

# GRADUATE SCHOOL OF LIFE SCIENCE

## DIVISION OF LIFE SCIENCE

TRANSDISCIPLINARY LIFE SCIENCE COURSE

BIOSYSTEMS SCIENCE COURSE

BIOMEDICAL AND PHARMACEUTICAL SCIENCE COURSE

## DIVISION OF SOFT MATTER

## DIVISION OF CLINICAL PHARMACY

# Message from the Dean



Masakane Yamashita / Dean  
Graduate School of Life Science

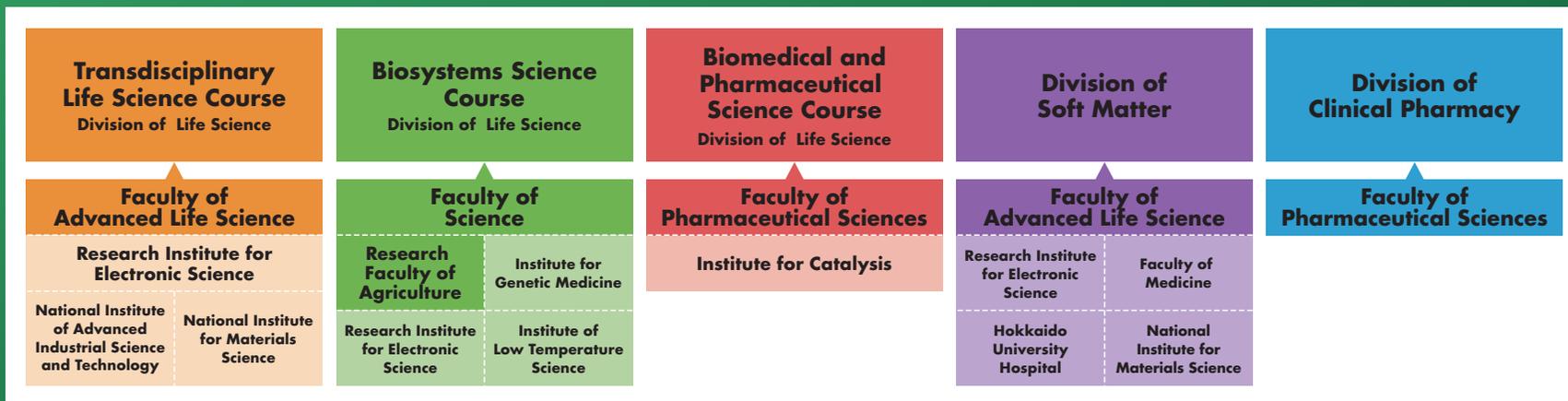
Hokkaido University has a longstanding history and has been dedicated to the education of students with global perspectives for nearly 140 years. The Graduate School of Life Science was established in 2006 to foster the development of students with multi-disciplinary views beyond the conventional boundaries of life sciences.

At the Graduate School of Life Science, students are taught by faculty members from five separate faculties (the Faculty of Science, Faculty of Pharmaceutical Sciences, Faculty of Advanced Life Science, Research Faculty of Agriculture, and Faculty of Medicine) and seven research institutions (the Institute of Low Temperature Science, Research Institute for Electronic Science, Institute for Genetic Medicine, Institute for Catalysis, Hokkaido University Hospital, National Institute of Advanced Industrial Science and Technology, and National Institute for Materials Science). It offers innovative graduate programs designed to help students acquire the knowledge and skills necessary to make

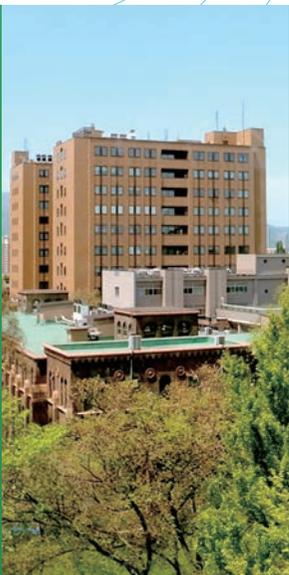
meaningful contributions to the continued development of life sciences. Following scientific training at Hokkaido University, many graduates continue their careers at academic institutions, including universities and diverse industries such as food, medical, pharmaceutical, chemical, environmental, educational, and engineering companies.

We welcome students from all over the world into our graduate program and offer various scholarship opportunities for international students who wish to study at the Hokkaido University (<https://www.global.hokudai.ac.jp/prospective-students/scholarships/>). Please review our laboratory list and contact faculty members at any time to obtain more detailed information pertaining to our educational and scholarship programs. We encourage you to join the Graduate School of Life Science, learn advanced life sciences with us, and enjoy life on our beautiful campus in Sapporo, Japan!

The Graduate School of Life Science has three divisions (Life Science, Soft Matter and Clinical Pharmacy) and three courses (Transdisciplinary Life Science, Biosystems Science and Biomedical and Pharmaceutical Science). Students can choose a division and/or course according to their research interests.



# Organization



# Transdisciplinary Life Science Course

## Division of Life Science



Website <https://life.sci.hokudai.ac.jp/en/tl/>



This course will help students develop research skills to investigate the nature of life from new perspectives based on a foundation in physics, chemistry, and biology. The course is designed to give individuals the life sciences knowledge and practical skills to have an active role in various industries.

As a prerequisite for the course, candidates are expected to have learned not only biology but also the basic natural sciences such as chemistry, physics, and mathematics during their undergraduate years.

To cultivate the next generation of leaders with innovative ideas supported by solid background knowledge, this course provides structured and comprehensive education in the life science fields. This educational program introduces four new essential life science study areas that were difficult to cover in previous curricula.

Research Fields and Laboratories

### Bioinformation and Molecular Sciences

Genome-based research, including structure and function analysis of biological molecules, super-molecular complexes and organelles, has made it possible to consider life as a network of bio-functional molecules. Furthermore, it is essential to establish a new research area of "Bioinformation and Molecular Sciences" by fusing various research fields. Students in this field will do research on revealing life phenomena using genetic information, X-ray structural biology, cellular biological techniques, and molecular cell biology.

### Biomaterials Science

In this field, students learn about the structures and characteristics of the substances that form life, as well as the chemical interactions and structures that are essential to biological functions. Students also focus on how these chemicals control the biological responses to the external environments. Moreover, they will use state-of-the-art technology to learn about drug discovery, functional foods, and the creation of artificial functional molecules. This field offers an overview of life from the perspective of material science based on chemistry and physics.

### Functional Cellular Sciences

All biological phenomena are caused by cellular activity. In this field, students learn about cellular functions through studying the molecular biology of internal and external cellular communication networks, interactions among cells, biological functions, and control mechanisms of the immune and nervous systems. It is also aimed at analyzing the mechanism and morphogenesis of stimulus reception and cellular responses using cutting-edge biomolecular imaging Efforts to clarify the cellular functions that support biological complexity enables developments in disease treatments.

### Functional and Regulatory Life Science

The biopathways from translation of genetic information to posttranslational protein modifications form a highly complicated system that is regulated by a variety of biomolecules. Disruption of this sophisticated biological system causes various diseases. We also have immune systems to protect against pathological injury and to repair or regenerate damaged tissues to restore normal function. In this field, you can learn and study complex living systems using a systematic and comprehensive approach that utilizes experiments at the molecular and cellular levels to specific tissues and animal models. A comprehensive study of the molecular mechanisms that maintain and regulate complicated biological functions can be achieved by means of organic synthesis and even genetic engineering, including emerging genome editing techniques. Conducting this research will give you the opportunity to master advanced strategies and methodologies needed in the drug discovery and biomedical fields.

### (Cooperative Education) Biomolecular Adaptation Science

Organisms produce various biomolecules that can be utilized for industrial and medicinal applications. To practically design and construct such biomolecules, students in this field learn both the basics and applications of molecular biology, biochemistry, nucleic acid engineering, photo-microscopy, and structural biology using both NMR and X-ray approaches. Specifically, our studies focus on the structure-function relationship of different types of macromolecular antifreeze and regulatory mechanisms of functional nucleic acids. We believe that your research experience on such biomolecules at the nucleic acid, protein, and cellular levels will improve your expertise in life science and will be indispensable for the advancement of science.

### (Cooperative Education) Frontier Biomaterials Science

The educational objective is to develop knowledge and experience in the fields of life science, materials science, and nanotechnology. The National Institute for Materials Science (NIMS) is the core research organization for the fields of materials science and nanotechnology in Japan. The Institute is highly experienced in the creation of metals, and inorganic and organic materials, as well as the manufacturing of materials. In the field of Frontier Biomaterials Science, the Institute will take full advantage of these skills to analyze phenomena such as the impact of nano-microstructures on cell differentiation and function at the molecular level and to control cell function and sense the state of cells, using biomolecules such as proteins, peptides, and oligonucleotides.



# Biosystems Science Course

## Division of Life Science



Website <http://www.lfsci.hokudai.ac.jp/bs/en/lab/>



Living organisms are dynamic systems in which a variety of organs, tissues, cells and cellular molecules interact to form a complex network. In Biosystems Science Course, graduate students are provided with tremendous opportunities to learn about diverse formation of living organisms through knowledge on the structure (morphology) and function (physiology) of these constituents. In particular, this course will focus on the mechanisms for maintaining the homeostasis and the adaptive modification of the cellular functions, as well as on the principles for the evolution of life. This course also promotes the integrative studies of organisms and their cells, including the analysis of the individual molecules' dynamic behavior in a spatiotemporal manner. In addition, graduate students will learn state-of-the-art methodologies and principles of microscopes, including electron and confocal laser microscopy, in order to master "the high resolution, multi-dimensional bio-imaging system."

Research Fields and Laboratories

### Higher Order Cellular Functions

Cells of microorganisms, plants, and animals display a variety of cellular functions, including growth, polarity, morphology, movement, adhesion, differentiation, and apoptosis. These cellular functions play essential roles in higher order events in life, and abnormality of them leads to diseases such as cancer. In order to understand higher order cellular functions, we have to know functions of signaling proteins and how these proteins are regulated in a whole cell system. We tackle problems in membrane dynamics, plant morphology and development, stress response, cancer, and neurodegeneration using model organisms, plants, and animal models.

### Animal Behavior and System Control

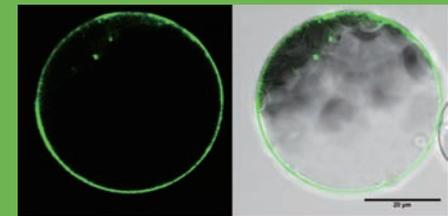
Animal behavior is causally linked with a variety of nervous system functions, including sensory integration, motor control, memory formation, emotion, and decision making. In this research group, insects and vertebrates (mainly birds) are used as subjects to study the organism-level behavior and the underlying neural mechanisms. Particular attention has been paid to ontogenetic development of animal communication, system-level understanding of associative learning, and the cellular computation responsible for precise sensorimotor coordination. Students will acquire leading-edge knowledge through use of state-of-the-art experimental techniques, such as molecular biology, microscopic imaging, neurophysiology /anatomy, and a variety of psychological manipulations. This course will also study the theoretical approaches to statistical analysis of behaviors and mathematical modeling of neural network.

### Reproductive and Developmental Sciences

In general, an important goal of life science research is to determine the factors that regulate the formation of germ cells and the generation of a new individual after fertilization. Reproductive and developmental science has two aspects: a basic science which pursues the mechanisms that guarantee the continuity and diversity of life, and an applied science which develops a technology to artificially control reproduction and development. In this course, students study the general mechanisms of germ cell formation and maturation, cell division regulation, and differentiation in embryonic development. The knowledge from this area of study can be applied to various reproductive manipulations with direct life consequences, such as in vitro fertilization, contraception, and the production of useful crops and animals. Currently, social interests in this academic field are extremely high, as represented by cloned animals and the regenerative medicine among other examples.

### Environmental Life Science

All living things are exposed to environmental stresses. A solid understanding in the basic concepts of environmental biology is achieved through the studies of the physiological processes to avoid stress injury, and the mechanisms for adapting and acclimating to environmental stress. Lectures in this course will focus on how living organisms sense and respond to environmental changes, which consequently lead to a reconstitution of the organisms. The subjects covered in this course will include: 1) the energy conversion systems for photosynthesis and mass production; 2) the metabolic regulation controlled by the functional RNA species and the post-translational processes, such as the ubiquitin-mediated protein degradation; and 3) the cellular regulations, such as cell division, cell differentiation, and cell development triggered by chromatin remodeling, gene regulation, and growth regulators.



# Biomedical and Pharmaceutical Science Course

## Division of Life Science



Website <http://www.pharm.hokudai.ac.jp/en/index.php>



“Innovative Genomics for Medicinal Science” is 21st century strategy for drug discovery. In Biomedical and Pharmaceutical Science Course, a new educational program for training of Ph.D. and Master Course students will be established based on the science and technologies of innovative drug design, structural biology, and genomic drug discovery. In this program, students will be able to effectively contribute to modern life sciences and medicine. This program discusses, at the molecular level, the relationship between the disruption of the genetic network and diseases, protein structural analysis, and structure function. In addition, the program also includes research to identify new target molecules, the molecular design and synthesis of drugs that act on these targets, the molecular mechanisms of the immune system, and custom nanomedicine.

In Biomedical and Pharmaceutical Science Course, there are three core divisions and one center: the Molecular and Cellular Biological Sciences division, the Chemistry and Medicinal Chemistry division, and the Biopharmaceutical Sciences and Pharmacy division, and the Center for Research and Education on Drug Discovery. Each group consists of biologists, physical chemists, organic chemists, and medicinal chemists. This course’s teaching staff conducts collaborative projects within the course as well as with researchers at other institutions and companies. Outstanding research projects include following: (1) analysis of pathogenic mechanisms for brain-wasting diseases (e.g. Alzheimer’s disease, Parkinson’s disease), immune diseases (autoimmune diseases), infectious diseases (measles, herpes, AIDS), and metabolic syndromes; (2) drug discovery for small molecules, biologics, and vaccines; (3) the logical design of pharmacological activity compounds ; (4) the development methodology for large scale synthesis; and (5) the development of a specific drug delivery system for a pharmacological activity. The Center for Research and Education on Drug Discovery was recently established in the Faculty of Pharmaceutical Sciences to facilitate academic drug discovery within the Hokkaido area. This center provides students with an opportunity for practical research on drug development.

Research Groups and Laboratories

### Molecular and Cellular Biological Sciences

**Biochemistry:** Regulation of cellular functions by lipid molecules; **RNA Biology:** Deciphering cellular and molecular processes regulated by RNA molecules; **Neuroscience:** Understanding the neuronal functions and disorders; **Immunology:** Cellular and molecular immunology; **Biomolecular Science:** Protein science of host defense

using nuclear medicine (PET, SPECT) and optical imaging technologies; **Innovative Nanomedicine:** Establishment of an innovative drug delivery system targeted to blood vessels; **Clinical Pharmaceuticals and Therapeutics:** Mechanisms of drug interactions and scientific to regulatory approaches, including optimizing and tailor-made pharmacotherapy; **Pathophysiology and Therapeutics:** Approach to pathophysiology of diseases and clinical therapeutics; **Pharmacokinetics:** Pharmacokinetics for suitable drug therapy

### Chemistry and Medicinal Chemistry

**Natural Products Chemistry:** Application of bioactive natural products to biomedical and life sciences; **Fine Synthetic Chemistry:** Development of novel reactions directed towards drug discovery, organic synthesis developed by transition metals; **Synthetic and Industrial Chemistry:** Synthetic organic chemistry toward drug design and development; **Organic Chemistry for Drug Development:** Rational design and efficient synthesis of drugs; **Catalysis in Organic Synthesis (at the Institute for Catalysis):** Development of novel catalysts and catalytic reactions for synthesis of new materials including biologically active substances

### Center for Research and Education on Drug Discovery

Low molecular weight compounds and biologics for intractable diseases, as one of six core centers of “The Leading-edge Research Infrastructure Program Compound Library Center” supported by the Ministry of Education, Culture, Sports, Science, and Technology.

### Biopharmaceutical Sciences and Pharmacy

**Pharmacology:** Cellular and molecular neuropharmacology; **Molecular Design of Pharmaceuticals:** Development of an intracellular drug delivery system and its application to nanomedicine; **Molecular Imaging:** in vivo molecular imaging research for visualizing the biomarkers of the disease



# Division of Soft Matter



Website <https://life.sci.hokudai.ac.jp/en/sm/>



The Division of Soft Matter offers both a Master's and Doctoral course that provide systematic education on basic knowledge related to scientific research of soft matter (physics, chemistry, biology) and its applied sciences (material science, life molecular science, biophysics, medicinal chemistry, and functional science) for students who lead researches and development of soft matter globally.

Soft matter is a general term for soft substances such as polymers, gels, biological materials, etc. Soft matter has many interesting behaviors and functions that so-called hard matter, such as metals and ceramics, do not have. Interesting behaviors arise from soft matter in ways that cannot be predicted or are difficult to predict, directly from its atomic or molecular constituents. This is often because soft matter self-organizes into mesoscopic structures that are much larger than the microscopic scale, and yet are much smaller than the macroscopic scale of the substance. The properties and interactions of these mesoscopic structures may determine the macroscopic behavior of the substance.

Soft matter is getting great attention as a growing field in the 21st century where there is a possibility of inventing brand new soft matter materials for various applications, from artificial tissues in the biomedical field to super-tough rubbers in industry.

Research Fields and Laboratories

## Soft Matter Materials Science

In this field, we aim to create new soft matter with a flexible, dynamic hierarchical structure, and discover unprecedented functions by understanding the advanced hierarchical structure and its functional principles from the molecular level up to the individual organism level in biological systems. In addition, we aim to actively cooperate with different fields, including the medical field, to develop high-performance soft matter suitable for specific applications.

ofbiophysics, we aim to elucidate the universal principle behind diverse life phenomena by making full use of physics and mathematics. Specifically, cooperative movements and three-dimensional morphogenesis of cell populations, animal behavioral studies of ameba and ciliates, mechanical functions and network formation of herbaceous trees, etc. are studied. Our aim is to raise the next generation of researchers in the interdisciplinary fields of biophysics and mathematical biology.

and synthesized towards applications in wearable-, stretchable- sensor, actuator, and polymer-gels based cell culture scaffold materials. National Institute for Materials Science is the location to conduct their experiments and offers students to have multidisciplinary collaborations with metals, inorganic, medical materials fields and advanced nanotechnologies as well as informatics.

## Biomolecular Soft Matter

Biopolymers such as proteins, peptides, and DNA are representatives of soft matter. For example, soft structural changes of polymer chains such as protein folding and dynamics are closely related to their functions. It is expected that this analysis is crucial not only for the understanding of natural soft matter but also for the creation of new types of soft matter. In this education field, we analyze biomacromolecules using various spectroscopic methods centered on NMR spectroscopy, essential for molecular structure and dynamics research, and train researchers specializing in molecular design.

## Soft Matter Medical Science

Students acquire basic knowledge necessary for the clinical application of soft matter, such as macromolecule synthesis hydrogels by applying skills in biochemistry, molecular cell biology, and pathological analysis for studying physiological activities and biological reactions of soft matter materials. In this field, we aim to raise personnel capable of interdisciplinary thinking and research that combines material science and medicine. In addition, by carrying out animal experiments and clinical research, we will work in a position to bridge our research towards clinical application, which will allow powerful development of soft matter materials in practical clinical applications.



## Soft Matter Biophysics

Understanding biological phenomena such as movement, proliferation, and morphogenesis of the cell, tissue, and individual is indispensable not only in biology but also in biochemistry, physics, and mathematics. While studying soft matter in the field

## (Cooperative Education) Functional Soft Matter

This field aims to develop functional molecular and polymeric ultimate-soft matters such as optoelectronically-active liquids, ionic liquids, and block copolymers. These functional soft matters are designed



# Division of Clinical Pharmacy



Website [https://www.pharm.hokudai.ac.jp/en/research\\_03.html](https://www.pharm.hokudai.ac.jp/en/research_03.html)



The Division of Clinical Pharmacy was established in close cooperation with the medical field, in order to expand clinical and practical science-oriented education and research in collaboration with life science majors (Division of Life Science). The Division of Clinical Pharmacy offers a four-year doctoral degree program aimed at developing highly-trained professionals who possess the pharmaceutical clinical abilities and expertise demanded from society. Based on the practical science of pharmacy, this division aims to impart knowledge on pharmaceutical sciences that contribute to public health and safety, and to provide a graduate education in which students may cultivate a higher sense of ethics. In addition to basic pharmaceutical theories and technologies, this division's students participate in educational and research programs focused on advanced clinical pharmaceutical knowledge and technology (i.e. development and evaluation of advanced drug treatments, medical systems, regulatory sciences, etc.), which allow them to develop the practical abilities needed to apply their studies to clinical practices and to discover and solve clinical issues in the medical field through surveys and research.

## Departments

### Department of Clinical Pharmaceutics

- **Laboratory of Clinical Pharmaceutics and Therapeutics**  
Optimizing and customizing pharmacotherapy
- **Laboratory of Pharmacokinetics**  
Pharmacokinetics for suitable drug therapy
- **Laboratory for Molecular Design of Pharmaceutics**  
Development of intracellular drug delivery systems and applications to nanomedicine
- **Department of Pharmacy, Hokkaido University Hospital**  
Clinical trials and optimal pharmacotherapy

In this field, students gain highly specialized clinical pharmacy knowledge and skills needed for medicine and information management. In addition to experimental sciences, this department's research includes medical systems and pharmaceutical regulatory sciences designed to meet recent societal demands. One of the research themes centers on therapeutic

drug monitoring, in which pharmacokinetic variations related to changes in physiological functions during pathological conditions and drug interaction are considered. These programs will aid in the deployment of clinical research design and effective clinical pharmaceutical research.

### Department of Pharmacotherapy and Clinical Informatics

- **Laboratory of Pathophysiology and Therapeutics**  
Approach to the pathophysiology of the disease and clinical therapeutics
- **Laboratory of Bioanalysis and Molecular Imaging**  
Molecular imaging research for pharmaceutical sciences

Drug development begins with finding the targeted molecule to which medicine is applied. Animal models of cancer and inflammatory diseases are

used to clarify their mechanisms and verify whether medicines will have an effect on these diseases in humans. Also, it is important to develop methods to diagnose these diseases at early stage. This department conducts *in vivo* molecular imaging research for visualizing the biomarkers of the disease using nuclear medicine (PET, SPECT) and optical imaging technologies.

### Education Research Center for Clinical Pharmacy

The Education Research Center for Clinical Pharmacy was established in April 2010 with the aim of fostering pioneering pharmacists who will possess the skills and leadership necessary for responding to society's ever-growing needs and contributing to a wide range of work fields. This center operates in accordance with the 2006 national educational reform of pharmaceutical science and seeks to enrich the education and research that takes place under this new scheme.



# Useful Links

## Admissions

<http://www.lfsci.hokudai.ac.jp/en/>

## Faculty of Advanced Life Science

<https://life.sci.hokudai.ac.jp/en/fa/>

## Faculty of Science

<http://www.sci.hokudai.ac.jp/faculty/en/>

## Faculty of Pharmaceutical Sciences

<https://www.pharm.hokudai.ac.jp/en/>

## Hokkaido University

<https://www.global.hokudai.ac.jp/>

## Related Graduate Schools

### Graduate School of Science

<http://www.sci.hokudai.ac.jp/graduateschool/en>

### Graduate School of Chemical Sciences and Engineering

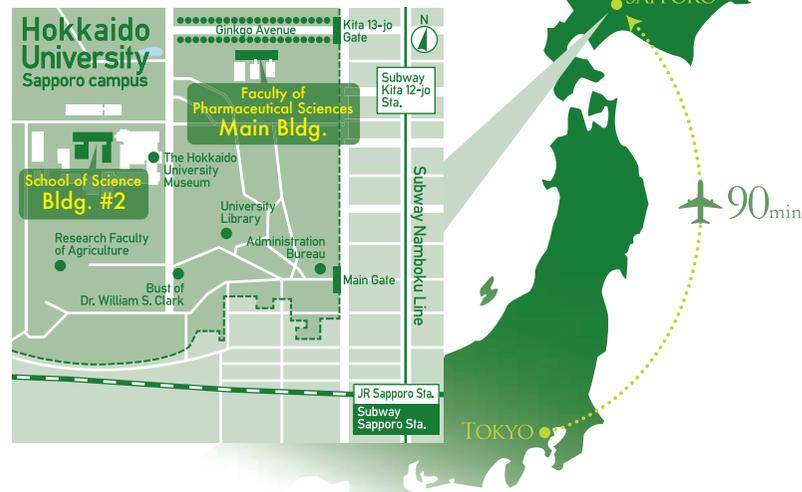
<http://www.cse.hokudai.ac.jp/english/>

# Contact

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# Step-by-step Guide To Entry

You need to have completed Step 1 at least six months prior to your intended enrollment !

**STEP 1**

## Find a Supervisor

Graduate and research students conduct research under the guidance of a supervisor. To enter the Graduate School of Life Science as a research or graduate student, you need to find a faculty member who is willing to give you instruction on your research. Find a prospective supervisor from our website:

### 1. Graduate School of Life Science Website

<http://www.lfsci.hokudai.ac.jp/en/>

List of supervisors and research fields are available in the application guidelines

### 2. Hokkaido University Website(HU Researchers Database)

<https://researchers.general.hokudai.ac.jp/search/index.html?lng=en>

### 3. HUSCAP

<http://eprints.lib.hokudai.ac.jp/dspace/>

**STEP 2**

## Apply to the graduate school

You can check how to apply in the application guidelines. Applicants must pay the examination/application fee at the time of application.

[http://www.lfsci.hokudai.ac.jp/en/admission\\_information/](http://www.lfsci.hokudai.ac.jp/en/admission_information/)

**STEP 3**

## Take the entrance screening (For Residing Abroad)

Screening procedures for research students are conducted on the basis of documentation submitted whilst screening procedures for graduate level students differ between each department.

**STEP 4**

## Commence enrollment procedures

After passing the screening process, you will be required to submit necessary documentation, pay the entrance fee, and complete other necessary procedures to become enrolled.