DOSHISHA UNIVERSITY
KYOTANABE CAMPUS
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ANNIVERSARY
1986-2026

Graduate School of Brain Science
Doshisha University

Doshisha University

Graduate School of Brain Science

- Division of Molecular and Cellular Neurosciences
- Division of Systems Neuroscience
- Division of Brain Pathology

The Graduate School of Brain Science training next -generation scientists in the field of neuroscience

The Graduate School of Brain Science at Doshisha University offers a five-year doctoral program.

Research in brain science and neuroscience is considered one of the frontiers of the life sciences, and numerous studies are being conducted around the world. As research into higher brain functions, such as learning, memory, and decision-making as well as neurodegenerative and psychiatric disorders, is gaining attention, it is essential to further strengthen basic research on neurons and neural circuitry that underpin these functions.

The relationship between basic research and applied research is similar to that of a bulb and a flower; in the bulbous state, there is no telling which flowers will bloom in the future.

Even if the flower called "applied research" blooms, it will die if the bulb is removed. We, the Graduate School of Brain Science, are committed to promoting basic research that may bloom in the future.

We hope that you will acquire "genuine skills" to become an independent researcher in the future through this five-year course.

■ Faculty

Molecular and Cellular Neurosciences

Molecular mechanisms underlying neural and brain functions

Laboratory of Molecular Synaptic Function

SAKABA Takeshi, Ph.D.

- Synaptic plasticity: Underlying mechanisms and their functional implications in neural circuits

Laboratory of Neural Membrane Biology

TAKAMORI Shigeo, Ph.D., D.V.M

- Bioenergetics of neurotransmitter uptake into synaptic vesicles
- Molecular mechanism for synaptic vesicle acidification
- Molecular anatomy of neuronal large dense core vesicles
- Molecular basis for neurite, synapse, and SV formation

Laboratory of Developmental Neurobiology

MOTOYAMA Jun, Ph.D.

- Understanding the molecular mechanisms that control neural stem cell development
- Effect of maternal separation stress on hippocampal development in neonates
- Spontaneous fluctuation of intracellular Ca^{2+} concentration during mammalian neural stem cell development

Systems Neuroscience

Mechanisms operating to establish and maintain neural networks

Laboratory of Cognitive and Behavioral Neuroscience

TAKAHASHI Susumu, Ph.D.

- Neural substrates of episodic memory encoding and retrieval
- Neuronal mechanisms underlying spatial navigation

Laboratory of Functional Brain Circuit Construction

MASAMIZU Yoshito, Ph.D.

- Development of techniques to produce a neuronal fiber
- Development of techniques to construct novel brain's neural circuits
- Recovery of brain functions with novel neural circuits
- Extension of brain functions with novel neural circuits

Laboratory of Neural Computation

MATSUI Teppei, Ph.D.

- Principles of visual information processing by the brain
- Functions of spontaneous brain activity during development, adulthood and pathology
- Large-scale neural data analysis using AI and data science techniques
- Neural circuit analysis using molecular biology and optical techniques

Brain Pathology

Mechanisms underlying disorders of the nervous system

Laboratory of Neuronal Regeneration

KANEKO Naoko, Ph.D., M.D.

- Elucidating the nature and role of newborn neurons in adult
- Adult-born neurons in neuronal regeneration after brain injury
- Development of interventions to promote adult neurogenesis

[Highlights]

1 **Five-year integrated doctoral program**

Concentrated and comprehensive training facilitates students obtaining essential skills and knowledge to carry out cutting-edge brain research.

2 **Customized training program by internationally renowned program faculty**

The ratio of students to faculty is 50 : 8

Hands-on research training provided by two research staff members per laboratory

Advisor system

Each student will have an academic advisor to consult on curriculum selection, thesis research, and career decisions.

3 **Total tuition remission**

Students under 32 years of age (34 for transfer students) at the time of admission are provided with a five-year (three years for transfer students) scholarship covering tuition.

4 **Education centered on self-study with tutorials and class discussions**

5 **Global-standard education**

English is the primary language of teaching materials, presentations, and class discussions.

6 **Training in a wide range of research methodologies in brain science**

Laboratory rotations and active collaborations in the department offer opportunities for students to learn a variety of techniques used in the field.

7 **Training for real world skills**

We offer practical training that will hone students' abilities and skills, such as goal setting, self-study, professional communication, diversity appreciation, and presentation.

8 **Career support**

We encourage students to appreciate diverse opportunities for their career development by inviting speakers from abroad, sending students to summer training courses and scientific meetings, and offering internships in affiliated biomedical companies.

Interviews with faculty members

The Graduate School of Brain Science has eight laboratories across three divisions of molecular and cellular neurosciences, systems neuroscience, and brain pathology, and faculty members provide high-quality education and research mentoring.

Here, two faculty members of the Graduate School of Brain Science introduce their research and their views on graduate education.

Systems Neuroscience

Laboratory of Functional Brain Circuit Construction

Professor **MASAMIZU Yoshito**

Success! Development of techniques to produce a neuronal fiber that needs to create novel neural circuits into the brain

In our brain, neurons in different brain regions make local and inter-regional connections and form the functional brain network. In neurological disorders, for example, in Parkinson's disease, dopamine neurons in the substantia nigra par compacta innervating to the striatum die, and therefore dopamine released into the striatum is reduced. This in turn impairs the function of the striatum and impairs motor functions to control bodily movements. Neuronal loss due to brain injuries such as strokes and trauma also results in the loss of brain functions. Other than the loss of neurons in specific brain areas, the loss of the connections among brain regions also impacts the brain functions important for physiological regulations and cognition.

To ameliorate such damage on inter-neuronal connections, the development of neuronal fibers in culture has been considered as a candidate intervention. My research goal has been to establish methods to create neuronal fibers, which are competent for transplant into the brain, using my bioengineering expertise. After a long effort, I have been able to establish a method to create a fiber which consists of neuronal spheroid and axons.

My research career at various research institutes fostering my current research in brain neurons

My research started in the graduate school of Kyoto University. My initial interest was how neurons are generated in embryonic and newborn brains. From 2008, I became a researcher in the National Center for Neurology and Psychiatry and studied cognitive neuroscience in human and primates. From 2010, I conducted neurophysiological research using mice at the National Institute for Basic Biology, and then from 2016 at the University of Tokyo in the laboratory of Cellular and Molecular Physiology. From 2019 to 2021, I served as a deputy team leader of the Brain Functional Dynamics Collaboration Laboratory at RIKEN Center for Brain Science. I was also a JST Sakigake investigator in the"Optical control of biological functions for the elucidation of biological systems" area.

While I went through my career at different places, I initiated my original research to generate neuronal fibers since 2018. Then, in 2021, I have been appointed as professor at the Graduate School of Brain Science in Doshisha University. My lab aims to establish methods to transplant neuronal fibers into mouse brain to construct novel brain's neural circuits. Currently, we are verifying whether the transplanted fibers can properly transmit information between the brain regions connected by the fibers, using genetic labeling, fluorescent calcium sensors, and a wide-field-of-view multi-scanning confocal microscope to examine this functional innervation.

We hope that these methods can be used to regenerate damaged neuronal circuits. Also, we may be able to create a bypass: For example, given a network from region A to region C via region B, when the region B is damaged, a bypass from the region A to C could route the damaged region and restore the function. Furthermore, we hope to deepen our understanding of the primate brain by copy-pasting a primate-specific circuit into a rodent brain using our neuronal fiber implant.

Research with information technology students: Prospective students favoring original ideas

At the moment, we have two graduate students. They are from the Department of Biomedical Engineering of Doshisha University. We also have an undergraduate student as an intern from the Department of Biomedical Sciences and Informatics. Since my research is related to bioengineering and regenerative medicine and also to information processing in the brain, it seems to attract students from information technology. I myself am from the pharmacy background and would like to have students in diverse backgrounds.

My research is really pioneering new areas of brain research. The useful outcome for human therapeutics or enhancement probably will come 20 or more years later. It would take a while to be paid, but the return would be promising. I would like to continue my research with staff and students, who can enjoy pioneering new research areas with trial-and-errors or failures.

Brain Pathology

Laboratory of Neuronal Regeneration

Professor **KANEKO Naoko**

Realization of the importance in understanding the root cause of brain disorders as a clinical psychiatrist

In 2007, I obtained my degree at the Integrated Graduate School of Medicine and Engineering of University of Yamanashi. I then continued my research in regenerative medicine at Nagoya City University and came to the Graduate School of Brain Science in Doshisha University as a professor in 2022. I have also practiced clinical psychiatry while doing basic research on brain cells. What I realized through my career as a clinical psychiatrist is that there have not been virtually no groundbreaking discoveries, innovations, or major breakthroughs in medical research in mental/neurological disorders in the past 20 years. The jobs of a clinician are to provide pharmacological treatments and psychotherapy. However, these practices rarely help us understand the actual cause of mental disorders. For this reason, I became more focused on basic research of the brain under physiological and pathological conditions tackling the nature of these disorders.

The nature and role of adult neurogenesis

My research interest focuses on neurons, which form neural circuits and underlie brain computation. Until recently, it had been believed that neurons are generated during embryogenesis but not in the adulthood. Therefore, when neurons are lost due to disorders or injuries, they would not be replaced by new neurons. This should make the regenerative ability of the brain quite low. In other words, a person must live the 80 years-long life with the neurons made before his/her birth.

There is a region called subventricular zone around the lateral ventricle. Recent studies using various mammalian species have revealed that neurogenesis occurs in the adult brain particularly in this region. Interestingly, neurons generated in the subventricular zone actively migrate in the adult brain and modify existing neuronal circuits. Also, newborn neurons seem to migrate to damaged brain areas and contribute to regeneration. My research has focused on the nature of these adult-born neurons.

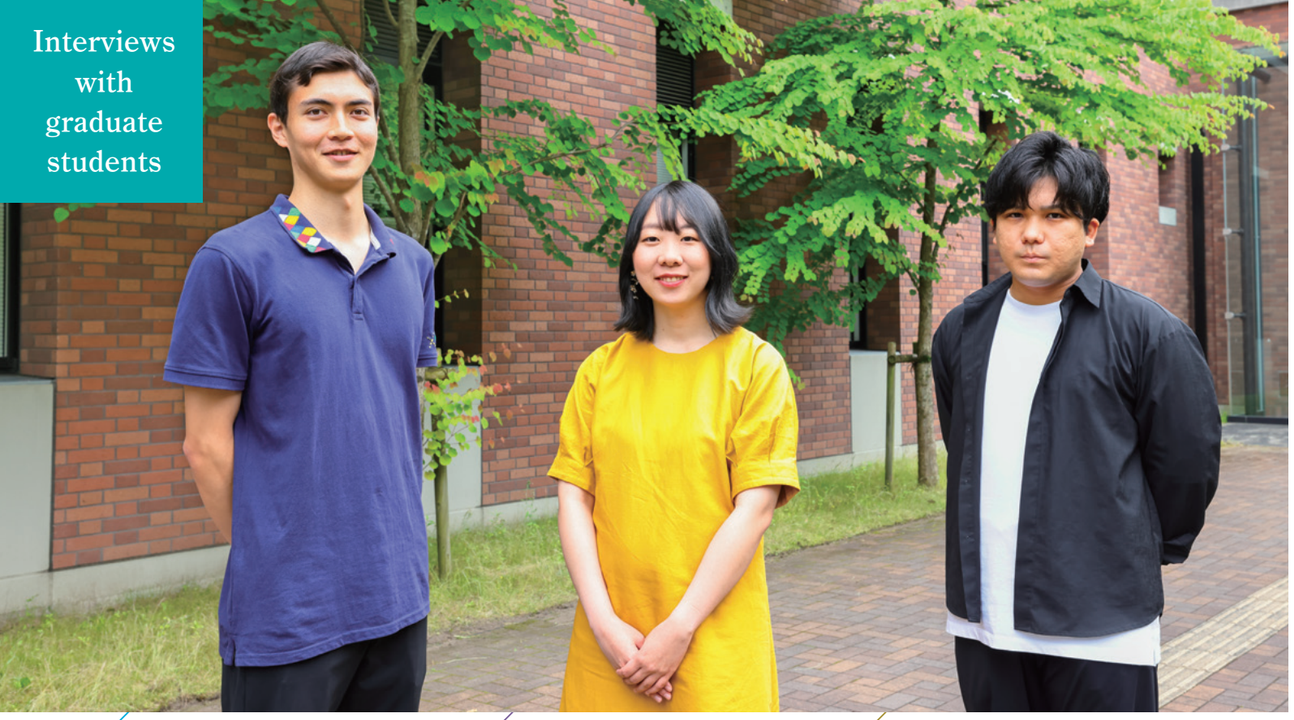
Neurogenesis in the human subventricular zone greatly declines in the first one and half year after birth. However, studies reported that, when analyzing the brain of a patient died of a stroke, there were a significant number of newborn neurons. These reports made researchers aware that active neurogenesis may occur in some special conditions such as brain disorders and injuries in adult human brain. Unfortunately, these newborn neurons do not have enough power to recover the lost function completely. The goal of my research is to understand the role and mechanism of adult neurogenesis and to use this knowledge to control the number, differentiation, and migration of newborn neurons. By establishing these methods, we can develop new therapeutic treatments for brain disorders and injuries, for which clinical intervention is limited.

Fostering young scientists who can dive into the joy of research

In my lab, we use mice to analyze the behavior of newborn neurons in adult brains in the presence of strokes or injuries employing live-cell imaging, histology, and behavioral tests. We hope to understand how these neurons migrate and take posts, and how they interact with existing neuronal circuits. We will then develop means to accelerate neurogenesis and to control their behavior with the potential and limitation of the regenerative ability of adult neurogenesis in mind. If we can control newborn neurons to situate them in damaged brain areas effectively, we can also adopt the methods to improve the regenerative capacity of transplanted neurons and functional recovery of the brain by them.

This is my first time to carry out research in a university without a medical school. In the previous institutes, students I trained for research mostly chose clinical jobs afterward. At Doshisha University, one of my goals is to train outstanding and enthusiastic young scientists. As I myself migrated from clinical to basic science and became immersed into the excitement of research, I hope to continue my research with people who also wholeheartedly enjoy and devote themselves to basic research.

Interviews with graduate students



MAEJIMA Raymond
Laboratory of Developmental Neurobiology
"Understanding the Mechanisms of Brain Development in Adolescence"

NAKATA Rinaho
Laboratory of Ion Channel Pathophysiology
"Axonal Localization Mechanisms of Tau Proteins"

SAWATANI Fumiya
Laboratory of Cognitive and Behavioral Neuroscience
"The Neural Mechanisms of Time Perception"

At the Graduate School of Brain Science in Doshisha University, graduate students are engaged in research from various angles on the theme of brain science.
We asked three graduate students to talk about their motivation to enter the Graduate School of Brain Science and the appeal of brain science research.

Why did you choose the Graduate School of Brain Science? What motivated you to do this?

NAKATA: I graduated from a college in paramedics, where I focused on becoming a clinical psychologist during my undergraduate studies. As I delved deeper into my studies, I developed an interest in understanding how medications used in psychiatric treatment interact with the brain and the nervous system to produce their effects. This led me to shift my interest from clinical practice to research. In this regard, the five year training program of the Graduate School of Brain Science at Doshisha University was very attractive to me to dedicate myself to pursue research in the field of neuroscience.

MAEJIMA: Prior to entering the graduate school, I was studying psychology at a university in the United Kingdom. There, my focus was primarily on conducting various experiments with human subjects. However, as time went on, I developed a growing interest in the brain cells that underlie human cognition and behavior. I became particularly intrigued by the study of brain development, which led me to choose the neuroscience research program that provides a strong training opportunity in basic neuroscience research.

SAWATANI: I also have a background in psychology. I was interested in providing support to individuals with mental disorders, which led me to study at the Department of Psychology at Doshisha University. Starting from my second year as an undergraduate, I actively participated in neuroscience research as an intern in the research internship program offered in the graduate school. Around the summer of my second year, I began considering continuing my research even after graduation. I decided to skip a year and enter the graduate school directly at the end of the third year. I am currently conducting further investigation on the same topic within the same research laboratory.

What kind of research are you currently involved in?

NAKATA: Tau proteins are originally localized in the axons, which are elongated projections extending from the cell body of neurons. The aggregation of these proteins in the brain's cell bodies is considered to be the cause of Alzheimer's disease. Currently, various studies are being conducted on the treatment of Alzheimer's disease, most of which aim to prevent the aggregation of tau proteins in the cell body. However, I am researching the opposite aspect: why tau proteins are localized in the axons in the first place and exploring the mechanisms behind it.

MAEJIMA: I am currently conducting research on the development of the brain during adolescence in humans. Adolescence is a period characterized by accelerated physical growth, but it is also a sensitive time when the development of the mind is strongly influenced by interactions with family, friends, and others. What I am particularly interested in is the social interactions during adolescence. Similar to the "imprinting" phenomenon observed in birds, I hypothesize that humans also have a sensitive period during adolescence, in which interactions with others shape brain functions related to the development of the mind. Therefore, I am investigating how social experiences during adolescence contribute to the establishment of emotional and social traits in adulthood.

SAWATANI: Animals, including humans, can perceive "time." For instance, even without measuring it with a clock, humans can intuitively grasp the "approximate duration" of activities like cooking instant noodles for 3 minutes or waiting at a traffic light. Similarly, in certain animals such as fish or birds, if they are consistently fed at a particular time of day, they may start gathering near the feeding area as that time approaches, anticipating the availability of food. The sensory perception of time is an inherent feature of the individual's brain. I am conducting research on the mechanisms underlying the cognition of time.

How do you plan to make use of the experiences of your studies in graduate school?

NAKATA: In the Graduate School of Brain Science, I had the opportunity to acquire various research methodologies. As a result, my interests have expanded to include the relationship between human psychology, behavior, and emotions. Currently, I am contemplating whether to pursue research in the United States after graduation, where I could work as a researcher. However, I find molecular-level neuroscience research equally fascinating. So, I am currently in the midst of a serious dilemma, trying to decide which path to pursue.

MAEJIMA: I am currently pondering whether to continue with fundamental research or transition into applied research after obtaining my doctoral degree. However, one aspect remains consistent: my strong desire to unravel the developmental mechanisms of human sociability. I believe it is crucial to have a solid foundation in research, which is why I aim to acquire comprehensive knowledge during my time at the Graduate School of Brain Science. Following graduation, my goal is to contribute to the fields of healthcare and education by scientifically understanding the adolescent brain and its implications.

SAWATANI: I am currently interested in continuing my research in my chosen field, regardless of whether it is at domestic or international universities. However, on the other hand, I also have a desire to explore research in a different field, perhaps at the molecular level. I cannot predict how my interests will evolve in the future. At present, I believe that accumulating experiences uniquely attainable during a studentship will serve as valuable assets in my future as a researcher.

What is the appeal of the Graduate School of Brain Science, and what is your message to prospective students?

NAKATA: Even though I love research, there are times when I question myself, "Was it really the right decision to come to the graduate school?" But, research is enjoyable, and there is an endless list of things I want to try. It is precisely because the joy and curiosity outweigh the hardships that I am able to continue my research. I encourage you to embrace those challenges. It is through facing them that you truly discover the joy that comes with it.

MAEJIMA: Neuroscience is a highly interdisciplinary field. Various researchers approach different topics from different perspectives, making it challenging to fully comprehend the studies of others. Therefore, I believe it is important not to label oneself strictly as either "natural science-oriented" or "social science-oriented" when seeking to understand topics outside of one's own specialty. It is crucial to maintain an open-minded attitude and absorb knowledge from diverse sources. By doing so, one's perspective can broaden and expand.

SAWATANI: I have come to realize the importance of physical stamina and perseverance as a researcher. As I progress in my research, there are often instances where experiments I have been working on for months end up failing. However, I choose not to be discouraged by these setbacks and instead continue to persistently pursue my goals, believing that significant achievements await me in the end. What sustains my physical stamina and perseverance is the joy of uncovering things that no one else in the world knows, by actively engaging in research. When one can appreciate the allure of such research, I believe it becomes possible to make the life in the graduate school a fulfilling experience.

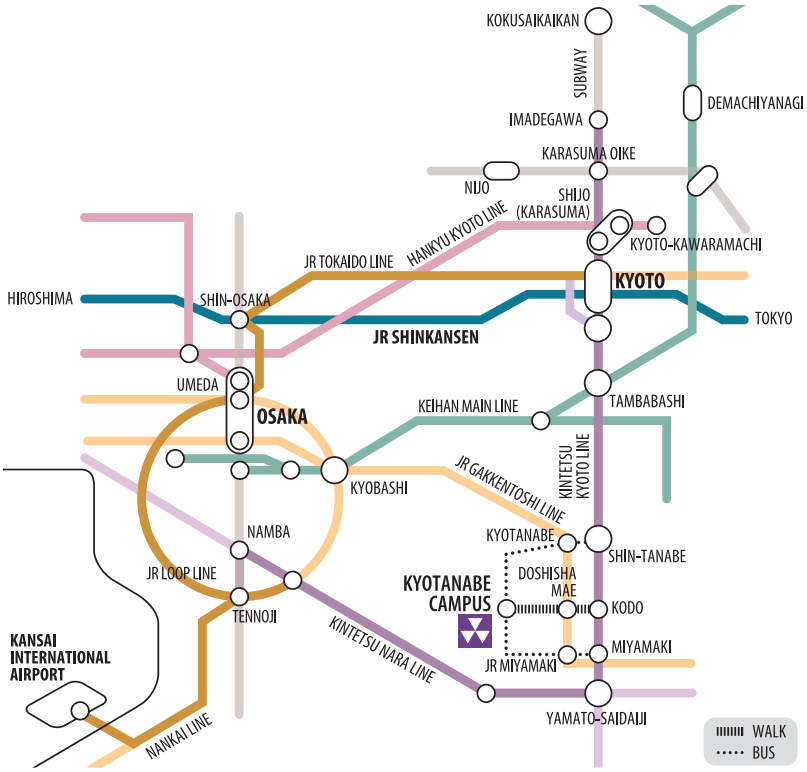
■ Total tuition remission

Students under 32 years of age (34 for transfer students) at the time of admission are provided with a five year (three years for transfer students) scholarship covering tuition.

Access map

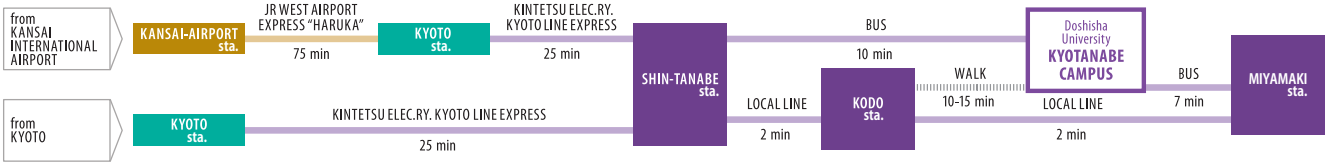
https://www.doshisha.ac.jp/en/information/campus/access/kyotanabe.html

KYOTANABE CAMPUS



Hochikan Building (Graduate School of Brain Science) on the Kyotanabe Campus of Doshisha University

To Kyotanabe Campus



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