RIKEN Center for Brain Science (CBS) is a core research center that investigates the human brain as the foundation of the human mind.

The brain is the last frontier in natural science. The mission of CBS is to probe this frontier with thoughtful and diverse methods at the cellular, individual, and social levels, to produce results with societal impact.
Brain science — one of the ultimate frontiers in natural science — explores the mechanisms of brain and mind, spanning memories and emotions to decision-making and meta-cognition. Brain science is a multidisciplinary research endeavor that contributes to, and draws from, areas as diverse as information technology, artificial intelligence and neuropsychiatry. The Center for Brain Science (CBS) was established in April 2018 to explore and understand the brain and mind and to address many problems facing modern society. Under the leadership of the center’s first director, Yasushi Miyashita, CBS recruited outstanding international researchers, established Collaboration Divisions to bridge the gap between diverse brain science fields such as clinical medicine and information technology, and initiated training programs for young researchers.

In 2020 and beyond, we will continue to delve deeper into the unexplored realms of brain science. Further, CBS will join efforts with both domestic and international research institutes, universities, and inter-university research institutes, foster connections with the industrial sector, promote Japan’s Brain/MINDS project, and develop as a hub for an industry-academia-government network in the field of brain science. The public can look forward to even greater achievements from CBS in the future, as we are committed to returning the results of our research and contributing to the realization of a sustainable society.

Hiroyuki Kamiguchi
Acting Director, RIKEN Center for Brain Science
The brain and mind remain shrouded in mystery. How do people understand themselves and others and how do they form relationships? We will elucidate the brain’s highly-developed cognitive functions such as language and emotion.

Information science and new technologies are crucial to advancing brain science. Analyzing already-collected data and examining the brain from new angles will allow researchers to reveal the internal computational principles, which can lead to a new generation of artificial intelligence.

Looking at the brains of other species offers multiple comparative insights at the molecular, cellular or neural network levels. We will work out universal principles that link the brain and body across species.

People face an array of social problems and physical disorders. Many are caused by the deep involvement of the brain. Brain science can clarify the causes of mental and neurological disorders, leading to possible solutions for social problems.

Four Keys to Unravelling the Brain

1. Understand what is unique about the human brain
   - The brain and mind remain shrouded in mystery. How do people understand themselves and others and how do they form relationships? We will elucidate the brain’s highly-developed cognitive functions such as language and emotion.

2. Learn from the brains of other species
   - Looking at the brains of other species offers multiple comparative insights at the molecular, cellular or neural network levels. We will work out universal principles that link the brain and body across species.

3. Analyze the brain with big data
   - Information science and new technologies are crucial to advancing brain science. Analyzing already-collected data and examining the brain from new angles will allow researchers to reveal the internal computational principles, which can lead to a new generation of artificial intelligence.

4. Improve quality of life by studying the brain
   - People face an array of social problems and physical disorders. Many are caused by the deep involvement of the brain. Brain science can clarify the causes of mental and neurological disorders, leading to possible solutions for social problems.
We study how aversive experiences trigger alterations in brain circuits and neural coding resulting in emotional memory formation.

Understanding language acquisition through the window of infant speech perception.

We study how the neural circuits for decision making under given circumstances work.

Clarifying the brain mechanisms underlying higher-order functions, such as visual recognition and goal-oriented behavior.

Understanding cellular mechanisms that control nervous system formation and repair.

Our goal is to elucidate the neuronal and network mechanisms underlying cognitive functions such as episodic memory and decision making.

Determining the principles of synaptic circuit mechanisms that underlie animal behavior.
Our lab asks: how does a neuron grow up to be different; how are differentiation pathways initiated and directed to create diversity in neuron form and function?

Our goal is to understand the neural circuits that allow the brain to encode, consolidate and recall memories.

We aim to elucidate molecular, cellular and neural circuit mechanisms underlying various olfactory behaviors.

We study the neural basis of decision making from the viewpoint of visual perception.

We aim to elucidate molecular, cellular and neural circuit mechanisms underlying various olfactory behaviors.

We observe the living brain and clarify the relationship between perceptual behavior and neural activity at the single-cell and network level.

We study the neural basis of decision making from the viewpoint of visual perception.

We develop statistical methods that extract more information from brain data.

We study how computations in neural circuits produce memory and other mental capabilities.
Our goal is to elucidate molecular mechanisms of protein aggregation and its physiological consequences in neuropsychiatric diseases. We aim to causally identify the contributory factors for psychiatric disorders, which could provide the knowledge necessary to establish circuit-centric therapeutics as well as molecular-based drug designs.

Deciphering the mechanisms for schizophrenia and autism spectrum disorder and developing early diagnostic measures.

Our laboratory aims to understand higher brain functions and pathophysiology of human psychiatric and neurological diseases, by mapping the marmoset brain precisely.

We are working to understand the features of primate-specific neural circuits and their functions by studying a large-scale structural brain mapping of marmoset as a model system.
Collaborations with Universities and Research Institutes

CBS has established two collaborative divisions promoting inter-organizational communication with universities and research institutes.

Integrative Computational Brain Science Collaboration Division

The Integrative Computational Brain Science Collaboration Division develops technologies to analyze big data and works together with the Graduate School of Information Science and Technology at the University of Tokyo. A unit specializing in data science promotes data-driven explorations of the field.

- **Keiji Tanaka**
  - Integrative Computational Brain Science Collaboration Division
  - Neuroinformatics Unit
  - Data-driven Brain Science Collaboration Unit

- **Fumiyasu Komaki**
  - Mathematical Informatics Collaboration Unit

- **Henrik Skibbe**
  - Connectomes Analysis Unit
  - Brain Mapping by Integrated Neurotechnologies for Disease Studies (Brain/MINDS)

Brain Medical Science Collaboration Division

The Brain Medical Science Collaboration Division promotes academic exchange with university medical schools and research institutes. Joint laboratory facilities are shared with the Graduate School of Medicine at the University of Tokyo.

- **Shigeo Okabe**
  - Brain Medical Science Collaboration Division

- **Alexander Woodward**
  - Connectomes Analysis Unit
  - Brain Mapping by Integrated Neurotechnologies for Disease Studies (Brain/MINDS)

- **Hirofumi Nakatomi**
  - Biomedical Neural Dynamics Collaboration Laboratory
  - Analyzing the genomics from brain tissue, and investigating the pathophysiology of cerebrovascular diseases and epilepsy.

- **Masanori Matsuzaki**
  - Brain Functional Dynamics Collaboration Laboratory
  - The goal of our laboratory is to elucidate the prefrontal neural dynamics relevant to cognition and behavior by studying the common marmoset.
Industrial Collaborations

CBS has established three industrial collaboration centers with the aim of ensuring our research outcomes have social benefit.

RIKEN CBS – Olympus
Collaboration Center (BOCC)
Established in June 2007

Linking the 20 years of brain science expertise of CBS with the optical know-how of Olympus, this center develops and harnesses fundamental bio-imaging technologies and instruments. The center also disseminates bio-imaging technology and knowledge through the technical support of researchers. Operational logs of microscopes at BOCC are used to improve bio-imaging products.

RIKEN CBS – Toyota
Collaboration Center (BTCC)
Established in November 2007

This research organization was set up under a comprehensive agreement with Toyota Motor Corporation to serve as a base for socially-relevant innovation and exploration of the potential by merging brain science and technology. The center promotes research on social systems to boost the capabilities of individuals and support group creativity. There are separate units focused on Intelligent Behavior Control, Rhythm-based Brain Information Processing and Social Value Decision Making. The center aims to understand the mechanisms of the human body, the human brain, and the human social network, to advance greater well-being in society.

RIKEN CBS – KAO
Collaboration Center (BKCC)
Established in April 2016

This center fuses cutting-edge neuroscience with the technologies owned by KAO Corp. to explore the brain science of kansen, or perceptual sensibility. KAO is experienced in chemical and molecular biology, biochemistry and cell biology. It places importance not only on functional values but also on behavioral characteristics and emotional judgment by use of the five senses, like the tactile, form, color and smell. Research in this collaboration contributes to brain science outcomes that can apply to daily life, such as neuro-marketing, and expands the definition of brain science to include concepts like “sensitivity perception” and “emotional sensitivity”.

An example of research supported by KAO:
Research Resources Division (RRD)

Research resources and research technologies are crucial for conducting brain science. Our Research Resources Division provides technological support, such as bio-material analysis, and maintains shared research equipment facilities for animal experimentation and human MRI, for example. RRD also provides support for researchers to use these resources. The division has specialized technical staff who offer guidance on experimental technologies to research teams.

Support Unit for Bio-Material Analysis

Researchers in bioscience including brain science require a variety of scientific technologies. This unit provides essential technical support and experimental environments to RIKEN members. The skillful staff carry out commissioned analyses on nucleic acids, proteins, amino acids, peptide synthesis, and more. The unit maintains research equipment in shared experimental areas and also gives technological advice. Educational seminars and exhibitions of research instruments are held as required.

Support Unit for Animal Resources Development

Brain science has accelerated through the use of laboratory animals. This unit maintains large-scale animal experimentation facilities, supplying high-quality laboratory animals. It provides relevant technological support, such as the production of mutant mice by genome editing and mouse embryo manipulation. It also offers administrative support, for example animal health certificates.

Support Unit for Functional Magnetic Resonance Imaging

The ultimate goal of brain science is to understand the functioning of the human brain. This unit provides technological support for experimentation that uses non-invasive measurements of the structure and activities of the human brain, or the brains of other species, though magnetic resonance imaging (MRI). The unit is equipped with a 3 Tesla human MRI scanner, and a 7 Tesla human MRI scanner will be installed by mid-2021. Experiments with DTI, MRA, MRS and fMRI can be supported. The unit also develops its own technological imaging and analysis methods.

Technical Personnel Support Section (TPSS)

This section provides expert technicians to offer customized technical support. It assists researchers with close support, such as experiments that cannot be conducted at research labs and undertakes routine experiments on their behalf.

Large Experimentation Apparatus TissueCyte

CBS has a shared-use equipment called TissueCyte, an integrated system of a high-level slicer and a two-photon confocal microscope. It is available to visualize a whole 3D brain, reconstructed from successive 2D images, without adjusting position during the process. This equipment is useful for studies across neuroscientific areas, from the investigation of neural circuits to the elucidation of abnormalities associated with mental and neurological disorders.

Brain Mapping by Integrated Neurotechnologies for Disease Studies (Brain/MINDS)

Brain/MINDS is a national project to fully understand the structure and networks of the brain. Similar projects are underway in the USA, EU and China, but Brain/MINDS is characterized by an emphasis on the study of the marmoset (a small, non-human primate). To understand our human brains, it is essential to learn from other primates. Marmoset brains can be genetically modified and comprehensively analyzed and have significant advantages as research targets, allowing an understanding of the neural circuit mechanisms developed in primates. These studies can lead to overcoming mental and neurological diseases in humans. CBS is the core partner in the Brain/MINDS project and promotes research in collaboration with domestic and overseas universities and other scientific institutions.
Human Resource Development

CBS Summer Program

This program began in 1999 with the aim of training junior brain scientists, mainly those currently in graduate school. About 50 students from around the world are selected each year through a rigorous application. The program offers a two-month laboratory internship and a one-week intensive lecture course with domestic and overseas experts in cutting-edge research areas. The entire program, including exchange meetings, is delivered in English.

Brain Science Training Program

BSTP is a one-year program for fostering young researchers, directed mainly at first-year Master’s students. Systematic exposure is given to acquire comprehensive as well as specialized knowledge of brain science. Instruction is in English. Many alumni have gone on to become successful researchers at overseas institutions.

Young Investigators’ Seminar

This event allows young researchers to present their work to the CBS community. Participants are given feedback from team leaders and the audience. Seminars provide an opportunity to initiate future joint research and social gatherings are held to allow informal discussion and exchange.

Career Development Program

This program fosters career-building opportunities for researchers of proven ability and experience. Selected candidates are nominated to the position of CDP Young Chief Investigator and awarded an annual research budget to manage independent laboratory activities. The program is targeted for researchers to transition to principal investigators at universities or institutions beyond RIKEN.

CBS – MIT Interaction Opportunity for Young Scientists

A biennial program sends junior researchers from CBS to the Picower Institute for Learning and Memory at MIT, where they participate in the institute’s retreat, make poster presentations and give talks. Lab visits and discussions with MIT researchers are organized to develop research and networking.

Retreat

The annual off-site retreat is an opportunity for exchange of ideas among researchers in different branches of brain science. Free discussion is encouraged across specialized fields. The retreat program has lectures, workshops, poster presentations and roundtables for researchers who might not normally interact to meet and exchange ideas. A lecturer from UCSF is invited every year.

PDFA (Postdoctoral Fellow Association)

PDFA is a self-governing organization within CBS. It was formed by young researchers who organize workshops and forums for career development, scientific discussion and advancement of diversity. Members volunteer at the CBS Summer Program to interact with and assist invited junior researchers from across the globe.

Collaborations with Domestic and Overseas Universities

Collaborations have been established to promote developments in the field of brain science. CBS team leaders may be appointed as visiting professors, while Ph.D. students from collaborating universities are able to visit and undertake research.

Public Relations and Outreach

CBS places great importance on outreach activities. We use social media to deliver press releases and research news to wide audiences. CBS welcomes some 1,000 visitors every year and holds an annual RIKEN Open Day with lectures and demonstrations for adults and children.

As part of World Brain Awareness Week (an international awareness campaign for brain science), CBS holds a popular summer science class for high school students that is known for its clear lectures and hands-on research experience opportunities.
CBS welcomes diverse personnel and promotes gender equality and internationalization.

### Staff

**Researchers**
Excluding administration and part-timers

- **Men:** 54.3% (190)
- **Women:** 45.7% (160)

**Team Leaders**
Excluding collaboration research teams

- **Men:** 80% (28)
- **Women:** 20% (7)

### Foreign Researchers by Region

- **Asia:** 37% (24)
- **Europe:** 40% (26)
- **North America:** 14% (9)
- **Other:** 9% (6)

**Total:** 65

As of October 1, 2019

### Bio-resources

635 model mice with Alzheimer’s disease, developed by Laboratory for Proteolytic Neuroscience and 183 DNA clones from the Laboratory for Cell Function Dynamics have been supplied to domestic and overseas research institutions (2018). Other CBS research teams accept inquiries concerning bio-resources from all over the world. Genetically modified zebrafish, for example, have been provided by CBS.