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Message from Dean and Chair

The Department of Evolutionary Studies was established in Hayama in 2007 with the aim of conducting academic research with “evolution” as its keyword and creating a new view of life and nature. We are a small department with 20 full-time faculty members and about 30 students. We take advantage of this small size to provide research guidance to all students with all faculty members involved in their education. We have unique courses in our curriculum, such as laboratory rotations and sub-thesis, and we also focus on providing financial support to our students.

The educational goals of our department are twofold. First, to develop human resources who can conduct research from the perspective of the hierarchy of organisms, from genes to ecosystems. This is achieved through the four departments of Integrative Anthropology, Evolutionary Biology, Behavioral Biology, and Theoretical Biology. The second is to nurture human resources that can take a hard look at the relationship between scientific activities and human society based on their understanding of the development of biological science. This is the responsibility of the ‘Science and Society’ division. As a researcher, you need to be clear about the specialty you rely on. At the same time, however, the development of research is limited if it is buried deep within one’s field of expertise.

In order to encourage interdisciplinary interaction, we have kept the walls between the five departments very low. As you know, Sokendai has no faculty, and the students are extremely diverse. In addition, there are many young postdoctoral fellows and foreign researchers; so students are working hard on their research in a diverse and stimulating environment. Because of this diversity, Hayama’s research environment has a unique vibrancy that cannot be found anywhere else. For those who wish to pursue biological sciences in depth, for those who are not satisfied with one field of study, and for those who want to think deeply about the contribution of science to society, I would like to invite you to spend your graduate school life in scenic Hayama.

Dean of School of Advanced Studies
KUTSUZAKE Nobuyuki

Chair of Department of Evolutionary Studies of Biosystems
SASAKI Akira
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Dean of School of Advanced Studies
KUTSUKE Nobuyuki

Chair of Department of Evolutionary Studies
SOKAI Akira

Studies of Biosystems

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Overview and Features of the Department’s Research and Education

The Department of Evolutionary Studies of Biosystems is one of only a few departments in Japan specializing in evolutionary studies. We offer a unique and innovative program to foster scientists with broad perspectives, who can address such questions as “What is the ramifications for our society of today’s advances in life science?” and “How should we, as humans beings, deal with the issues surrounding these advances?” Every living organism is the product of a long evolutionary history. Furthermore, organisms do not exist in isolation, but rather are interrelated via the biosystems that they form together. “Evolutionary studies” is the key to understanding the history and diversity of organisms. Unfortunately, conventional biology have narrowly focused on extremely segmented and specialized areas, resulting in a failure to form a unified picture of biological phenomena. This department therefore emphasizes the importance of obtaining both depth and breadth of knowledge, so that our graduates are able to view biological phenomena within a wider evolutionary framework.

Our department welcomes prospective students not only from science majors - including biology, engineering, and agriculture - but also from humanities majors, such as sociology and philosophy. Introductory courses are provided for those from humanities majors so that they may acquire the fundamental biology skills and knowledge required for study at the graduate level. The department offers courses in five specialized fields of biology and social studies: “Anthropology”, “Evolutionary Biology”, “Behavioral Biology”, “Advanced Theoretical Biology”, and “Social Studies of Science.” Each student selects one of the five fields for his/her doctoral dissertation. In addition, students are required to submit a paper (“sub-thesis”), the aim of which is to develop a broad perspective in order to understand the relationship between science and society. We expect that our graduates will become researchers, curators, and professionals in media and other intellectually intensive industries, and will serve as contacts between life science and society, bridging the conventional disciplinary boundary between “science” and “humanities.”
Overview and Features of the Department’s Research and Education

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A

The observation of animals leads us to a number of questions such as “How do animals live?”, “Why do animals behave in a certain way?”, “What do animals know and understand?”, and “Why are there so many species?” A goal of my studies is to understand animal behavior and ecology from a standpoint of evolution. I have two ongoing projects. The first one is on social evolution in group-living mammals. I want to know how individuals should behave in order to maximize their (inclusive) fitness in a complex social environment. So far, I have been working on cooperation, conflict, conflict resolution, and communication in mammals and other vertebrates (birds, amphibians, and fish, reptiles not yet, unfortunately). The second one is on phenotypic evolution and comparative approaches with information of phylogeny. I am applying a new computational framework of phylogenetic comparative analyses to complex and heterogeneous data to infer processes of trait evolution.

Representative treatise.book


HONGO, Hitomi

Associate professor

1998 Ph.D. Department of Anthropology, Harvard University
1998-1997 Research Fellow and Lecturer, International Research Center for Japanese Studies, Kyoto University. 1997-2006 Assistant Professor, Department of Evolution, Systematics and Paleontology, Primate Research Institute, Kyoto University. 2006- Present Associated Professor, Department of Evolutionary Studies of Biohistory, Gakushuin University for Advanced Studies.

Career

*Introduction to domestication in East Asia's prehistoric period

Research interests in Animal Behavior and Comparative Animal Sciences, focusing on the evolutionary and ecological studies in animals. My research interests include the studies on the social evolution and adaptive radiation of Asian elephants, the ethological studies of human-animal interactions, and the evolutionary studies of domestication.

Representative treatises, books

### Environmental Archaeology (Zoarchaeology) and Palaeoanthropology

I investigate the socioeconomic and cultural changes of past human societies through the relationship between human groups and the environment. Emergence of sedentary settlements in c. 15000 years ago and domestication of plants and animals brought significant changes in human history and facilitated the development of complex societies. On the other hand, influence of human activities on the ecosystem has increased and eventually lead to the global environmental crisis today. Aiming for an integrative understanding of relationships between humans and their environment in the past, present, and future, I carry out research in southeastern Turkey, one of the domestication centers, as well as other parts of West Asia. Since domestication is a coevolutionary process of humans and animals or plants, the process needs to be studied both from biological and sociocultural points of view. Therefore, cooperation of researchers from various fields, such as archaeology, genetics, environmental sciences, behavioral ecology, and anthropology, is essential for the investigation of domestication process.

### Representative treatises, books


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### Animal Behaviour, Ethology, Behavioural Ecology, Primatology

**How do animals live and what do they think?**

The observation of animals leads us to a number of questions such as “How do animals live?”, “Why do animals behave in a certain way?”, “What do animals know and understand?”, and “Why are there so many species?” A goal of my studies is to understand animal behavior and ecology from a standpoint of evolution. I have two ongoing projects. The first one is on social evolution in group-living mammals. I want to know how individuals should behave in order to maximize their (inclusive) fitness in a complex social environment. So far, I have been working on cooperation, conflict, conflict resolution, and communication in mammals and other vertebrates (birds, amphibians, and fish, reptiles not yet, unfortunately). The second one is on phenotypic evolution and comparative approaches with information of phylogeny. I am applying a new computational framework of phylogenetic comparative analyses to complex and heterogeneous data to infer processes of trait evolution.

**To aspires**

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kutsukake99

**Representative treatises, book**


The Laboratory of Biological Anthropology mainly utilizes analyses of biomolecules to investigate the various lived experiences of "us". The laboratory studies how "we" were born, grew, reproduced, and died. Here, "we" includes ancient humans, evolutionary-related primate species such as chimpanzees and orangutans, and people living in modern society. How do the lived experiences of "us" differ in different cultures and environments, and how did it lead to biological evolution and adaptation? We are trying to find out such things. The laboratory is closely related to the scientific fields of human evolution, bioarchaeology, primate ecology, and family sociology. Our subjects and approaches are interdisciplinary and wide-ranging. For example, we are reconstructing child-rearing practices in the Jomon and Edo periods of ancient Japan, revealing the diet of wild orangutans living in the rainforests of Malaysian Borneo, and investigating child-rearing practices in shared houses in modern Japanese society. We use mass spectrometry, such as stable isotope and proteome analyses, and sociological interviews as our main methods, as well as reading historical, archaeological, and ethnographic literature to discuss the results. Our scientific approaches range from the field to the lab. For example, we are participating in excavations and wildlife studies to collect samples and data, pre-processing and analyzing the samples in the laboratory, and using computers to analyze data and develop mathematical models.

The Laboratory of Biological Anthropology is located in the Department of Physical Anthropology, University of Tsukuba, Japan. The laboratory was founded in 2002 under the leadership of Professor Takumi Tsutaya. The laboratory is currently headed by Professor Michiyu Kinoshita. The laboratory is equipped with state-of-the-art laboratories for anthropological research, including mass spectrometry, stable isotope analysis, and proteome analysis. The laboratory has a strong focus on interdisciplinary research, collaborating with fields such as archaeology, primatology, and biology. The laboratory is home to a team of researchers dedicated to advancing our understanding of human evolution and contemporary human behavior.
The Laboratory of Biological Anthropology mainly utilizes analyses of biomolecules to investigate the various lived experiences of “us.” The laboratory studies how “we” were born, grew, reproduced, and died. Here, “we” includes ancient humans, evolutionarily related primate species such as chimpanzees and orangutans, and people living in modern society. How do the lived experiences of “us” differ in different cultures and environments, and how did it lead to biological evolution and adaptation? We are trying to find out just such things. The laboratory is closely related to the scientific fields of human evolution, bioarchaeology, primatology, and ecology. Our subjects and approaches are interdisciplinary and wide-ranging. For example, we are reconstructing child-rearing practices in the Jomon and Edo periods of ancient Japan, revealing the diet of wild orangutans living in the rainforests of Malaysian Borneo, and investigating child-rearing practices in shared houses in modern Japanese society. We use mass spectrometry, such as stable isotope and proteomics analyses, and sociological interviews as our main methods, as well as reading historical, anthropological, and ethnographic literature to discuss the results. Our scientific approaches range from the field to the lab. For example, we are participating in excavations and wildlife studies to collect samples and data, pre-processing and analyzing the samples in the laboratory, and using computers to analyze data and develop mathematical models.

Biological anthropologists, bioarchaeologists, and primatologists explore the impact of differences in culture and the natural environment on the lived experiences of “us” (Homo sapiens and other evolutionarily related species).

The sensory world of animals can be very different from ours. One of the fields to reveal their sensory world is behavioral neuroscience.

My research interest is “Behavioral flower foraging behavior.” I have studied visual abilities and spectral organization of the compound eye in the Japanese swallowtail butterfly, Papilio xuthus. Papilio butterflies have sophisticated color vision, which rival our own. The compound eye, providing the most peripheral light processing, contains at least six classes of spectral receptors in a complicated manner. Based on the previous studies, we further explore visual processing in higher brain regions and the integration processes of visual and olfactory signals for flower foraging. I recently started two new projects. One is a comparative study on the brain structure in Lepidopteran insects. The other is visual ecology to investigate which flower species butterflies visit in their habitat. These studies would reveal the evolution of flower foraging behavior.
Most insects undergo metamorphosis to develop into adults. The brains of holometabolous insects (e.g., flies, butterflies, bees) drastically change their morphology during metamorphosis, which is required to prepare neural circuits for adult-specific behaviors. On the contrary, the brains of direct-developing insects (insects develop without pupal stage, e.g., cockroaches, crickets) show moderate structural changes throughout post-embryonic stages. However, similar to holometabolous insects, adults of direct-developing insects exhibit adult-specific behaviors such as courtship and mating behaviors, which are not observed in juveniles. This raises a question from the viewpoint of evolutionary developmental biology: when and how the brain of direct-developing insects becomes adult without the pupal stage? To address this question, Takayuki Watanabe is investigating the development of the neural circuits for adult-specific behaviors in a model hemimetabolous insect, Gryllus bimaculatus (two-spotted cricket).

Representative treatise, book

Modern humans, Homo sapiens sapiens, migrated from Africa approximately 60,000 years ago and rapidly spread to every corner of the Earth. In this migration process, our ancestors encountered new environments and developed various cultures to survive. Culture is a strong evolutionary agency that drives evolution of human and other organisms’ genomes. Gene-culture coevolution is exemplified by lactase persistence alleles in milk-drinking pastoralist populations and Schizophrenia resistant SNP variants in almost all countries. It is possible to learn the process of culture-driven evolution by looking at positive Darwinian selection that operates on particular genomic regions. To this end, we conduct our evolutionary researches on 1) metabolizing enzyme genes, 2) detoxification enzyme genes, 3) mental disorder-related genes. In particular, detoxification enzyme variants are intimately related to metabolisms of luxury grocery items (e.g. spices, coffee, alcohol) as well as drugs, both essential to modern life. Learning the history of variants in these systems will provide some answers about how we got here.
Most insects undergo metamorphosis to develop into adults. The brains of holometabolous insects (e.g., flies, butterflies, bees) drastically change their morphology during metamorphosis, which is required to prepare neural circuits for adult-specific behaviors. On the contrary, the brains of direct-developing insects (insects develop without pupal stage, e.g., cockroaches, crickets) show moderate structural changes throughout post-embryonic stages. However, similar to holometabolous insects, adults of direct-developing insects exhibit adult-specific behaviors such as courtship and mating behaviors, which are not observed in juveniles. This raises a question from the viewpoint of evolutionary developmental biology: when and how the brain of direct-developing insects becomes adult without the pupal stage? To address this question, Takayuki Watanabe is investigating the development of the neural circuits for adult-specific behaviors in a model hemimetabolous insect Gryllus bimaculatus (two-spotted cricket).

Representative treatise, book


By observing the chromosomes, we can see the history and evolution of life as well as the whole set of genome of the species. I have been examined how the spatial arrangement of chromosomes and genes is organized within the cell nucleus by FISH techniques and molecular biological approaches using various cultured cells. Chromosome territories (CTs) in the interphase nucleus have a radial positioning depending on the gene density and chromosome size. Spatial positioning of CTs shows dynamics and is affected by the gene expression status due to the process of cell division and cell differentiation, physiological environmental changes, aging and tumorigenesis, and so on. The hierarchical structures from CTs to DNA are as follows: compartments, TADs (Topologically Associated Domains), and chromatin structures. The mechanism of how spatially regulated of each structure is unknown in many parts. Therefore, I am trying to elucidate the molecular basis of how CTs, compartments, TADs, and chromatin are spatially organized by making full use of 3D-FISH and genome editing techniques.

**Representative treatise book**


**Conclusions**

As analyses of omics such as genomes and transcriptomes have been progressing for the increasing number of species, it becomes possible to study an organism as a whole, with recognizing each and every underlying system as product of complex products of genes expressed. In our laboratory, with emphasizing the viewpoints of molecular evolution and population genetics, a few biosystems have been studied to solve questions such as “How have the mutations of individual genes led to phenotypical changes and become subject to natural selection?” or “How have complex systems been formed through the accumulation of mutations?” With the aims in mind, we have conducted specific researches on the followings: (1) the evolution of reproductive systems in Polygonaceae, such as the heteromorphic self-incompatibility system in buckwheat in which one genetic locus controls dimorphic floral morphology and self-incompatibility, (2) the evolution of vertebrae immune systems such as adaptive and innate immune systems of fishes.
Molecular Cytogenetics • Chromosome Biology

Spatial visualization of chromosomes within the cell nucleus by multi-color FISH techniques

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Representative treatise book


Molecular Evolution

Study evolution of biological systems, such as vertebrate immune systems and plant reproductive systems, at molecular level.

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Representative treatise book

OTAs, Tatsuya

Associate Professor

Research keywords

Molecular evolution, immune system, and cancer using genome analysis, transcriptome analysis.

Published papers


To aspirants

Graduate university is the starting point of your research life. Why do you try to find research subject/problem worth for your time in lifetime together?

To apply

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http://researchmember.jipr.or.jp/ota/

http://researchmember.jipr.or.jp/ota/

Young female and short-styled flower of buckwheat

Long-styled flower and short-styled flower of buckwheat

Together with a characteristic flower for the chestnut blossom project

Evolutionary Biology

TANABE, Hideyuki

Associate professor

Research keywords

Chromosomes, chromosome territory, FISH technique, 3-D-FISH, FISH imaging, cell nucleus, gene, chromosome, nuclear architecture.

Career

Graduated from the Department of Anthropological Faculty of Science, the University of Tokyo and entered the Graduate School of Science, obtaining a Master’s degree in 1993 (Tokyo University). After engaged as a senior staff scientist at the Division of Services and Management, National Institute of Health Sciences, became an associate professor at the School of Advanced Sciences. Senior. Studying abroad for Professor Thomas Cremer laboratory. (M.A. University of Tokyo 2003-2005). B.B.S.

To aspirants

I was fascinated by the microscopic world with FISH technique. I then entered the research field for analysis of chromosome structure and function in terms of evolution. Humans and primates were the first subjects, but the observations are expanding to mammal-like vertebrates, fish and marine invertebrates. Chromosomes are the basis of the genome and the bridge between molecules and cells. Why don’t you first look at the chromosomes of the species of your interest?

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Molecular Evolution, Population Genetics, Physical Anthropology
Learning human evolution from genetic diversity

How our species, Homo sapiens, emerged? To address this question, I take two approaches. One is "to understand the evolution of human specific traits". The other is "to understand the demographic history of human after they appeared in Africa". I study Molecular Evolution and Population Genetics to understand these processes of human evolution at DNA level. One of the current targets is tandem repeat of single amino acids, which is called as homopolymeric amino acid repeat. It is known that unusual length of this repeat causes genetic diseases, which affect central nervous systems and skeletalogenesis. These kinds of diseases related to human specific traits such as large brain size or bipedal locomotion. I expect that the evolution of homopolymeric amino acid repeats can be a key to understand human evolution. And there are many projects aim to find markers or genes that are responsible for human genetic disease. As a consequence of these projects, massive amount of SNP data or human genetic variation data are produced. I apply these medical data to human evolutionary study and try to connect medical and evolutionary researches. My interest is not only limited to human evolution but also includes evolution of primates, mammals and vertebrates.

Representative treatise, book


TERAI, Yohey
Assistant Professor

Ph D. (Science), Graduate School of Life Science and Technology, Tokyo Institute of Technology Assistant Professor of SECE, Tokyo Institute of Technology Assistant Professor Graduate School of Advanced Studies, Graduate School of Integrated Studies

Career

Research interests: Adaptation, speciation, and symbiosis

To aspires

"Better be the head of a dog than the tail of a fox"
If you are interested in evolutionary biology and want to research your own theme, studying in ESB is the best choice for you.

Evolutionary biology with a focus on adaptation and speciation Investigating the generation of biodiversity

It is believed that biodiversity has been achieved through countless repetitions of speciation and adaptation in the evolutionary history. I am attempting to elucidate how speciation and adaptation have occurred in terms of genome, ecology, and protein function. Ongoing research projects are 1) adaptation to local environments and speciation in seven species of macaques endemic to the island of Sulawesi, 2) establishment of the Japanese dog as revealed by the Japanese wolf genome and the ancient Japanese dog genome, 3) adaptation of fliers to extreme environments through symbiosis with symbiotic bacteria, 4) adaptation of fish vision to light environments, 5) speciation of corals in the ocean without physical barriers, 6) molecular mechanisms of human-specific skin formation, and 7) adaptation of vision in marine reptiles to marine environments. Our research approaches include the collection of ecological information and samples from habitats, genome decoding and analysis, molecular evolutionary analysis of genes, and functional analysis of proteins, in an attempt to understand how speciation and adaptation have occurred.
How our species, Homo sapiens, emerged? To address this question, I take two approaches. One is "to understand the evolution of human specific traits". The other is "to understand the demographic history of human after they appeared in Africa". I study Molecular Evolution and Population Genetics to understand these processes of human evolution at DNA level. One of the current targets is tandem repeat of single amino acids, which is called homopolymers amino acid repeat. It is known that unusual length of this repeat causes genetic diseases, which affect central nervous systems and skeletogenesis. These kinds of diseases related to human specific traits such as large brain size or bipolar locomotion. I expect that the evolution of homopolymeric amino acid repeats can be a key to understand human evolution. And there are many projects aim to find markers or genes that are responsible for human genetic disease. As a consequence of these projects, massive amount of SNP data or human genetic variation data are produced. I apply these medical data to human evolutionary study and try to connect medical and evolutionary researches. My interest is not only limited to human evolution but also includes evolution of primates, mammals and vertebrates.

**Representative treatise, book**

- Jun Gojobori, Fumio Mizuno, Li Wang, Kusuke Okushi, Julio Granados, Celta Gomez-Trejo, Yoko Acuna-Alonzo, Shintaro Ueda (2015) In DNA diversity of the Zapotec in Mexico suggests a population decline long before the first contact with Europeans. *Journal of Human Genetics* 60(9): 557-559. doi: 10.1038/jhg.2015.35

**To aspirants**

"Better be the head of a dog than the tail of a fox". If you are interested in evolutionary biology and want to research your own theme, studying in EB is the best choice for you.

**Japanese and Haplogroup diagram**

*Species in Subantarctic region; Environmental adaptation of speciation and speciation; Evolutionary biology with a focus on adaptation and speciation: Investigating the generation of biodiversity.*

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1) adaptation to local environments and speciation in seven species of macaques endemic to the island of Sulawesi.
2) establishment of the Japanese dog as revealed by the Japanese wolf genome and the ancient Japanese dog genome.
3) adaptation of threes to extreme environments through symbiosis with symbiotic bacteria.
4) adaptation of fish to light environments.
5) speciation of corals in the ocean without physical barriers.
6) molecular mechanisms of human-specific skin formation, and
7) adaptation of vision in marine reptiles to marine environments.

Our research approaches include the collection of ecological information and samples from habitats, genome decoding and analysis, molecular evolutionary analysis of genes, and functional analysis of proteins, in an attempt to understand how speciation and adaptation have occurred.
**Theoretical Biology**

**Evolutionary Projection, Evolutionary Dynamics, Diversity**

Pathogens like human immune deficiency virus and Trypanosoma brucei, the causative agents of AIDS and sleeping disease, are known to repeatedly change their cell surface coat proteins, thereby escaping the host immune response and enabling their persistent infection. To predict such rapid and complicated evolutionary processes of pathogens, we need to develop mathematical models to describe the evolution of pathogens' cell surface protein and immune response within an infected host. With these mathematical models, I have been studying, for example, the antigenic drift of HIV and influenza viruses to escape host immune system, the evolution of pathogen virulence with host spatial structure or metapopulation heterogeneity, the evolution of viral mutation rates, and the optimal strategies for vaccination and drug therapy. Other topics I am studying intensively include Mullerian mimicry and formation of spatial mosaic, coevolutionary cycles and their geographical asynchrony, species packing and sympatric speciation, the evolution of division of labor in mutualism, and the evolutionary fragility of mutualist systems.

**Population genetics**

**Understanding the mechanism of molecular evolution**

We aim to theoretically understand the mechanism of molecular evolution. The genetics-based theory can be applied to a wide range of species. Genomic polymorphism data are analyzed to understand how and when Darwinian selection worked in the genome.

**Representative treatise, book**


Pathogens like human immune deficiency virus and Trypanosoma brucei, the causative agents of AIDS and sleeping disease, are known to repeatedly change their cell surface coat proteins, thereby escaping the host immune response and enabling their persistent infection. To predict such rapid and complicated evolutionary processes of pathogens, we need to develop mathematical models to describe the evolution of pathogen’s cell surface protein and immune response within an infected host. With these mathematical models, I have been studying, for example, the antigenic drift of HIV and influenza viruses to escape host immune system, the evolution of pathogen virulence with host spatial structure or metapopulation heterogeneity, the evolution of viral mutation rates, and the optimal strategies for vaccination and drug therapy. Other topics I am studying intensively include Müllerian mimicry and formation of spatial mosaic, coevolutionary cycles and their geographical asynchrony, species packing and sympatric speciation, the evolution of division of labor in mutualism, and the evolutionary fragility of mutualist systems.
**Mathematical Biology**

Revealing roles behind biological phenomena and exploring universal principles of life through mathematical analysis

When starved, cells of slime mold, Dictyostelium discoideum, aggregate and some of them die to form stalks in order for others to disperse to a better location. In most eusocial insects such as bees and ants, queens dominate reproduction whereas workers are specialized in various labors in the colony. Reciprocal cooperation forms a basis of human society. Cooperation is ubiquitous in biology, yet its evolutionary origin is paradoxical because one can expect the emergence of "social parasites" which do not pay the cost but enjoy the benefit of cooperation. One of my main goals is to theoretically unveil the origin of cooperation. My research topics include: kin recognition in microorganisms, dynamic optimization in ant colonies, generalization of inclusive fitness theory, interplay between population structure and evolutionary dynamics, indirect reciprocity in humans, evolution of punishment and reward, and evolution of dominance hierarchy. I also work on modeling of animal behavior, species diversity, cultural evolution, social networks, human life-history evolution, and cancer progression. In addition, I study mathematical foundations of evolutionary game theory and adaptive dynamics theory.

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M Mathematical Biology

Revealing roles behind biological phenomena and exploring universal principles of life through mathematical analysis

When starved, cells of slime mold, Dictyostelium discoideum, aggregate and some of them die to form stalks in order for others to disperse to a better location. In most eusocial insects such as bees and ants, queens dominate reproduction whereas workers are specialized in various labors in the colony. Reciprocal cooperation forms a basis of human society. Cooperation is ubiquitous in biology, yet its evolutionary origin is paradoxical because one can expect the emergence of “social parasites” which do not pay the cost but enjoy the benefit of cooperation. One of my main goals is to theoretically unveil the origin of cooperation. My research topics include: kinetic recognition in microorganisms, dynamic optimization in ant colonies, generalization of inclusive fitness theory, interplay between population structure and evolutionary dynamics, indirect reciprocity in humans, evolution of punishment and reward, and evolution of dominance hierarchy. I also work on modeling of animal behavior, species diversity, cultural evolution, social networks, human life-history evolution, and cancer progression. In addition, I study mathematical foundations of evolutionary game theory and adaptive dynamics theory.

Representative treatise.book


H History of science and technology

Let’s think about the landscape of knowledge. What do we know and what don’t we know? Why?

My main interests are in history of biology in Japan. I have examined how genetics developed in Japan from the 1920s to 1960s through dynamic social contexts such as modernization, imperial expansion, postwar reconstruction /democratization, and Cold War. My current interests include how concepts of radiation and its effects were shaped after the war and what roles the Japanese community played in that shaping.

Representative treatise.book


Philosophy of Science

Investigates the nature of science and scientific knowledge

Science and technology today have huge impacts on every aspect of our lives. While they considerably benefit us, the emergence of new technologies sometimes brings about unprecedented disasters and ethical dilemmas. In light of this, the relation between science and society has been actively discussed from various aspects in various disciplines, including philosophy of science. A sufficient understanding of the relation between science and society requires a deeper understanding of science itself. For example, what are the features that make science so special and different from other activities called 'pseudoscience'? Is science free from social values? If it is, how is it possible when scientific research is conducted by scientists who are situated in particular social and cultural settings? If it is not, does it inevitably undermine the rationality of science and its authority? These are the topics discussed in philosophy of science. My research interest in this area has been in the nature of scientific knowledge. In particular, I have worked on the issue called ‘the scientific realism debate’ (a debate concerning the approximate truth of what scientific theories tell us about the world, including its unobservable aspects) and applied insights from epistemology (theory of knowledge, justification, or warrant) to this debate. I’m also interested in philosophical implications of emergent technologies such as machine learning and data assimilation.

Representative treatise, book


The Model of the Study Process

### Five-year doctoral course
- **D1 (1st grade)**
  - Through "lab rotation" (research experience in multiple laboratories) and taking an introductory course in sub-themes, the themes of the thesis and sub-thesis are determined; research plans are prepared; and supervisors are decided upon.
  - Determination of the themes of doctoral thesis and sub-thesis; Advancement examination
- **D2 (2nd grade)**
  - Research begins in earnest. An advancement examination is held at the end of the second year.
  - Research begins; Research advances on doctoral-theses and sub-theses.
- **D3 (3rd grade)**
  - Research advances on doctoral-theses and sub-theses.
  - The supervisors, the themes of the thesis and sub-thesis are determined; Research advances
- **D4 (4th grade)**
  - A sub-thesis is submitted at the end of the fourth year (recommended).
  - Research advances on thesis and sub-theses.
  - Research advances on thesis and sub-theses.
- **D5 (5th grade)**
  - The doctoral-thesis is submitted. It is reviewed for the conferment of the degree.
  - The doctoral-thesis is submitted. It is reviewed for the conferment of the degree.

### Three-year doctoral course
- **D1 (1st grade)**
  - Students can learn the latest research trends and historical Society, to give guest lectures, holding eight seminars a year.
  - We invite researchers who are active at the forefront of Sciences. Faculty members in the relevant field will provide guidance and support for research on sub-theses.
- **D2 (2nd grade)**
  - Students who write their primary thesis in the biosciences write their sub-thesis on the theme of Science and Society; Students who write their primary thesis in the field of Biosciences. Faculty members in the relevant field will provide guidance and support for research on sub-theses.
- **D3 (3rd grade)**
  - The supervisors, the themes of the thesis and sub-thesis are determined; Research advances
- **D4 (4th grade)**
  - A sub-thesis is submitted at the end of the fourth year (recommended).
  - Research advances on thesis and sub-theses.
- **D5 (5th grade)**
  - The doctoral-thesis is submitted. It is reviewed for the conferment of the degree.

### Educational Characteristics
Our educational program is structured so that individuals can establish their own perspective on life and is aimed at developing professionals who can be employed in the future development of society. The biggest feature is that all faculty members are involved in the management of learning and research processes for all students, and a number of novel initiatives are engaged in that are not found in conventional graduate school education.

### Comprehensive Support for Students
- **The Research Assistant (RA) Employment System**
  - We will provide payment up to an amount equivalent to the annual tuition fee for RAs.
- **Laptop Rentals**
  - All students will be lent a laptop for use in research and learning.
- **Support for Overseas Travel Expenses**
  - The government will provide support for the presentation of research results overseas, as well as travel and accommodation expenses associated with research activities and the collection of materials at overseas research institutes.
- **Support for Domestic Travel Expenses**
  - We will provide support for travel and accommodation expenses for those taking courses in other major fields of study or other graduate schools, as well as for the presentation of research results at Japanese academic societies, and experiments at institutions and shared laboratory facilities.
- **SOKENDAI Publication Grant for Research Papers**
  - We will cover expenses necessary for the publication of research papers, etc.
- **SOKENDAI Student Dispatch Program**
  - We will support long-term collaborative research in Japan and overseas.

### Subjects of Basic Education
- Advanced Course: Seminars by external lecturers
- Progress Report: Presentation of research progress and results

### Subjects of Specialist Education: Advanced specialties

### Broad Perspective and Communication Skills

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**Note:** The above text is a summary of the study process and educational characteristics as per the document. For a detailed understanding, please refer to the full document.
Our educational program is structured so that individuals can establish their own perspective on life and is aimed at developing professionals who can be employed in the future development of society. The biggest feature is that all faculty members are involved in the management of learning and research processes for all students, and a number of novel initiatives are engaged in that are not found in conventional graduate school education.

- **The Collective Leadership System**
  Every teacher pays attention to the progress of each individual student’s learning and research as they instruct them. Students may request research guidance and advice not only from instructors (one supervisor and two sub-supervisors) but also from other faculty members.

- **The Sub-Thesis System**
  In order to cultivate the broad perspective that is also the philosophy of this university, the submission of sub-theses as well as degree papers in specialized fields (main papers) is required for the conferral of degrees. Students who write their primary thesis in the Biosciences write their sub-thesis on the theme of Science and Society, while students who write their primary thesis in the field of Science and Society write their sub-thesis on a theme from Biosciences. Faculty members in the relevant field will provide guidance and support for research on sub-theses.

- **Support for Domestic Travel Expenses**
  We will provide support for travel and accommodation expenses for those taking courses in other major fields of study or other graduate schools, as well as for the presentation of research results at Japanese academic societies, and experiments at institutions and shared laboratory facilities.

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**Educational Characteristics**

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**The Model of the Study Process**

- **Five-year doctoral course**
  - Determination of the themes of the doctoral thesis and sub-thesis
  - Advancement examination
  - Research on doctoral-theses
  - Research on doctoral-theses and sub-theses
  - Submission of doctoral-theses

- **Three-year doctoral course**
  - Determination of the themes of the thesis and sub-thesis
  - Advancement examination
  - Research on theme and sub-themes
  - Research on theses and sub-theses
  - Submission of sub-theses (recommended)

**Subjects of General and International Education**

**Subjects of Basic Education**

**Subjects of Specialist Education: Advanced specialties**

**Advanced Course: Seminars by external lecturers**

**Progress Report: Presentation of research progress and results**

**Broad Perspective and Communication Skills**
We held open-campus events and information sessions on the academic program at Hayama Campus twice a year in early summer and winter. We have been holding an online information session on the academic program since AY 2020. In addition, for those who so desire, we accept requests for trial enrollment, consultations on admissions, and laboratory visits at any time.

2022 On-line Session

- May 14, 2022 (Held online)
  "Research Frontline:
  Let's study at graduate school!"
  lecture meeting
  Entrance Examination information Session

- August 19, 2022 (Held online)
  Open Campus

- November 12, 2022
  Information Session on the academic program

For details, please refer to the following URL.
http://www.esb.soken.ac.jp/admissions/open_campus_detail.html

Cross-disciplinary Educational Programs

- Freshman Course
  The Freshman Course is an intensive course for many enrolled students of SOKENDAI. It is a unique program that provides fundamental knowledge and skills to a researcher, as well as an opportunity to build connections with people in different fields.

- Life Science Retreat
  Life Science Retreat invites faculty members and students of biological fields to deepen academic exchange. The meeting will be held in English. Participating students have the opportunity to acquire presentation skills through research presentations (oral and poster), and to gain a broader perspective on biology by interacting with people from different fields.

Subjects of General and International Education

- Scientific Writing
- Science, Technology and Society I - II
- Life Science and Society I - II

Subjects of Basic Education

- Introduction to the "Science & Society" Subthesis
- Introduction to the "Biological Science" Subthesis
- Introduction to Science and Technology Studies
- Biostatistics
- Laboratory of Basic Biology
- Micro- and Macro-scopic Biology
- Integrated Evolutionary Biology
- Academic English (Basic) I - IV
- Academic English (Advanced) I - IV

Life Sciences

- Subjects of Anthropology
  Integrative Anthropology
  Environmental Archaeology
  Human Genetics

- Subjects of Evolutionary Biology
  Evolutionary Physiology
  Cell Biology
  Molecular Evolution

- Subjects of Behavioral Biology
  Sensory Physiology
  Neuroethology
  Evolutionary Behavioral Ecology

- Subjects of Advanced Theoretical Biology
  Population Genetics
  Mathematical Biology
  Evolutionary Game Theory

Science and Society

- Subjects of Social Studies of Science
  STS and History of Science I
  STS and History of Science II
  STS and History of Science III

Subjects of Specialist Education

- "Advanced Specialties" and "Broad Perspective"

The department has two groups of subjects: "General and International Education" and "Basic Education" to develop a broad perspective and communication skills. In addition, there are highly specialized subjects in the "Specialist Education" groups, which are designed to help students acquire a high level of expertise and to cultivate a broad perspective by taking subjects in multiple fields.

Briefing Session Flow

Overview of SOKENDAI
Brief description of the major
Curriculum/Explanation of Admissions
Individual Discussions

ראשון לציון
הはじめて
- A cornered rat will bite the cat

Please note: on the HP site

For more information, (http://www.esb.soken.ac.jp/index.html)
3 Subject Groups

"Advanced Specialties" and "Broad Perspective"

The department has two groups of subjects: "General and International Education" and "Basic Education" to develop a broad perspective and communication skills. In addition, there are highly specialized subjects in the "Specialist Education" groups, which are designed to help students acquire a high level of expertise and to cultivate a broad perspective by taking subjects in multiple fields.

Subjects of General and International Education

Scientific Writing  Science, Technology and Society I - II  Life Science and Society I - II

Introduction to the "Science & Society" Sub-theme  Introduction to the "Biological Science" Sub-theme  Introduction to Science and Technology Studies  Biostatistics  Laboratory of Basic Biology  Micro- and Macro-scopic Biology  Integrated Evolutionary Biology  Academic English (Basic) I - IV  Academic English (Advanced) I - IV

Subjects of Basic Education

Subjects of Anthropology  Environmental Archaeology  Human Genetics

Evolutionary Anthropology  Environmental Archaeology  Human Genetics

Subjects of Evolutionary Biology

Evolutionary Physiology  Cell Biology  Molecular Evolution

Subjects of Behavioral Biology

Sensory Physiology  Neuroethology  Evolutionary Behavioral Ecology

Subjects of Advanced Theoretical Biology

Population Genetics  Mathematical Biology  Evolutionary Game Theory

Life Sciences

Subjects of Social Studies of Science

STS and History of Science I  STS and History of Science II  STS and History of Science III

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  Open Campus

- November 12, 2022
  Information Session on the academic program

  For details, please refer to the following URL:
  http://www.esb.soken.ac.jp/admissions/open_campus_detail.html

- January 6, 2023
  Open Campus (Implementation method undecided)

We held open-campus events and information sessions on the academic program at Hayama Campus twice a year in early summer and winter. We have been holding an online information session on the academic program since AY 2020. In addition, for those who so desire, we accept requests for trial enrollment, consultations on admissions, and laboratory visits at any time.

Cross-disciplinary Educational Programs

Freshman Course

The Freshman Course is an intensive course for new enrolled students of SOKENDAI. It is a unique program that provides fundamental knowledge and skills for a researcher, as well as an opportunity to build connections with people in different fields.

(The photo was taken in 2018)

Life Science Retreat

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(The photo was taken in 2018)

For more information, please visit the HP site:
http://www.esb.soken.ac.jp/index.html
What was your motivation for entering SOKENDAI? Since my childhood, I have been interested in how organisms evolve. When I graduated from my undergraduate program and went on to graduate school, I was particularly interested in the theory of evolution, and when I thought about where I could study this theory in Japan, I decided that it was at SOKENDAI. There is really nowhere else that you can study the theory of evolution specifically.

What was your research life like? There is only a small number of students, but I am glad I along with people from various fields. In ordinary universities, people are divided between students in the liberal arts and those in the sciences. As a researcher of humans, I like both ways of thinking. I was invited to participate in a lecture on the arts at SOKENDAI, and through this experience, I realized a variety of things. For one lecture, I went to a museum in Hokkaido and was shown their exhibits; for another, a folklore teacher led me to visit museums in Shikoku. Although it is difficult to connect these experiences directly to my own field of research, my perspective expanded greatly.

How was the Hayama Campus? When I arrived, I got on the bus, and it went into the mountains, so it was kind of thrilling (haha!). As I engage in research, there are many times when it is tough because I do not get results, so in order to be stimulated and release the stress, I need to come down from the mountains. If you take a walk, the sunset is beautiful, which is good for changing your mood. I liked the compact environment.

What will you do when you are finished? I find human diversity interesting. It is an interesting trait of humans that both genetic diversity and cultural diversity are intertwined. It is extremely interesting to look at why humans have so widened their habitats around the world and expanded them to the greatest extent of all primates, despite their very low levels of genetic diversity. I would like to continue my research in this vein in the future.

What are the merits of SOKENDAI? Since there is no undergraduate program here, my time is rarely taken up by classes, and it is really great that I can feel free to engage in casual discussions with faculty members and senior students. You do not have to worry about time, and even if you go to your room, they will make sure to listen to you.

What kind of research did you engage in? There is a strange creature called a vestimentiferan that lives in the deep sea, and it contains with bacteria in the body. I was researching the theoretical model of the evolution of the symbiotic relationship by which the bacteria co-exist with the host. I submitted it when I was in my second year, and after years of proofreading, it was published in DS. It took quite a long time (haha!).

Do you have a few words for those who aim to enroll at SOKENDAI? I am glad I came here, but of course I cannot guarantee what other people think. Those who think it is best to come here so that they may do what they can to do should definitely come. Basically, in the doctoral course, the goal is to become a fully independent researcher. I think that if you have that kind of mindset, you can be happy.
Interview with Graduates

Dr. Iwasaki, Risa

What was your research life like?

There is only a small number of students, but I am glad I got along well with people from various fields. In ordinary universities, people in different fields attend different campuses and never meet each other, but as SOKENDAI, there are people from different fields on the same floor or nearby, and I was glad to be able to casually talk or hang out with them. “What are you doing now?” or something like that. In the “student’s room,” where students are board, it seems as though people have been intentionally placed so that those from different laboratories are mixed up together so that they may interact with each other.

What is research?

It is hard for anyone to know from the start how they will turn out. If you take hornet and spend about two weeks in bed, you never get to see. My undergraduate program and went on to graduate school, I was particularly interested in the theory of evolution, and when I thought about where I could study this theory in Japan, I decided that it was at SOKENDAI. There is really nowhere else that you can study the theory of evolution specifically.

What was your greatest challenge?

I was allowed to proceed at my own pace. I had good relationships with my teachers and other researchers, and, honestly, I did not have any real hurdles to overcome. When I was in D4, while it had nothing to do with my research, I was stung by a hornet and spent about two weeks in bed. In the process of proofreading the first paper I submitted for publication.

What is your greatest memory?

When I was in D4, I stayed at a Yasawa research institute in Austria, the UIASA (International Institute for Applied Systems Analysis) for about two weeks and then had the chance to engage in collaborative research with prominent researchers. From the point of view of my career as a researcher, I was able to train myself to discuss research in English, for which I was glad.

What was your research life like?

Since my childhood, I have been interested in how organisms evolve. When I graduated from my undergraduate program and went on to graduate school, I was particularly interested in the theory of evolution, and when I thought about where I could study this theory in Japan, I decided that it was at SOKENDAI. There is really nowhere else that you can study the theory of evolution specifically.

What is research like?

When I first decided on the theme of my research after entering university, the research theme that I had brought with me was accepted. I believe that my greatest achievement was my ability to proceed with research into that topic and have it published in The American Naturalist, a famous international journal that I really admired.

What are the merits of SOKENDAI?

Since there is no undergraduate program here, my time is rarely taken up by classes, and it is really great that I can feel free to discuss research in English, for which I was glad.

What will you do when you are finished?

I think that if you have that kind of mindset, you can be happy. To that end, I hope that I can continue to work on my research and contribute to the field of cultural diversity.

Do you have a few words for those who aim to enroll at SOKENDAI?

Even if you have decided on what you want to do or a theme, it is not easy to bring it to tangible form in accordance with the framework of academia. The process is often difficult and disheartening. But beyond that, things that are exclusively your own will appear, so I want you to enjoy the process.
Access to Hayama Campus

Access by train or bus
- From Zushi Station of JR Yokosuka Line (best route)
  - Take the Keihin Tohoku Line to Zushi Station (2 minutes on foot).
  - Transfer to the Zushi Line at Zushi Station (2 minutes on foot).
  - Get off at "Shirono Kukusetsu Komae" station (2 minutes on foot).
- From Zushi Station of JR Kii Line
  - Take the JR Kii Line to Zushi Station (2 minutes on foot).
  - Transfer to the Zushi Line at Zushi Station (2 minutes on foot).
  - Get off at "Shirono Kukusetsu Komae" station (2 minutes on foot).

Access by car
- From Zushi Interchange of Yokohama-Yokosuka Road (best route)
  - After going out of the exit of Zushi-Shinko Road (right way), turn left at the first intersection. Through the Nango Tunnel, go straight on the street for about 5 minutes. Then, turn left at the "Shirono Kukusetsu Komae" intersection and keep driving for about 1 minute to the University.

For more information, please visit the following websites for details.
Access to Hayama Campus

Access by train or Bus

- **From Zushi Station of JR Yokosuka Line (best route)**
  - Use the Shinkansen (Bullet Train) for "Shimoda Station" on Track # 1 and get off at "Shimoda Station". Approx. 20 min.
  - Use the Shinkansen (Bullet Train) for "Hakone Station" on Track # 2 and get off at "Hakone Station". Approx. 30 min.
  - Use the Shinkansen (Bullet Train) for "Zushi Station". Approx. 10 min.

- **From Shonan-Numazu Station of JR Yokosuka Line (south route)**
  - Use the Shinkansen (Bullet Train) for "Yokosuka Station" on Track # 1 and get off at "Yokosuka Station". Approx. 20 min. (Cost: 100 yen).
  - Use the Shinkansen (Bullet Train) for "Zushi Station". Approx. 10 min.

- **From Shonan-Numazu Station of JR Yokosuka Line (South route)**
  - Use the Shinkansen (Bullet Train) for "Zushi Station". Approx. 10 min.

- **From Shonan-Numazu Station of JR Yokosuka Line (North route)**
  - Use the Shinkansen (Bullet Train) for "Zushi Station". Approx. 10 min.

Available Bus Services:

- **By JR**
- **By Kaido**
- **By Bus**
- **By CAT**

Access by car

- **From Zushi Interchange of Yokohama-Yokosuka Road (1st way)**
  - After getting out of the exit of Zushi-Shinkansen Line (1st way), turn left at the first intersection. Through the Nango tunnel, go straight on the street for about 5 minutes. Then, turn left at the "Shonan Kukusukino Center" entrance and keep driving for about 5 minutes to the university.

- **From Zushi Interchange of Yokohama-Yokosuka Road (2nd way)**
  - After getting out of the exit of Zushi-Shinkansen Line (2nd way), turn left at the first intersection. Through the Nango tunnel, go straight on the street for about 5 minutes. Then, turn right at the "Shonan Kukusukino Center" entrance and keep driving for about 5 minutes to the university.

- **By car**
- **From Zushi Interchange of Yokohama-Yokosuka Road (3rd way)**
  - After getting out of the exit of Zushi-Shinkansen Line (3rd way), turn left at the first intersection. Through the Nango tunnel, go straight on the street for about 5 minutes. Then, turn left at the "Shonan Kukusukino Center" entrance and keep driving for about 5 minutes to the university.

- **By car**
- **From Zushi Interchange of Yokohama-Yokosuka Road (4th way)**
  - After getting out of the exit of Zushi-Shinkansen Line (4th way), turn left at the first intersection. Through the Nango tunnel, go straight on the street for about 5 minutes. Then, turn right at the "Shonan Kukusukino Center" entrance and keep driving for about 5 minutes to the university.

- **By car**
- **From Zushi Interchange of Yokohama-Yokosuka Road (5th way)**
  - After getting out of the exit of Zushi-Shinkansen Line (5th way), turn left at the first intersection. Through the Nango tunnel, go straight on the street for about 5 minutes. Then, turn left at the "Shonan Kukusukino Center" entrance and keep driving for about 5 minutes to the university.

- **By car**
- **From Zushi Interchange of Yokohama-Yokosuka Road (6th way)**
  - After getting out of the exit of Zushi-Shinkansen Line (6th way), turn left at the first intersection. Through the Nango tunnel, go straight on the street for about 5 minutes. Then, turn left at the "Shonan Kukusukino Center" entrance and keep driving for about 5 minutes to the university.

- **By car**
- **From Zushi Interchange of Yokohama-Yokosuka Road (7th way)**
  - After getting out of the exit of Zushi-Shinkansen Line (7th way), turn left at the first intersection. Through the Nango tunnel, go straight on the street for about 5 minutes. Then, turn left at the "Shonan Kukusukino Center" entrance and keep driving for about 5 minutes to the university.

- **By car**
- **From Zushi Interchange of Yokohama-Yokosuka Road (8th way)**
  - After getting out of the exit of Zushi-Shinkansen Line (8th way), turn left at the first intersection. Through the Nango tunnel, go straight on the street for about 5 minutes. Then, turn left at the "Shonan Kukusukino Center" entrance and keep driving for about 5 minutes to the university.

- **By car**
- **From Zushi Interchange of Yokohama-Yokosuka Road (9th way)**
  - After getting out of the exit of Zushi-Shinkansen Line (9th way), turn left at the first intersection. Through the Nango tunnel, go straight on the street for about 5 minutes. Then, turn left at the "Shonan Kukusukino Center" entrance and keep driving for about 5 minutes to the university.

- **By car**
- **From Zushi Interchange of Yokohama-Yokosuka Road (10th way)**
  - After getting out of the exit of Zushi-Shinkansen Line (10th way), turn left at the first intersection. Through the Nango tunnel, go straight on the street for about 5 minutes. Then, turn left at the "Shonan Kukusukino Center" entrance and keep driving for about 5 minutes to the university.