT - World Premier International Research Center Initiative (WPI).
(Established in 2012)

New ELSI building

Collaborative space 'AGORA'



ELSI research topics

Materials Research Center for Element Strategy (MCES)

https://www.mces.titech.ac.jp/en/

Director: Hideo Hosono

The MCES creates useful innovative materials from abundant elements such as gravel and cement. The only center for electronic materials in Japan, it was adopted by the MEXT Element Strategy Initiative Project (Core Research Center Formation). (Established in 2012)

Genso Cube is a new research facility with 18 windows at each floor, the same number of elements in a row of the periodic table

Atomic resolution analytical electron microscope

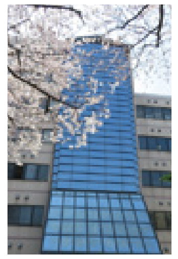
Research Institute for the Eeath Inclusive Sensing

https://www.coi.titech.ac.jp/ri-eis

Director: Hitoshi Wakabayashi

Research Center for the Earth Inclusive Sensing with Silent Voices (EISESiV)
The research center aims to solve social / earth issues for humans and nature to coexist using sensing technology and AI / IoT edge technologies. We are proceeding the research aimed at realizing a society of mutual assistance and coexistence and co-prosperity with the global environments by sensing phenomena that have not been noticed so far, providing them as interpretable information, and encouraging people to take voluntary actions.
Selected as a Center of Innovation (COI) Program of the MEXT.

Industry-University Consortium for Integrated Systems-Materials (iSyMs)
A consortium to accelerate the growth of integrated-circuit industry has just launched to research new materials, devices and architectures with novel operating principles. It aims to make a leap forward in the industry based on IoT/AI technologies achieving ultra low power consumption systems, which is the most important for the conservation of the global environments.



Ishikawadai Bldg.1

EISESiV Research Center for the Earth Inclusive Sensing Empathizing with Silent Voices

iSyMs Industry-University Consortium for Integrated Systems-Materials

Laboratory for Design of Social Innovation in Global Networks (DLab)

Developments in science and technology offer us infinite possibilities for a better tomorrow. By gauging the needs and desires of society through dialogue with the public, and by designing our future together, DLab aims to create a brighter, more prosperous world.

Open platform to create the future we want

Since its establishment in 2018, DLab has brought together Tokyo Tech students, faculty, and staff with members of the public at workshops and other events to brainstorm together the future we want.
In January 2020, DLab unveiled a jointly created image of future society, the Transchallenge concept which summarizes this vision, and the Tokyo Tech Future Chronology — currently consisting of 24 Future Scenarios — at a public event in central Tokyo. With the tools created so far, DLab continues to develop its future image through a broad perspective while encouraging all interested parties to join the conversation.

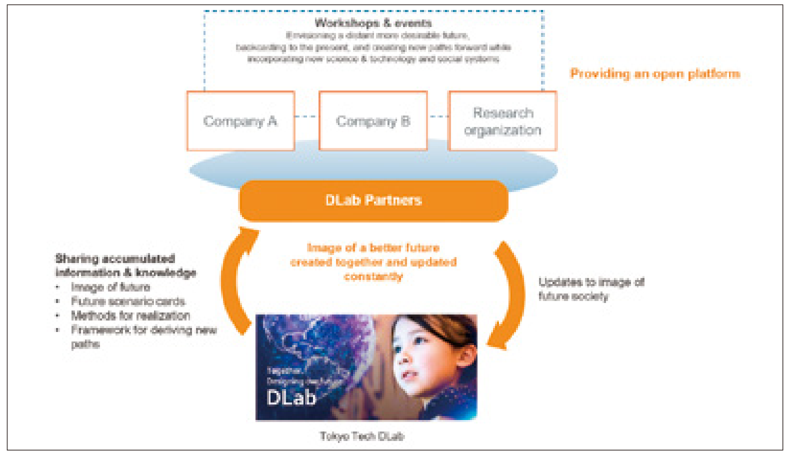
Scenes from bustling workshop

Tokyo Tech Future Chronology

Public launch of vision

Supporting future-oriented research
The DLab Challenge Research Grant supports research connected to the realization of the future image and scenarios created by DLab, and research that contributes to the creation of new disciplines required to realize this image.

DLab Partners — Connecting with the business sector
DLab welcomes the participation of businesses and organizations. After joining DLab on a membership basis, DLab partners Partners can expect a setting where ideas are freely shared regardless of affiliation or position — an open place to think about the future. In principle, all information shared and ideas created during these sessions are open to the public.



School of Science

Exploring and creating knowledge

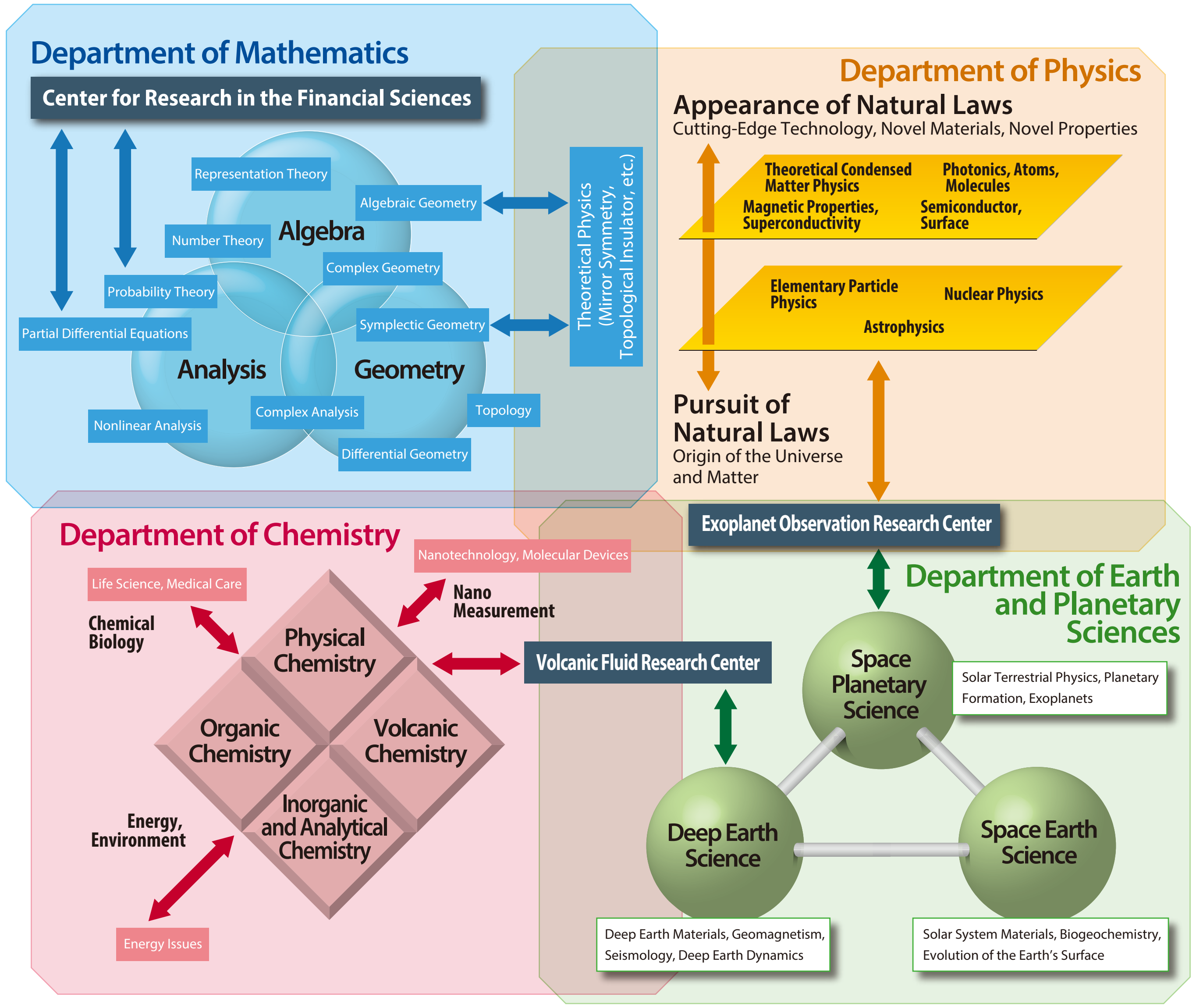
The School of Science comprises four departments, the Departments of Mathematics, Physics, Chemistry, and Earth and Planetary Sciences. The School is committed to advancing science as the culture and knowledge of humankind and to taking a leading role in research and exploration at the frontiers of the natural sciences. While scientific research is independent of immediate applications, the concepts developed and the knowledge obtained through scientific activities have not only enriched the culture of human beings but also, eventually after ten or more years, contributed to solving the problems society and nature were facing.

DATA	As of May 1, 2020
Faculty/International	149/5
Research staff	19
Total Students/International Students	1,133/59
Students in Bachelor's Program/ International Students	665/17
Students in Master's Program/ International Students	335/22
Students in Doctor's Program/ International Students	133/20

Structure and Research Fields

Department of Mathematics	■ Analysis ■ Geometry ■ Algebra
Department of Physics	■ Elementary Particle Physics ■ Nuclear Physics ■ Astrophysics ■ Theoretical and Experimental Condensed Matter Physics
Department of Chemistry	■ Physical Chemistry ■ Organic Chemistry ■ Inorganic Chemistry ■ Analytical Chemistry ■ Volcanic Chemistry
Department of Earth and Planetary Sciences	■ Earth and Space Science ■ Space Planetary Science ■ Earth Internal Science

Approaches to Research



School of Engineering

Creating new industries and advancing civilization

The School of Engineering comprises below five Departments.

Mechanical Engineering: We will educate and research to discover new phenomena, principles and methods, and create new machines that harmonize the environment with humankind.

Systems and Control Engineering: We will create new value in the future society by integrating the real world (physical) and information (cyber) as a system.

Electrical and Electronic Engineering: We will educate and research the core technologies of energy technology, electronics, communication technology, etc., which are the core technologies of the diversified and sophisticated modern society.

Information and Communications Engineering: We conduct research and education on basic technologies and applied systems that support a human-friendly and sustainable advanced information and communications society.

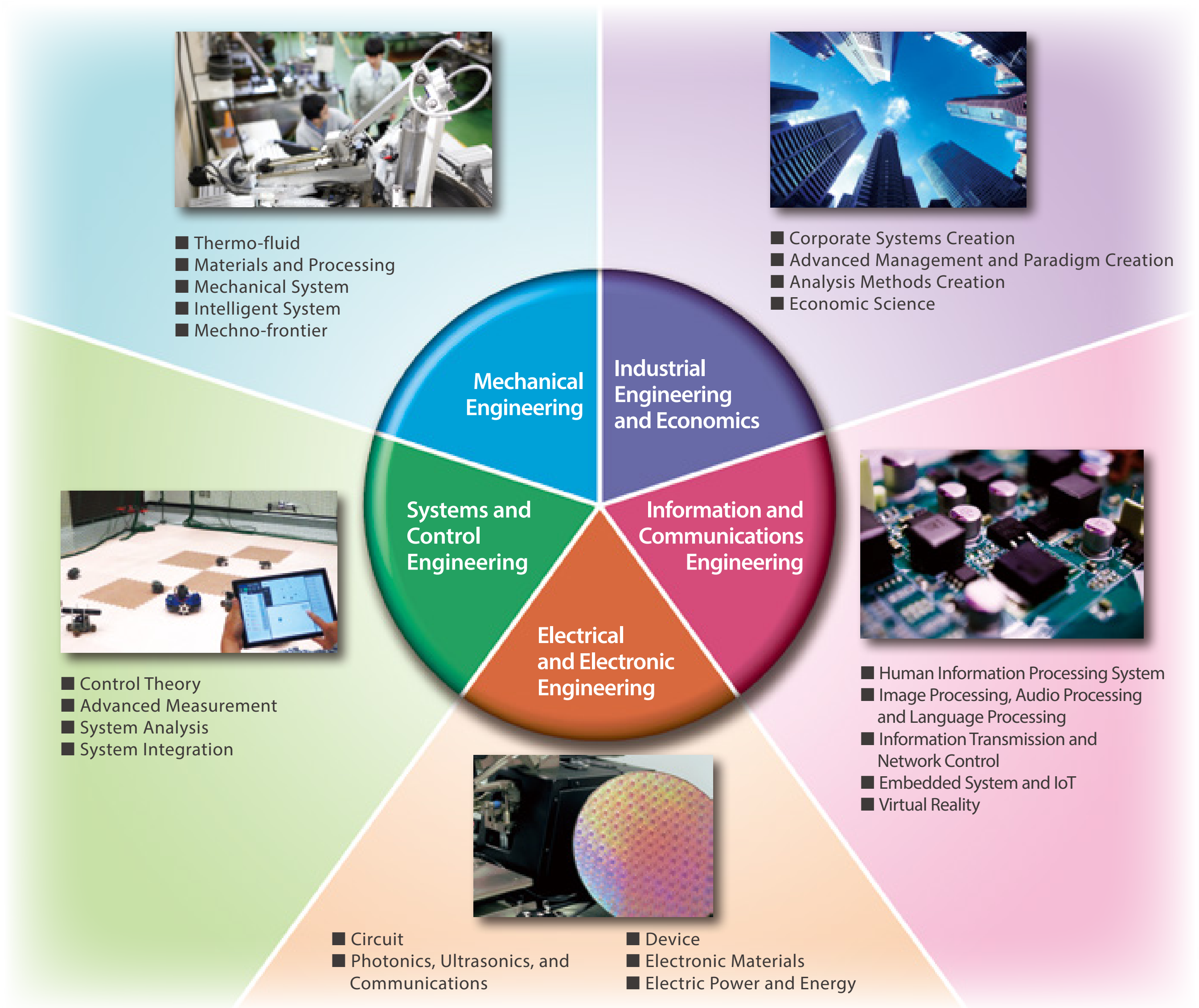
Industrial Engineering and Economics: Aiming to solve social issues in corporate management and economic systems from scientific and engineering perspectives.

DATA	As of May 1, 2020
Faculty/International	192/41
Research staff	41
Total Students/ International Students	3,230/544
Students in Bachelor's Programs/ International Students	1,636/79
Students in Master's Programs/ International Students	1,231/281
Students in Doctor's Programs/ International Students	363/184

We promote basic research aiming to expand the subjects in each technological field and promote interdisciplinary research through the establishment of cross-sectional groups with a focus on issues related to future society.

Industry-University Cooperation Office in School of Engineering organizes research teams made up of the best faculty members for each issue to respond to specific needs from industries. Through these systems, we advance technical development to identify solutions for a wide range of social issues and explore new industries such as renewable energy and energy saving technology, diversified spatial temporal system management, innovative interface devices and information networks that make use of the five senses, innovative sensing technology and information processing technology.

Structure and Research Fields



School of Materials and Chemical Technology

Creating of new compounds and new materials – Towards the foundation of an unlimited future

The School consists of two departments — Materials Science and Engineering, with its roots in solid state materials, and Chemical Science and Engineering, with its roots in molecular chemistry.

We also have affiliated research centers designated as national research hubs for research in chemistry and materials.

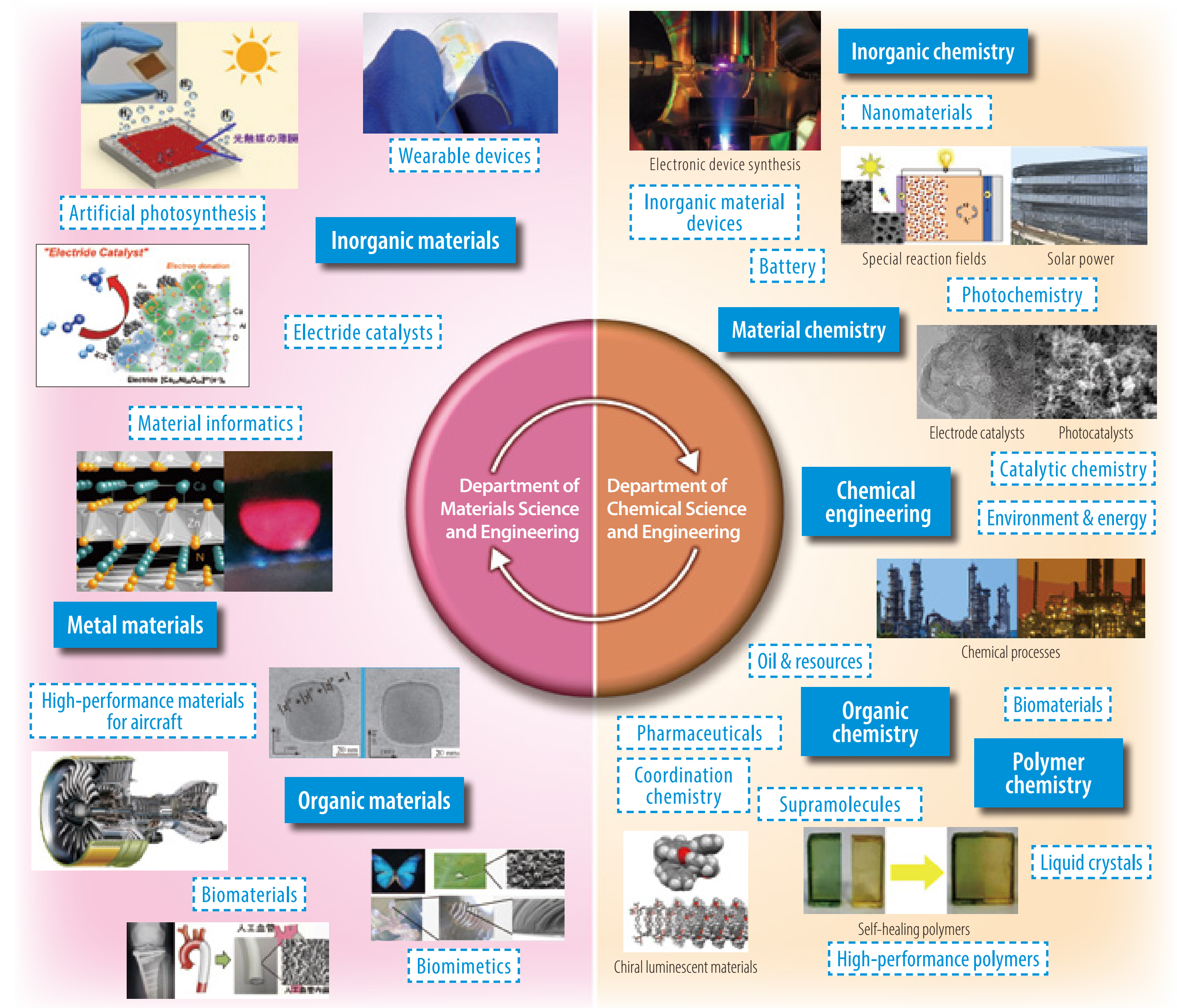
The department of Materials Science and Engineering 'creates new materials and new processes that contribute to the development of industry, and trains human resources that contribute to society', and the department of Chemical Science and Engineering 'applies the knowledge of chemistry and the latest technology with the aim to research chemistry that realizes dreams and create an infinite future'.

At the School of Materials and Chemical Technology, world-class researchers interact and cooperate with each other to study "theories and methods that give various new functions to substances and materials by manipulating chemical transformations." By creating substances and materials with new functions, we would like to contribute to improving the quality of our lives and solving issues such as the environment, resources, and energy.

Furthermore, through research, we are training researchers and engineers who can lead future material development with a high sense of ethics. We are also promoting education and research in close cooperation with industry through mechanisms such as "Research Alliance Program" and "Collaborative Research Cluster."

DATA	As of May 1, 2020
Faculty/International	146/6
Research Staff	31
Total Students/ International Students	1,934/298
Students in Bachelor's Programs/ International Students	799/31
Students in Master's Programs/ International Students	876/146
Students in Doctor's Programs/ International Students	259/121

Composition and research fields



School of Computing

Creating a Future Information Society

Information plays a key role in connecting people, advancing science and technology, and enriching our lives and society by making everything intelligent. Our mission is to contribute to the development of an information society by searching for truth in information and developing innovative technologies.

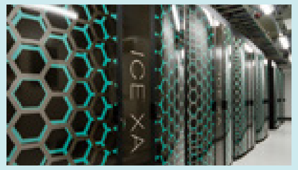
Our aim is to achieve our mission by pursuing truth in information, developing information technologies, and also expanding the applications of information technologies. To do this, we search for mathematical truth in information itself, as well as the computations that process information. Included in our scope is establishing fundamental technologies for software and computing platforms and also creating novel applications of advanced information technologies by overcoming technical challenges.

DATA	As of May 1, 2020
Faculty/International	76/5
Research Staff	18
Total Students/ International Students	949/165
Students in Bachelor's Programs/ International Students	446/19
Students in Master's Programs/ International Students	366/98
Students in Doctor's Programs/ International Students	137/48

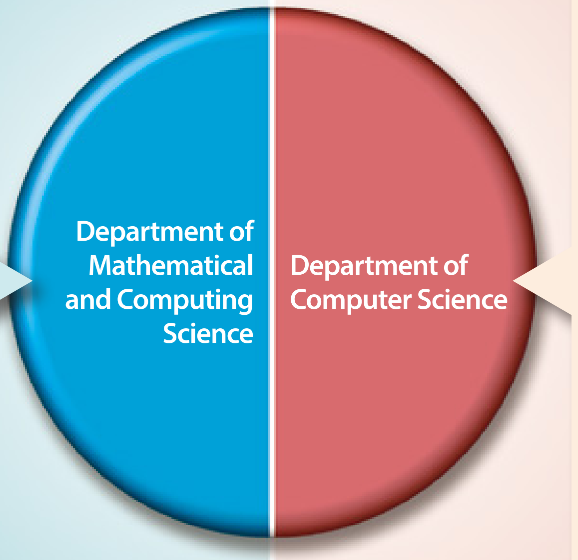
Structure and Research Fields

■ **Mathematics**
Differential Topology
Topology
Partial Differential Equations
Fluid Equations
Algebra

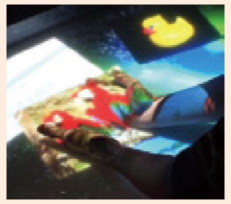
■ **Applied Mathematics**
Probability
Mathematical Optimization
Operations Research
Mathematical Statistics
Machine Learning
Big Data Analysis



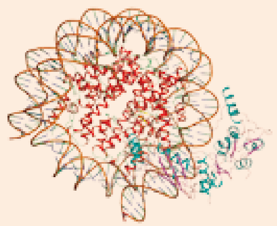
■ **Computer Science**
Cybersecurity
Algorithm Design
Mathematical Logic
Programming Languages
Information Visualization
High Performance Computing
Quantum Computing



Artificial Intelligence
Natural Language Processing
Speech/Image Recognition
System Control
Data Mining



Software Engineering
Parallel Computing
Human Interface
Virtual Reality
Databases



IoT
Bioinformatics
Signal Processing
Molecular Robotics
Molecular Simulation

Promotion of Academia-industry Collaboration and Social Partnership

Data Science & Artificial Intelligence Research Group for Social Good (DSAI) tackles various problems in our society through promoting research on data science and artificial intelligence with universities, research institutes, and companies all over the world.

Cybersecurity Research Center serves as a hub for collaborative research between industry, academia, and government, and responds to the demand for information security from industry. The center promotes practical research on information security through cooperation with universities, research institutes, and companies all over the world.

School of Life Science and Technology

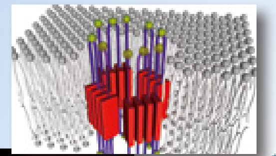
Unlocking life's code and transferring the knowledge to the benefit of society

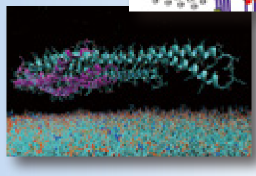
The School of Life Science and Technology's basic policy is "to unlock life's code, transfer the knowledge to the benefit of society, and contribute to establishing intellectual foundation shared by all humankind." In line with its policy, the School is promoting research exploring the truth, research creating the buds of next-generation industry, and research aiming at solving various issues for sustainable development of humankind, while creating better research environments for young scientists. In the School, over 100 faculty members are engaged in a wide spectrum of disciplines including structural biology, molecular biology, microbiology, biochemistry, genome informatics, evolutionary developmental biology, neurobiology, reproductive medicine, plant science, bio-imaging, organic chemistry, biophysics, biotechnology, bioengineering, and medical engineering, attempting to answer the question "What is life?" and transfer the knowledge to industrial applications. Moreover, to further attract researchers inside and outside and lead innovative science and technology, the School has identified bio-functional material sciences, synthetic biology & genome engineering, and health & medical sciences as three priority areas and is pioneering *Holistic Life Science*, an interdisciplinary research field aiming at the realization of bio-driven society.

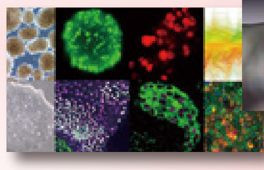
DATA	As of May 1, 2020
Faculty/International	94/2
Research staff	24
Total Students/International Students	1,195/147
Students in Bachelor's Program/ International Students	625/13
Students in Master's Program/ International Students	412/70
Students in Doctor's Program/ International Students	158/64

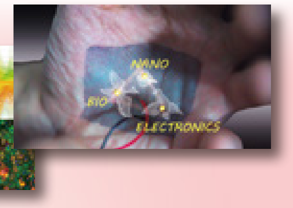
Structure and Research Fields

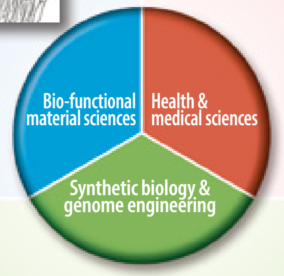
■ **Understanding the physics of life, learning from it, and creating superior materials.**
Meso-scale machine tools
Bio-nano devices
Drug delivery system
Low environmental impact materials
High-performance catalysts
High-precision analytical technologies





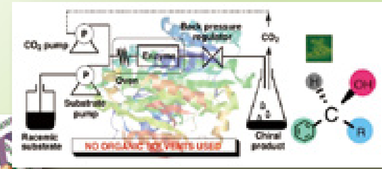


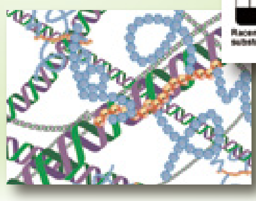




■ **Healthcare transformation to realize healthy longevity society.**
Reproductive medicine
Microbiology & health science
Medical devices
Innovative diagnosis & treatment
Brain & neural circuits

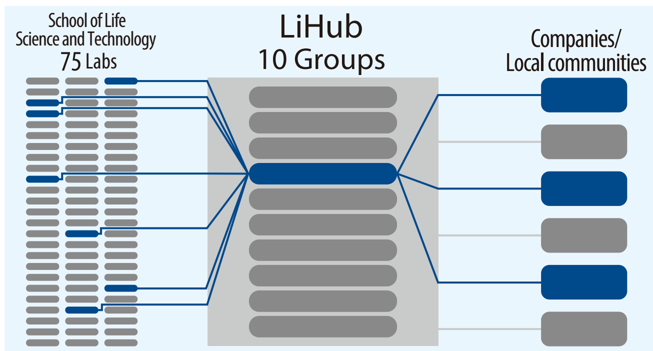
■ **Unlocking life's code and transferring the knowledge to society through analysis and synthesis.**
Functional genomics
Evolutionary process of genes
Development of multicellular organisms
Microorganisms for bioremediation
Artificial cells
Stable supply of rare substances



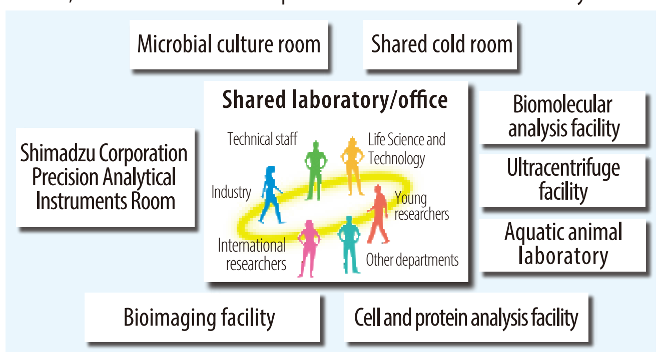


Promotion of Academia-industry Collaboration and Social Partnership

Life Science and Technology Open Innovation Hub (LiHub), as a center of knowledge for life innovation, fulfills its mission to serve as a bio-creative interface between frontier research and industry.



Open Research Facilities for Life Science and Technology (ORFLT) has been established for the sharing of advanced life science-related equipment at university-wide level at the School of Life Science and Technology. In 2019, we have started to accept users from outside the university.



School of Environment and Society

Solving complex social issues through the integration of humanities and science for inclusive and sustainable global development

The School of Environment and Society pursues academic and technological excellence not only in the construction of individual buildings, but also in the creation of sustainable environments on regional, national, and global scales. Contemporary issues relating to our environment, be it preparedness for large-scale natural disasters, the preservation of biodiversity, or a balance between the global economy and local historical and cultural traditions, cannot be achieved through expertise in one single discipline. Collaborative action across traditional borders is crucial. The School's departments of Architecture and Building Engineering, Civil and Environmental Engineering, Transdisciplinary Science and Engineering, Social and Human Science, and Innovation Science/Technology and Innovation Management utilize hard and soft technologies, technical ingenuity and creative action, and a wide range of interdisciplinary academic fields to address a variety of problems confronting the world.

DATA	As of May 1, 2020
Faculty/International	119/8
Research staff	23
Total Students/ International Students	1,745/473
Students in Bachelor's Program/ International Students	602/112
Students in Master's Program/ International Students	827/230
Students in Doctoral Program/ International Students	316/131

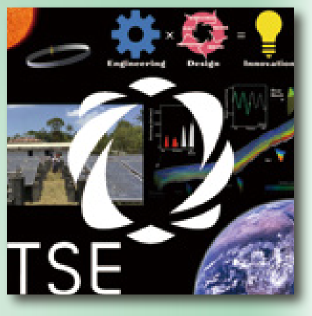
Structure and Research Fields

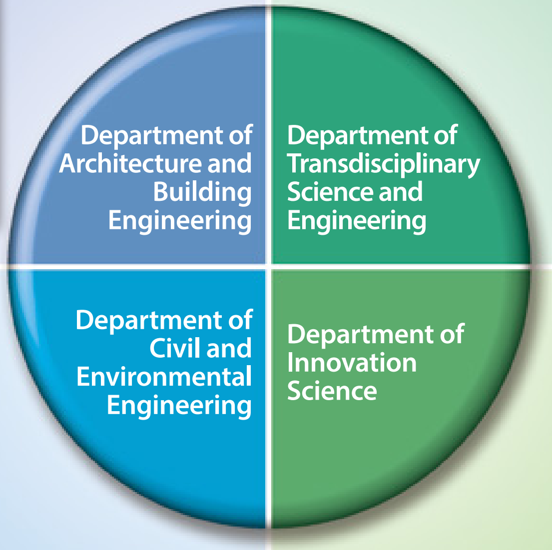
Covering a wide range of fields, including design theory, the history of architecture, architectural planning, structures and materials, and urban design and built environment

- Architectural Design
- Sustainable Architecture
- Architecture Engineering
- Architecture Project Management
- Urban Space Management

Solving global problems with knowledge from science and technology

- Human-Societal Systems
- Environment-Natural Systems
- Expert and Artificial Systems
- Integration-Harmonization Systems





Building our environment and societies, protecting life, and committing to future prosperity

- Next-Generation Infrastructure and Space Management
- Systems for Sustainable Society
- Social Safety Systems
- Urban Space Management

Establishing new theories and practical academic disciplines for innovation

- Intellectual and Technological Value Creation
- Economic Value Creation
- Social and Public Value Creation

Institute for Liberal Arts

Envisioning an alternate future through the fundamental and ethical integration of knowledge in science and engineering, and the utilization of logos, pathos, and ethos from the liberal arts

The Institute for Liberal Arts (ILA) carries out interdisciplinary research centering on the fields of humanity and social science. We seek to truly understand what we are and what the world is to discover new bases of intellect and knowledge to enhance lifestyles.

At the same time, the ILA also plays a role as a think tank to implement science and engineering knowledge into society, which contributes to large-scale research projects developed by Tokyo Tech.

DATA	As of September 1, 2020
Faculty/International	57/5

Structure and Research Fields

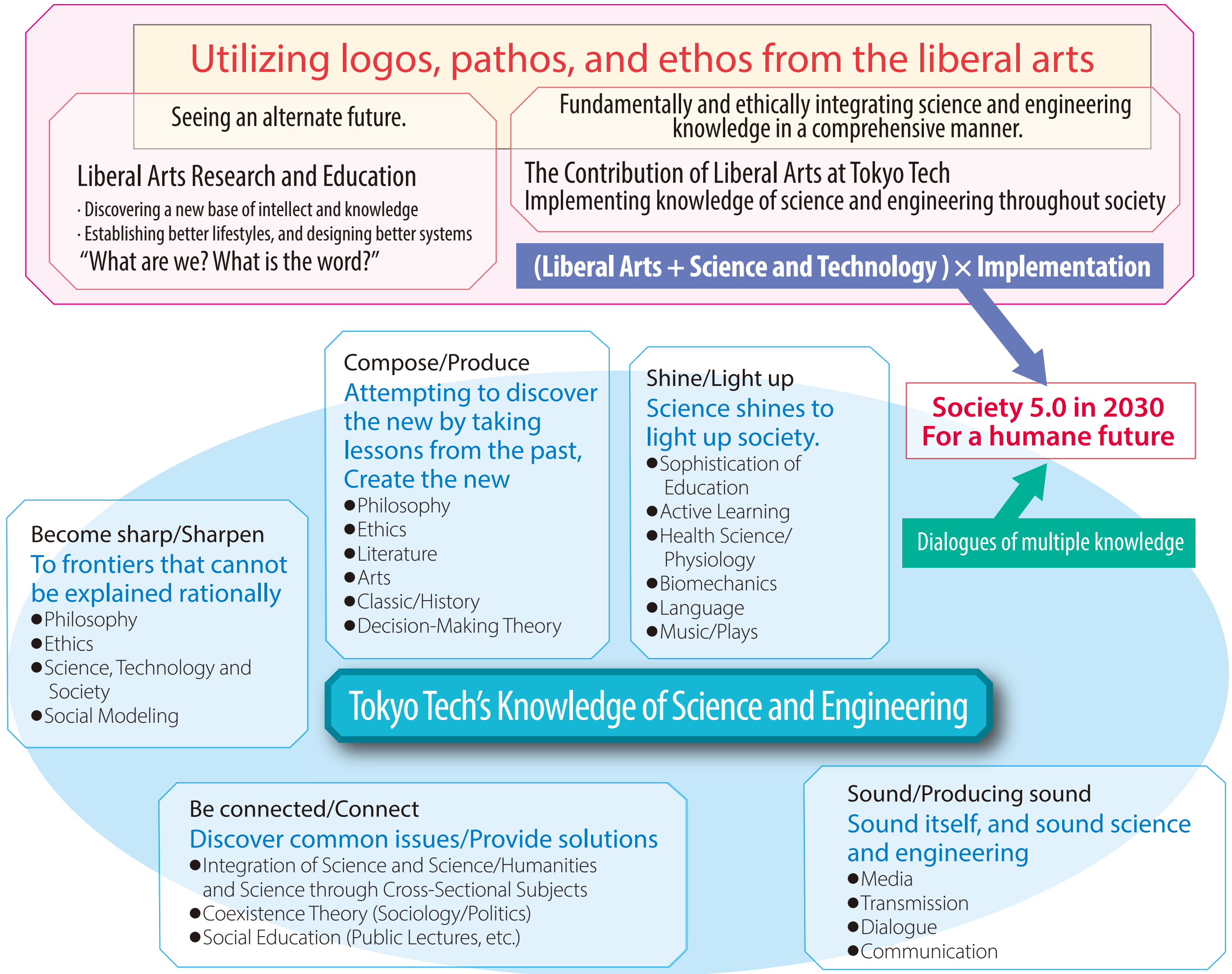
The ILA provides liberal arts education to all Tokyo Tech students. The ILA provides different courses in the Humanities and Social Science, English Language, Second Foreign language, Wellness, Japanese Language and Culture, and Teacher Education. The ILA also provides initial education immediately after enrollment, leadership education given in master's programs, and interdisciplinary research and education related to social issues given in doctoral programs, all beyond the boundary of specialization.

The ILA offers opportunities to conduct research in a wide variety of fields that cover an extensive range of research themes. For example, instructors in charge of language carry out research on art, or instructors in charge of humanities and social science handle mathematical models. Please see the table for the research fields of individual instructors.

The ILA oversees knowledge in science, engineering and society, and has come to play a role as a bridge to building better lifestyles.

Approaches to Research

— Future Vision —

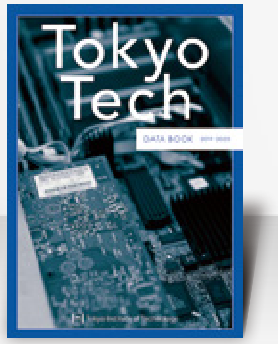


Publications

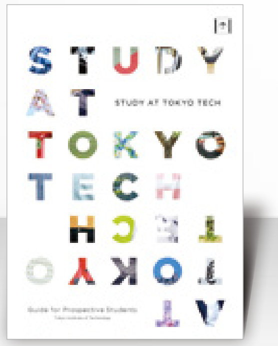
J Japanese E English J/E Japanese and English

Tokyo Tech Overview J E

Data Book J E



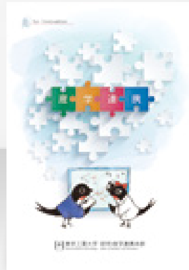
Study at Tokyo Tech 2021 E



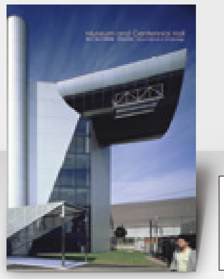
Tokyo Tech Faces Findings J E

Tokyo Tech Research 2021-2022 J E

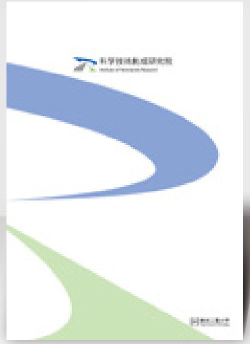
Industry Liaison J E



Museum and Centennial Hall J E

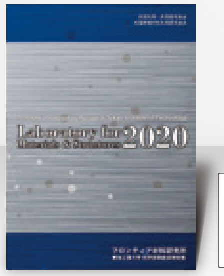


Institute of Innovative Research J E



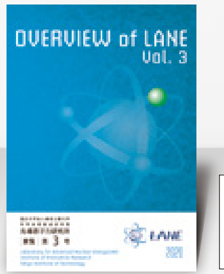
FIRST 2020 Laboratory for Future Interdisciplinary Research of Science and Technology J/E

Laboratory for Materials and Structures 2020 J/E

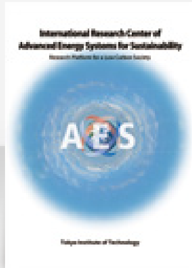


Laboratory for Chemistry and Life Science J

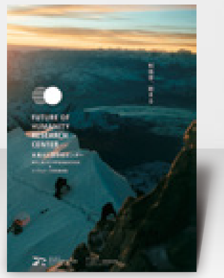
Overview of LANE Vol.3 Laboratory for Advanced Nuclear Energy J/E



International Research Center of Advanced Energy Systems for Sustainability J E

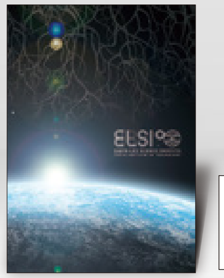


Future of Humanity Research Center J

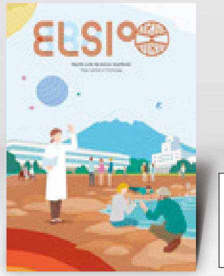


Research Unit J E

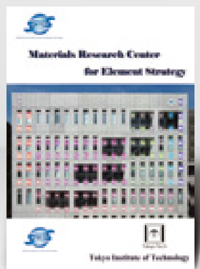
Earth-Life Science Institute ELSI J E



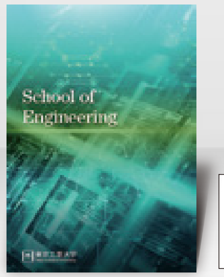
ELSI: Prospectus J E



Materials Research Center for Element Strategy J E



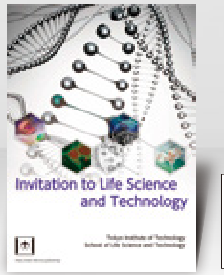
School of Engineering J E



Professor Profiles 2017 School of Materials and Chemical Technology J E

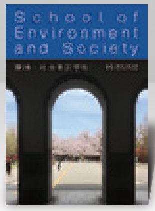
School of Computing 2020 J

Invitation to Life Science and Technology J E



Institute for Liberal Arts J

School of Environment and Society J/E



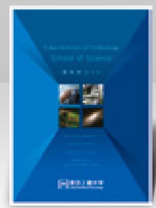
Architecture and Building Engineering J/E

Department of Civil and Environmental Engineering J

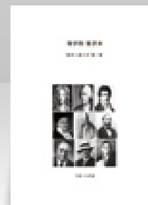
Undergraduate Major in Transdisciplinary Science and Engineering J/E

Department of Innovation Science J

School of Science J

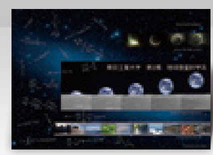


Department of Mathematics J

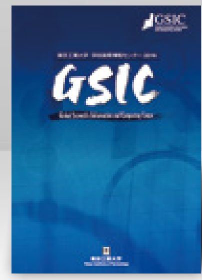


Department of Chemistry J

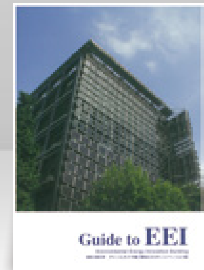
Department of Earth and Planetary Sciences J



Global Scientific Information and Computing Center J E

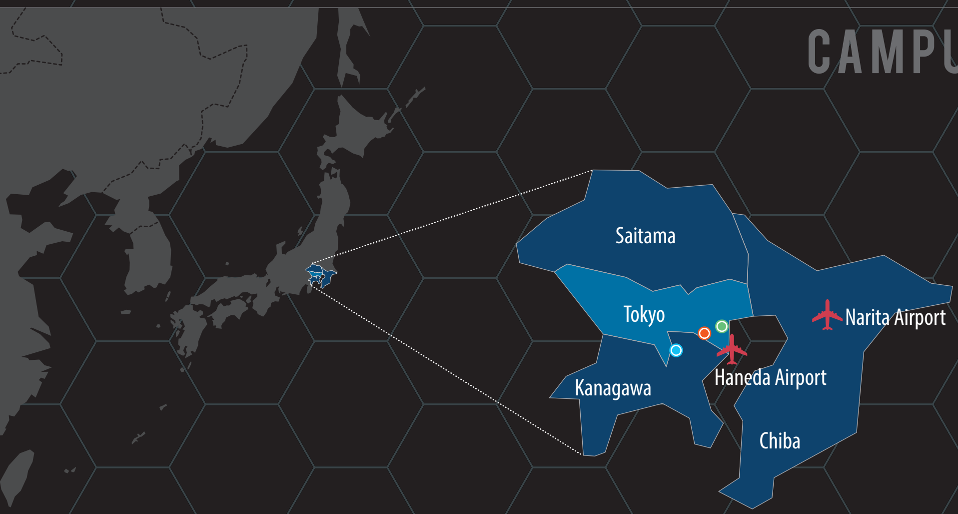


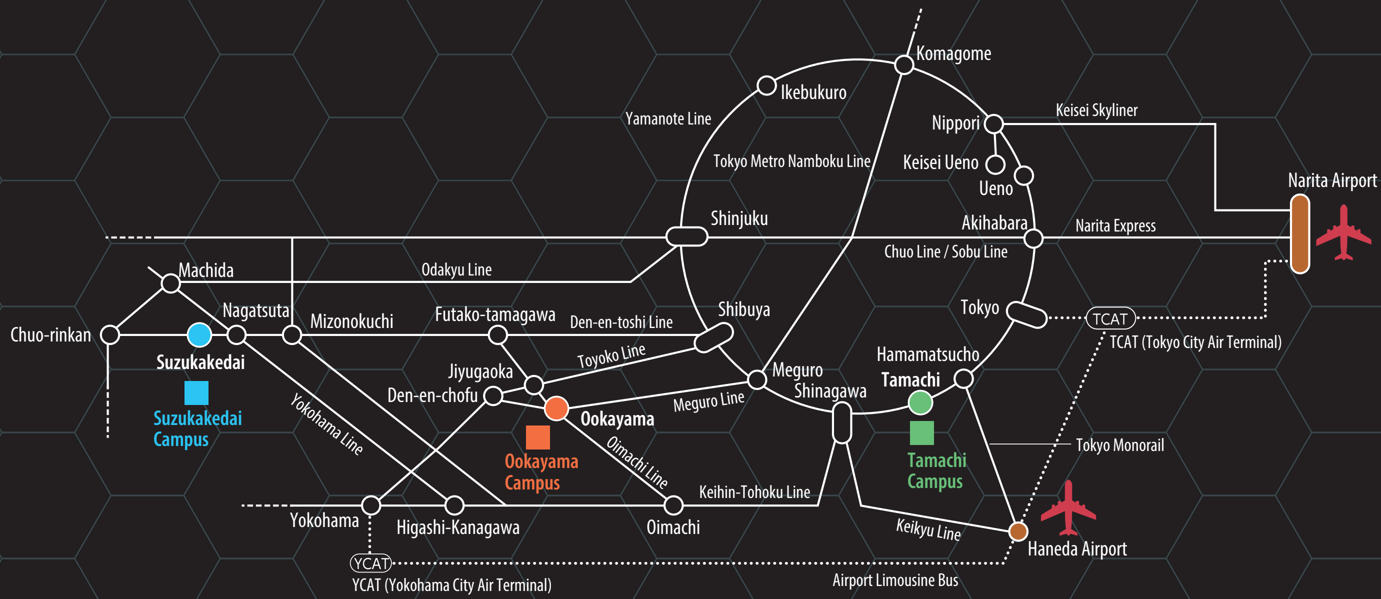
Guide to EEI Environmental Energy Innovation Building J E



Innovative Research Initiatives J

CAMPUS LOCATION & ACCESS





Suzukakedai Campus

4259 Nagatsuta-cho, Midori-ku, Yokohama, Kanagawa 226-8503 JAPAN

- 5-minute walk from Suzukakedai Station on the Tokyu Den-en-toshi Line
- 70 minutes from Haneda Airport
- 130 minutes from Narita Airport

Ookayama Campus

2-12-1 Ookayama, Meguro-ku, Tokyo 152-8550 JAPAN

- 1-minute walk from Ookayama Station on the Tokyu Oimachi & Tokyu Meguro Lines
- 45 minutes from Haneda Airport
- 85 minutes from Narita Airport

Tamachi Campus

3-3-6 Shibaura, Minato-ku, Tokyo 108-0023 JAPAN

- 2-minute walk from Tamachi Station on the JR Yamanote Line & Keihin-Tohoku Line
- 25 minutes from Haneda Airport
- 65 minutes from Narita Airport

東京工業大学
Tokyo Institute of Technology

Office of Research and Innovation
Tokyo Institute of Technology
2021. 2

www.titech.ac.jp/english