



Hokkaido University

# FACULTY OF SCIENCE

MATHEMATICS

PHYSICS

CHEMISTRY

BIOLOGICAL SCIENCES

EARTH AND PLANETARY SCIENCES

# Message from the Dean Koichiro Ishimori, Dean, Faculty of Science

Welcome to the Faculty of Science. The School of Science, which is the origin of the Faculty of Science, Hokkaido University, was established as the fourth School of the Hokkaido Imperial University in 1930. To accommodate 11 courses across six departments in the newly established School of Science, a modern building was constructed as the main faculty building (currently hosting the University Museum). The staircase room at the main entrance of the main science building has a dome-shaped ceiling with vintage reliefs displaying “fruits”, “sunflowers”, “bats”, and “owls” on the four walls, which signify “morning”, “noon”, “evening”, and “night” respectively. These reliefs express the determination of the people at the time of the establishment of the School of Science: Their devotion to unprecedented, cutting-edge research, regardless day or night, and determination that new scientific discoveries originating at the faculty should be conveyed from this northern land to the entire world.

Since its establishment in 1930, the determination and traditions of the pioneers at the time of establishment have been visible in the creative research conducted at the faculty. These include the first-ever artificial snow created by Dr. Ukichiro Nakaya and the development of the coupling reaction by Dr. Akira Suzuki, who was awarded the Nobel Prize in Chemistry in 2010.

Today, the faculty is one of the largest divisions in the university with more than 300 staff members, consisting of more than 200 teaching staff and 50 researchers, including specially appointed professors and postdoctoral fellows, as well as affiliated technicians, office staff, and support staff. It is composed of five departments, namely Mathematics, Physics, Chemistry, Biological Sciences, and Earth and Planetary Sciences. Affiliated institutes include the Institute of Seismology and Volcanology, the Genome Dynamics Research Center, and the Nuclear Reaction Data Centre. Every member of the faculty is engaged in cutting-edge research activities, and more than 10% of the faculty staff were listed as authors in the top 1% of the most cited papers published between 2003 and 2014. Additionally, the amount of competitive research funding and external funding acquired in recent years has remained at a high level, and the faculty has continuously been in the top one or two university divisions in terms of selections for Grants-in-Aid for scientific research.

On the other hand, its excellence does not simply concern a high level of research. As the division responsible for supporting scientific education throughout Hokkaido University, we are applying considerable efforts into constructing new teaching systems, including establishing the Leading Program Promotion Office in the faculty in 2014 in order to implement the graduate school's



“Ambitious Leader’s Program: Fostering Future Leaders to Open New Frontiers in Materials Science”. An Active Learning Promotion Office was also established with the goal of applying active learning, which is a new teaching method to scientific courses in 2015. Furthermore, in 2012, the Office for International Academic Support was established mainly to respond to internationalization as an organization that supports such research and education systems.

As the importance of university research and education in society increases, there will be a greater demand placed on universities in terms of the duty to produce numerous individuals who can contribute to society by, for example, supporting global cutting-edge research and a variety of advanced industries. The faculty must continue moving forward to be at the forefront of research and education so that we can respond to this demand from society. We would like to ask each and every one of you for your continuing and increasing support.



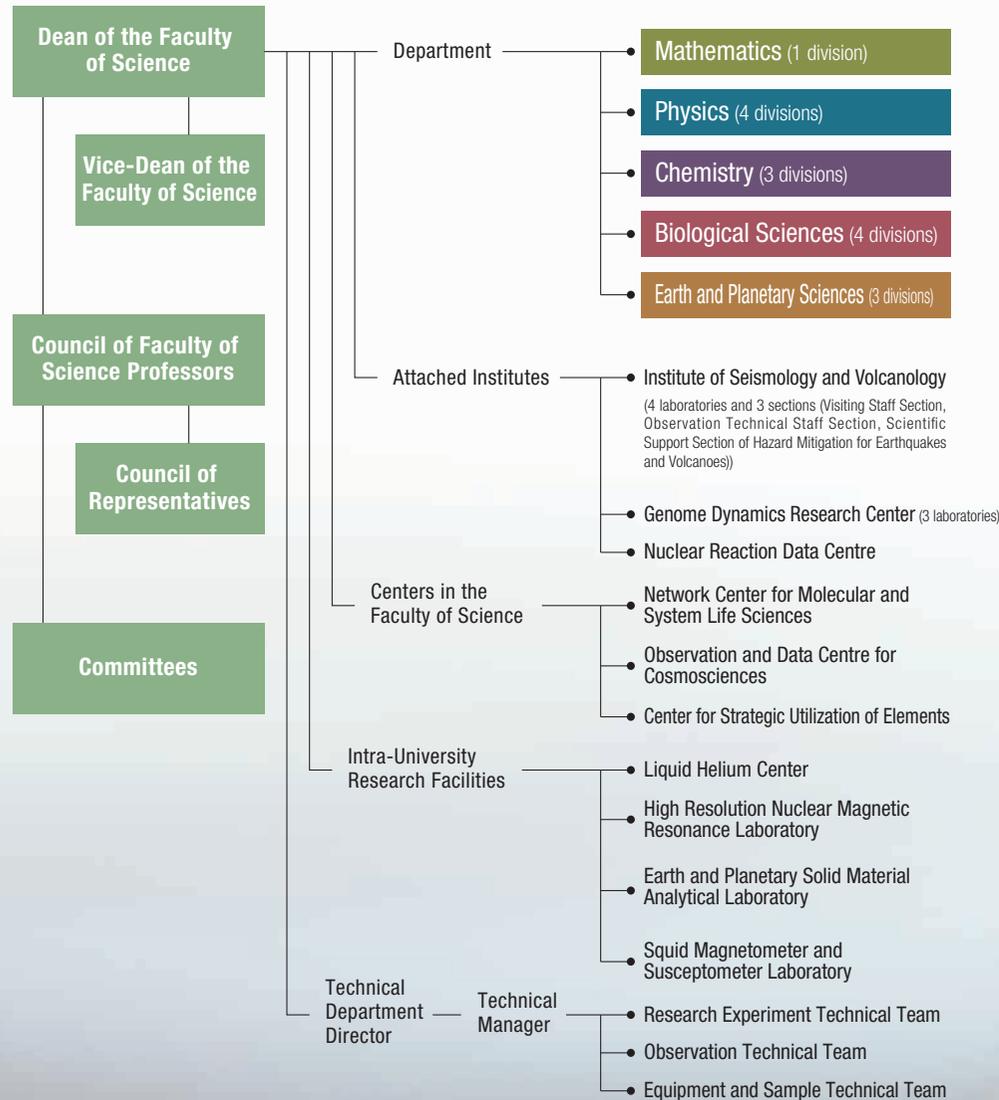
# History

- 1930** School of Science is established with six departments: Mathematics, Physics, Chemistry, Geology and Mineralogy, Botany, Zoology.
- 1949** Departments of Botany and Zoology are combined as Department of Biology.
- 1953** Graduate School of Science (post-war educational system) is established with six departments: Mathematics, Physics, Chemistry, Geology and Mineralogy, Botany, and Zoology. Department of Geophysics is created.
- 1959** Department of Polymer Science is established.
- 1963** Department of Chemistry II is formed.
- 1980** School of Science celebrates the 50th anniversary.
- 1981** High Resolution Nuclear Magnetic Resonance Laboratory is established.
- 1985** Laboratory for Energy Dispersive and Wave Length Dispersive X-ray Fluorescence Spectroscopy is established.
- 1988** Laboratory for Squid Magnetometer and Susceptometer is established.
- 1993** Departments of Biology and Polymer Science are reorganized into Department of Biological Sciences
- 1994** Departments of Geology and Mineralogy & Geophysics are reorganized into Department of Earth Sciences
- 1995** Departments of Chemistry and Chemistry II are reorganized as Department of Chemistry
- 1998** Institute of Seismology and Volcanology is established by combining 4 observatories, Research Center for Earthquake Prediction and Laboratory for Ocean Bottom Observatory.
- 2005** School of Science celebrates the 75th anniversary.
- 2006** Graduate School of Science is reorganized into “Graduate School of Science” and “Faculty of Science”. Faculty of Science consists of five Departments: Mathematics, Chemistry, Physics, Natural History Sciences and Biological Sciences.
- 2007** Nuclear Reaction Data Centre is established. Network Center for Molecular and System Life Sciences is established. Observation and Data Centre for CosmoSciences is established.
- 2008** Genome Dynamics Research Center is established. Center for Strategic Utilization of Elements is established. Move to the current set of buildings (Bldg 2-8) is completed.
- 2010** Dr. Akira Suzuki, a professor emeritus at our university and an alumni and former faculty member is awarded the Nobel Prize in Chemistry.
- 2011** Nuclear Reaction Data Centre is established.

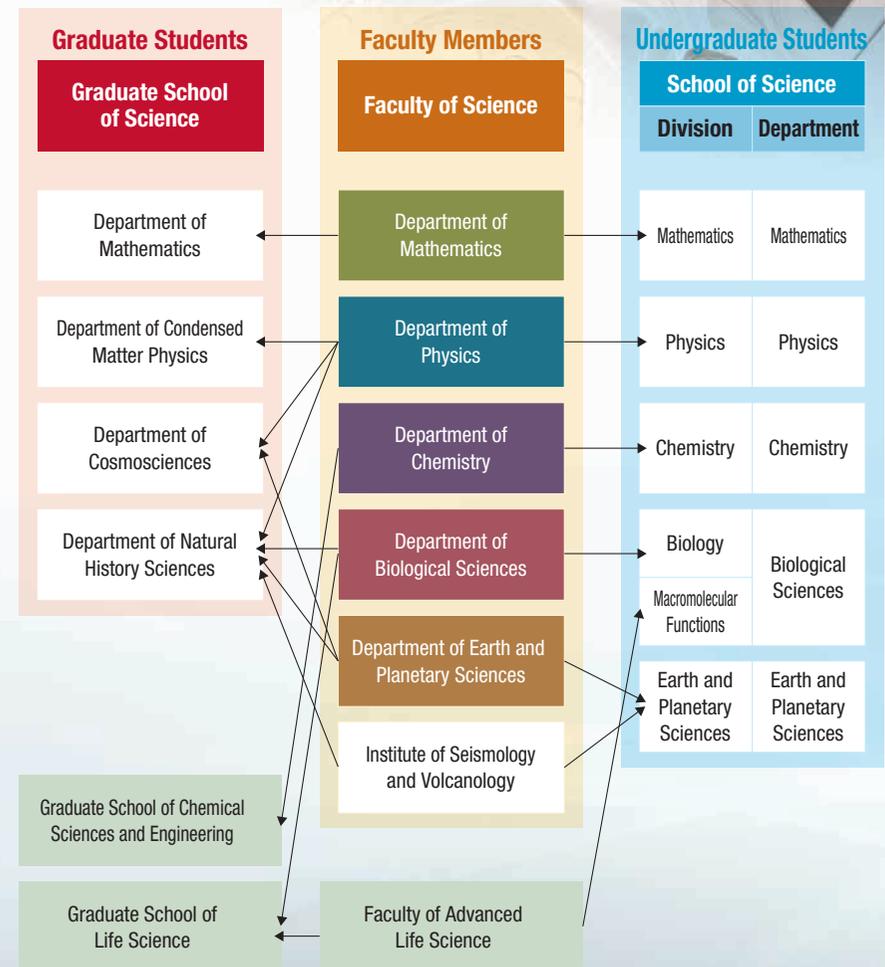


# Organization

## Faculty of Science



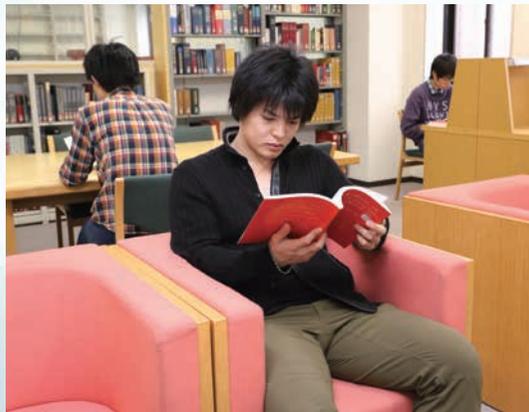
## Relationship between the Faculty, Graduate School and School of Science



# Department of Mathematics

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

The Department of Mathematics, established in 1930, has approximately 40 academic staff, 150 undergraduate students (2nd–4th year), and 100 masters/doctoral graduate students. We host several international conferences with over 200 visitors every year. Our department covers a wide range of research areas — from theory-driven approaches that mainly seek to achieve theoretical sophistication to more empirically oriented approaches that employ computers for calculations on various phenomena. More specifically, our research fields include hyperplane arrangements, representation theory, differential geometry, singularity theory, partial differential equations, mathematical physics, chaos, probability theory, dynamical systems, and so on. We have published the Hokkaido Mathematical Journal since 1972 in collaboration with the Mathematics Library, which contains about 85,000 books and 1500 journals.



Mathematics Library

Our major achievements are: (1) the 21st Century Center of Excellence (COE) Program *Mathematics of Nonlinear Structure via Singularity* from 2003 to 2008, and (2) the Japan Society for the Promotion of Science (JSPS) International Training Program *The International Sending-Elevating Project for Young Mathematicians Based on Singularity, Topology and Mathematical Analysis: Hokudai Model* from 2008 to 2012. After the fruitful success of the COE program, we founded the Research Center for Integrative Mathematics in 2008.

In addition to our departmental staff, several members of the Research Institute for Electronic Science contribute to our diverse educational program.



Discussion



International conference

## Specialized Fields and Laboratories

### Algebra

- Algebraic analysis
- Algebraic geometry
- Arithmetic geometry
- Hyperplane arrangements
- Infinite analysis
- Representation theory
- Special functions
- Vertex algebras

### Geometry

- Contact geometry of second order
- Differential geometry
- Dynamical systems
- Group cohomology
- Mirror symmetry
- Singularity theory
- Sub-Riemann geometry
- Topology

### Analysis

- Algebraic analysis
- $C^*$ -algebras
- Geometric measure theory
- Geophysical equations
- Harmonic analysis
- Mathematical physics
- Nonlinear dispersive equations
- Potential theory
- Probability theory

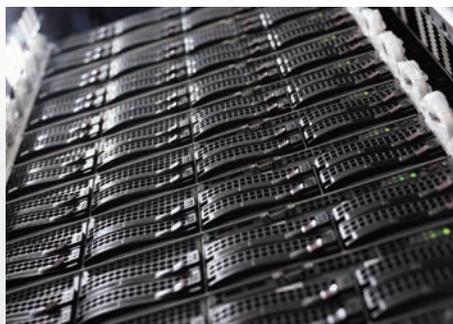
### Applied mathematics

- Asymptotic analysis
- Chaos
- Complex systems
- Dynamical systems
- Ergodic theory
- Ginzburg-Landau equation
- Probability theory
- Statistical Mechanics

# Department of Physics

<http://phys.sci.hokudai.ac.jp/en/>

Physics is a discipline that studies the universal laws and principles that are followed by each and every entity in the natural world. The early 20th century saw the establishment of quantum theory, and modern physics has been having a tremendous impact on science and technology ever since. Studying physics leads us to understand the foundation of every branch of science and technology, which in turn, leads us to acquire tools and perspectives that allow us to flexibly navigate the rapidly changing world of science and technology.



Computer: A computer cluster for the large-scale numerical calculations (Theoretical Physics groups).



STM: Experiments with the use of low-temperature high-vacuum scanning tunneling microscope (High-Pressure Physics).

The Department of Physics was established in 1930 and is one of the oldest departments in the Faculty of Science. In 1994, the History of Science course and the two cooperative courses in Condensed Matter Physics at the Research Institute for Electronic Science (RIES) were added to our department. Now about 40 staff members provide quality education and conduct cutting-edge research. Our challenging research covers natural phenomena on any spatiotemporal scale; from large-scale numerical simulations of the formation of stars and galaxies (Astrophysics), elucidation and manipulation of the various electronic properties in a material, including magnetism, dielectricity, and superconductivity (Condensed Matter Physics), the construction of new theory beyond the standard model (Elementary Particle Physics), and so on. In addition, the Theoretical Nuclear Physics group contributes to the construction and publication of a nuclear reaction database in the Hokkaido University Nuclear Reaction Data Centre, and stimulates the domestic and overseas research in the field.



Optical experiment: A Ti:sapphire laser system for the femtosecond pump-probe measurements (Optical Properties and Semiconductor Physics).

## Specialized Fields and Laboratories

### Theoretical Physics

- Theoretical Particle Physics
- Astrophysics
- Theoretical Nuclear Physics
- Condensed Matter Theory I  
(Phase transition on complex network systems and molecular dynamics on non-equilibrium systems)
- Condensed Matter Theory II  
(Superconductivity, Bose-Einstein condensation, and magnetism)
- Condensed Matter Theory III  
(Magnetic and optical properties of low-dimensional electron systems)

### Experimental Physics

- Radio Astronomy
- Dielectrics
- Low Temperature Physics
- Magnetism in Strongly Correlated Electron Systems
- Optical Properties and Semiconductor Physics
- High-Pressure Physics
- Electronic Properties of Low-dimensional Conductors
- Nanostructure Physics (RIES)
- Phase Transition (RIES)

### History of Science

- Science and Technology Communication
- Philosophy of Science



# Department of Chemistry

<http://wwwchem.sci.hokudai.ac.jp/en/>

Chemistry is the exploration of matter; it involves the creation of molecules and materials, and investigation of their structures, properties, functions, and reactivity. Chemistry is everywhere: in space, on the earth, and in the human body. Corresponding to the wide range of topics in chemistry, the Department of Chemistry consists of 15 main laboratories representing all sub-disciplines (physical, inorganic & analytical, organic, and biological), including interdisciplinary areas of physics and the life sciences. In addition, seven laboratories at the Catalysis Research Center, Research Institute of Electronic Sciences, and Institute for Genetic Medicine at Hokkaido University, and four laboratories at the National Institute for Materials Science in Tsukuba, contribute cooperatively to the department.

The Department of Chemistry has provided excellent programs for undergraduates since 1930 and for graduate students since 1953. Emeritus Professor Akira Suzuki, a 2010 Nobel Laureate,



Prof. Akira Suzuki with students of Chemistry Department

studied in the department and received his Ph.D. degree in 1960. Dr. Mamoru Mohri, an astronaut, graduated from the department in 1970. Many other graduates are actively involved in cutting-edge research worldwide. In 2010, the integrated Graduate School of Chemical Sciences and Engineering was established to allow students study to chemistry in a broader context so as to flexibly respond to the needs of the times. All faculty members in chemistry participate in graduate training in cooperation with faculty members from engineering. The Department of Chemistry also maintains active research programs to contribute to human society.



X-ray Diffraction  
Laboratory for Structure  
Analysis



Single-crystal X-ray diffraction measurement

## Specialized Fields and Laboratories

### Physical Chemistry

- Physical Chemistry
- Quantum Chemistry
- Structural Chemistry
- Condensed Matter Chemistry
- Solid-State Chemistry
- Material Chemistry

### Inorganic and Analytical Chemistry

- Inorganic Chemistry
- Coordination Chemistry
- Analytical Chemistry

### Organic Chemistry

- Organic Chemistry I
- Organic Chemistry II
- Organometallic Chemistry
- Mechanistic Organic Chemistry

### Biological Chemistry

- Biological Chemistry
- Bioorganic Chemistry

# Department of Biological Sciences

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

Living organisms are dynamic systems in which a great variety of cells and molecules form complicated networks. In the Department of Biological Sciences of the Faculty of Science, we conduct basic research to understand how the diversity of living organisms originated, based on the structure and function of individual cells and their constituents. In particular, we focus on mechanisms that maintain homeostasis in basic cellular functions and organisms, as well as on principles



Microinjection into an egg of the medaka fish *Oryzias latipes*



Multiphoton laser-scanning microscope in shared equipment room



Shared laboratory for molecular biology has high-speed large-scale DNA sequencers and real-time PCRs.

involved in maintaining the continuity and diversity of life. Our research fields explore diverse topics at various levels in the biological hierarchy, from molecules and cells to systems and individual animals and plants. The department of Biological Sciences is organized into four research groups. The first is “Cell Structure and Function”, which focuses on signaling mechanisms underlying higher-order cellular functions and on physiological mechanisms by which plants and bacteria adapt to environmental stresses. The second is “Behavioral Neurobiology”, which focuses on brain function in cognition and animal behavior. The third is “Reproductive and Developmental Biology”, which focuses on the molecular, cellular, and physiological underpinnings of animal ontogeny and phylogeny. The fourth research group, “Biodiversity“, tackles the evolutionary history of life, trying to establish classification schemes in various groups of organisms. It also addresses a wide variety of evolutionary issues including the mechanism of the formation of geographic variation, the evolution of developmental system including regeneration, and the mechanism of the formation of new species, called speciation. With about 35 faculty members in 2015, the Department of Biological Sciences has one of the longest histories of any biology department in Japan, dating to establishment of the Departments of Zoology and Botany in 1930 and reorganized in its present form in 1993.

## Specialized Fields and Laboratories

### Cell Structure and Function

- Molecular Genetics
- Plant Science
- Plant Developmental Physiology
- Development and Evolution of Plants
- Molecular Cell Biology
- Bacterial Physiology and Biochemistry

### Behavioral Neurobiology

- Neuroethology
- Behavioral Physiology
- Cognitive Neuroscience
- System Neurobiology
- Molecular Neuroethology
- Behavioral Ecology

### Reproductive and Developmental Biology

- Reproductive Biology
- Developmental Biology
- Comparative Endocrinology
- Molecular Endocrinology
- Molecular and Cellular Gamete Biology

### Biodiversity

- Animal Taxonomy and Speciation
- Algal and Protist Taxonomy
- Evolutionary and Developmental Biology
- Genetic Diversity



# Department of Earth and Planetary Sciences

<http://www.sci.hokudai.ac.jp/eps/>

Research groups in the Department of Earth and Planetary Sciences fall into three divisions. The “Division of Earth and Planetary Dynamics” studies mantle dynamics, earthquakes, volcanic activity, surface and ground water, and atmosphere-ocean circulation. The “Division of Earth and Planetary System Science” studies volcanoes, fossils, mineral microstructure, the isotopic composition of asteroids, the coordinated evolution of Earth’s bio- and geospheres, and plate tectonics. The “Division of Cosmo sciences” studies planetary atmospheric dynamics, Earth’s atmosphere, and the evolution of the solar and planetary systems. The interests of the Department of Earth and Planetary Sciences span a size scale from molecules to the solar system, and a time scale from microseconds to billions of years. Because significant alterations in the Earth’s abiotic environment are accompanied by, and often dictated by, changes originating in the biosphere, our department

views the integration of geosciences and biodiversity studies as crucial to understanding the evolution of Earth and its life, and for assessing the possibility of life on other planets. Our departmental staff of about 40 faculty members conducts a broad range of cutting-edge experimental, observational, and theoretical research; collaborates with leading domestic and international researchers and organizations; and continually seeks to explore new scientific frontiers.



Pirka telescope with an effective aperture of 1.6 m for planetary and astronomical observations.



Isotope microscope used for the survey of the isotopic composition of asteroidal materials.



Picture of the field measurement showing the sampling of the hot volcanic gas.

## Specialized Fields and Laboratories

### Earth and Planetary Dynamics

- Physical Oceanography and Climate
- Physical Hydrology
- Space Geodesy
- Global Seismology
- Earthquake Dynamics

### Earth and Planetary System Science

- Petrology and Volcanology
- Earth Environmental History
- Geochemistry
- Earth Materials Science
- Earth System Evolution
- Geotectonics

### Cosmo sciences

- Astrophysics
- Planetary and Space Science

# Institute of Seismology and Volcanology

<http://www.sci.hokudai.ac.jp/isv/english/>

The Institute of Seismology and Volcanology, established in 1998, conducts basic researches on generation mechanisms of earthquakes, tsunamis, and volcanic eruptions to contribute to their forecasts. It consists of four main research sections: The Laboratory of Seismological Observation, The Laboratory of Ocean Bottom Seismology, The Laboratory of Volcano Physics, and The Laboratory of Subsurface Structure. The Institute is one of main institutes in Japan

responsible for national research projects on predicting earthquakes and volcanic eruptions (proposed by the Council for Science and Technology of the Ministry of Education, Culture, Sports, Science and Technology). The Scientific Support Section of Hazard Mitigation for Earthquakes and Volcanoes was founded to accelerate our contribution through outreach and activities to raise hazard awareness in local communities and the general public.



Ocean bottom seismometers about to deploy



GPS survey at Tarumae volcano

# Genome Dynamics Research Center

<http://www.sci.hokudai.ac.jp/gdynamics/>

The Center consists of three laboratories that provide various types of support for biological research by qualified faculty members and students at Hokkaido University. The Laboratory of Experimental Animals and Plants provides the facilities necessary for breeding and culturing a wide variety of animals and plants, and adequate experimental environments. The Laboratory of Animal Cytogenetics maintains and supplies various vertebrate cell lines, and supports molecular studies

on chromosome structure by teaching the latest techniques. Facilities for cell culture are available for common use. The Laboratory of Molecular Genetics provides facilities necessary for research using recombinant DNA methodology, such as isolated greenhouses, a tissue culture room for plant materials, and P1- and P2-level biological laboratories. In 2015 the Center is being used by 46 research groups at Hokkaido University.



Greenhouse for cultivating various plants



Facilities for breeding rodents with automated water supply



# Nuclear Reaction Data Centre

<http://www.jcprg.org>

The Nuclear Reaction Data Centre was established in 2011 as the successor to the Japan Charged-Particle Nuclear Reaction Data Group (JCPRG) founded in 1974. Its objectives are: 1) Compilation of data obtained in Japan on charged-particle and photo-induced nuclear reactions, 2) Evaluation of reaction data for light nuclei, 3) Promotion of international collaborations, and 4) Training of graduate students. The Centre is a

member of the International Network of Nuclear Reaction Data Centres (NRDC) under the auspices of the International Atomic Energy Agency (IAEA). The NRDC collaborates in compiling experimental nuclear reaction data and maintaining the compiled data in the EXFOR (EXchange FORmat) database. We have contributed about 10 percent of the data on charged-particle nuclear reactions in the EXFOR database.

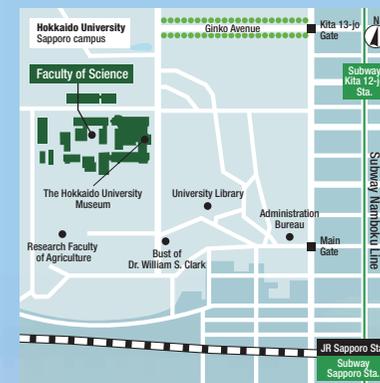


Discussion among members

## Contact

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# Useful Links

## Faculty of Science

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

## Hokkaido University

<http://www.oia.hokudai.ac.jp/>

## Facebook

<https://www.facebook.com/OIAS.Sci>

## Related Graduate Schools

### Graduate School of Science

<http://www.sci.hokudai.ac.jp/english/index.html>

### Graduate School of Life Science

<http://www.lfsci.hokudai.ac.jp/graduate-school/>

### Graduate School of Chemical Sciences and Engineering

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

