12 Course Catalog

Subject	Credit	About the course
Advanced Systems Neuroscience システム神経科学論	2	Higher-order brain functions such as sensory perception, behavioral actions, emotion, decision-making and thinking are mediated by nerve cells in the brain, more than 10 billion of which exist in the cerebral cortex alone, making local and global, hierarchical networks, and representing and processing neuronal information under specialized working principles. In Advanced System Neuroscience, graduate students are expected to master the coding of nerve signals, detection and perception of sensory stimuli, control of actions and motor learning, emotion and decision-making. Classes will consist of lectures, workshops and discussions in a small group of students and professors.
Systems Neuroscience Technique システム神経科学技法	1	To understand the mechanism of the neural system, researchers need to obtain precise and reliable experimental data by an appropriate combination of several experimental techniques. In this lecture, students will learn the basics and applications of anatomical and physiological techniques widely used in neuroscience, such as tracer injections, microscopy, electroencephalograms, and extracellular and intracellular recordings. The students will learn how to select experimental techniques and how to analyze their experiment data in accordance with the purpose of their own studies.
Computational Neuroscience 計算論的神経科学	2	In this course, we review theoretical and computational neuroscience, which is an approach for understanding brain functions through mathematical formulation. Participants learn how to analyze and hypothesize through a computational point of view on their own project. The approaches of computational neuroscience try to understand brain functions by analyzing multiple levels of neuroscientific phenomena on molecular, cell, network and system levels. The goal of this course is to study mathematical and statistical concepts bridging multiple levels of neural and behavioral data, such as neural encoding and decoding, information theory, and Bayesian statistics.
Computer Simulation Technique コンピュータシミュレーション技法	1	Computer simulation is an effective method to confirm what phenomena emerge from a hypothesized model. For instance, we can easily examine the effect of a certain cause by using a simulation of a biologically detailed model. This also allows us to understand the background mechanisms of an observed phenomenon by looking for the smallest model required in order to reproduce that phenomenon. This lecture provides concrete examples to study the required basic techniques in regards to the 2 contrary courses of action of pursuing biological fidelity on one side and of simplification in order to find mechanisms on the other.
Brain Image Analysis 脳画像解析学	2	The goals of this class are to master the theory of human non-invasive measurement of brain activity, functional magnetic resonance imaging (fMRI), and to cultivate the skills for experimental designs and analyses for fMRI. In the first half, students will learn about possible dangers, ethical issues for participants, and imaging mechanisms in MRI experiments. Also, students will gain understanding on RF pulse sequences and the meanings of the MR images. Furthermore, students will learn how to control interface devices, such as stimulus presentation systems, recording systems for biological reaction etc., which are necessary for fMRI experiments. In the latter half, students will study from basic analyses to applied ones for fMRI data. Then, in order to understand the detailed research methods of fMRI correctly, students will gain the knowledge required for task design with consideration of the characteristics of fMRI. Furthermore, students will actually try to make task designs along some given themes and have discussions in order to make up their skills for their own fMRI research.
Neuroimaging Technique ニューロイメージング技法	1	The aim of this course is to learn about procedures for fMRI studies. The student will be shown how to perform fMRI tasks and how to calculate fMRI data. The student will also experience 3 tesla MRI operation.

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Developmental Science 発達科学	2	This course is intended for students to seek the essence of human behavioral changes with a focus on cognitive psychology, developmental psychology and linguistics, in order to deepen their understanding. In particular, students will learn about the latest research on scientific approaches to understanding a variety of findings in the developmental process of infants. The first half of the course will focus on explaining the concept of development in science (Hiroyuki Okada). We will also touch upon the modeling of learning mechanisms through a connectionist approach, which has become a hot topic in recent years. In the latter half, we will reveal various experimental aspects of its development, by concentrating on language acquisition in infants (Mutsumi Imai).
Developmental Science Technique 発達科学技法	1	This course provides opportunities to learn and experience various research methods of developmental sciences so that students can apply suggestions from brain research to education, connecting information from linguistics, cognitive psychology, and developmental psychology. Students will experience data collection and analysis of questionnaires, surveys, behavioral observations, and behavioral experiments. Especially in behavioral observations, we will discuss the correlation between mother-child/child-child social interaction and first/second language acquisition. Students will also learn manipulations and acoustic analyses of sounds, which are used in studies of speech perception and production. By comparing these multiple research methods, we will discuss appropriate usage of these methods.
Communication Robot Engineering コミュニケーションロボット工学	2	In the case of communication between human subjects, one tries to estimate what the other party intends to do in order to establish optimal mutual interactions, because the other party is a human being with his/her own will. Lectures in Communication Robot Engineering cover theoretical models required for constructing robots that can interact with humans, for the development of cognitive functions and for algorithms for control systems. While studying the literature, graduate students introduce and discuss the latest researches, which will be provided by the professors, to learn about the backgrounds and perspectives of researches in the field of communication robot engineering, and about how to read the literature.
Brain-type Learning Systems 脳型学習システム	2	In the information processing of the brain, any information-integration is related to "learning and memory." Therefore, in order to understand high order functions, it is very important to study learning and memory systems. In this lecture, learning and memory systems from the synapse level of a single neuron to the network level of neurons are explained. The mechanism and dynamics of learning and memory are introduced from both the experimental side and the theoretic side. In addition, the relation between information representation and the memory function in the brain will be touched upon. Furthermore, the latest knowledge about learning and memory will be presented.
Parallel Information Processing パラレル情報処理解析学	2	To understand information processing in the brain, it is necessary to analyze functional spike activities of many neurons which are simultaneously measured through a multi-neuronal recording technique. In this lecture, students will learn the basics and applications of this multi-neuronal recording technique, focusing in particular on classical and up-to-date researches on the mechanism of spatial cognition and memory by hippocampal neurons in rats. The students will also have a simulated experience to review an original paper as a reviewer with scientific insight and criticism.

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Advanced Brain Sciences A (Robotics) 脳情報先端セミナーA（ロボット工学）	1	Robotics consists of various fields of technology, such as mechanics, electricity, electrons and information. It is thought that intelligence technology is of importance for this fusion. In this course, students will study the latest research on the forms of technology that are classified for intelligent robots. In particular, topics such as autonomous mobile robot, image recognition, and self-position identification are studied. This seminar is partly conducted in the Brain Science Retreat.
Advanced Brain Sciences B (Neural Computation) 脳情報先端セミナーB（神経計算論）	1	The purpose of this course is to learn about cutting edge studies in computational neuroscience, theoretical and practical approaches for neuroscience by using computational models, and about methods of analysis with computational hypothesis in the students' own research fields. In this course, we conduct a series of seminars by invited speakers who are globally active in computational neuroscience and related fields. Participants will not only study advanced ideas and approaches of these fields but will also learn computational and quantitative analysis methods for their own research projects. This seminar is partly conducted in the Brain Science Retreat.
Cognitive Psychology 認知心理学	2	The origin of human intellectual activity is the brain, but, depending on the actions, it is possible to observe activities to create wisdom. The understanding of intelligent behavior as information processing leads to a deeper understanding of knowledge. In this lecture, we discuss the concepts of cognitive science, methodology, and research trends.
Information Creation Science 情報創成科学	2	Animals with developed brains have inference abilities with which they can estimate relationships between events without direct experience. These abilities enable human beings, who have the most advanced inference abilities, to create new things and events. To understand the basic mechanisms of creative brain functions, we will study（1）psychological theories in learning and thinking and（2）theories in neural computation. At the end of the course, we will discuss the results of recent studies on inference, thinking and creativity.
The Impact of Brain Science on Social Sciences 社会科学から見た脳科学	2	Findings in the brain sciences have recently had significant impacts on various fields in the social sciences, providing impetus for collaborative efforts between brain scientists and social scientists. The goal of this course is to delineate the scope of the potential implications that findings in brain science could have on research and theory building in social sciences—beyond the fields of neuroeconomics and behavior economics—from the perspectives of the social scientists.
Advanced Brain Sciences C (Information Creation) 脳情報先端セミナーC（情報創成）	1	In this seminar, researches of information creation（i.e. thinking, decision making and creativity）are presented in the fields of experimental psychology, neuroscience, and computational neuroscience. The mechanisms of human creativity are main theme based on the evidence of neuroscience in animal and human experiments. This seminar is given mostly in English. The students are required to have the ability to discuss in English. This seminar is partly conducted in the Brain Science Retreat.
Advanced Brain Sciences D (Social Sciences) 脳科学先端セミナー D（社会科学）	1	Findings in the brain sciences have recently had significant impacts on various fields in the social sciences, providing impetus for collaborative efforts between brain scientists and social scientists. In this course, we conduct a series of seminars by invited speakers who are globally active in social sciences and related fields. This seminar is partly conducted in the Brain Science Retreat.
Scientific Research Ethics 研究者倫理論	2	Scientific development relies on trueness, trust and fairness of research practice. Scientific misconduct -violation of these norms- hampers the sound development of science. We discuss scientific misconduct and questionable research practice through case study and cultivate research ethics as practical wisdom.

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Psychophysics 心理物理学	2	In system-neuroscience, well-controlled stimulus presentation and accurate measurement of behavior are indispensable. Experimental psychology has developed psychophysical methods to analyze the relationship between stimulus and response. In this course, we will systematically study psychophysical methods and related psychological theories, as well as discuss recent psychological studies. We will also talk on how we can apply psychophysical techniques to neuroscience research.
Neuroeconomics 神経経済学	2	Neuroeconomis is a new academic field that suddenly arose at the end of the 20th century. Neuroeconomics is based on behavioral economics, systems neuroscience for decision-making, and human functional neuroimaging. In the neuroeconomics course, students will learn the basic methods for neuroeconomics and its findings. Students will also study the findings of neuromarketing, which is a current extension of neuroeconomics. We will assess how valid neuromarketing is for our society at present and in the future. Furthermore, we will try to identify the essence and search the future perspective of neuroeconomics by considering different aspects of this new research field.
Social System Control 社会システム制御論	2	It is important to understand the individual players that constitute a society in order to control the social system. However, a society is not a simple collection of individuals. Without a perspective to understand mutual communications among society members, it would be difficult to decide and implement social policies and plans. For better institutional design, it is necessary to understand the mechanisms of cognition and emotion in social decision-making and their neural substrates. This course will be delivered in the form of lectures, workshops, and group discussion.
Neural KANSEI Engineering 神経感性工学	2	This course discusses the information processing of music from the perspective of cognitive science. The student studies the structure, knowledge representation, and cognition of music in reference to recent music-theoretical research. In doing so, the student gains an insight into the formation of various categories of musical entities, the identification and designation of the categories, and the relationships between category formation and our understanding of music. Finally, as possible topics of final projects, we will discuss the computer modeling of composition and performance of music, and its theories and implementations.
Neuroethics 神経倫理学	2	Neuroethics recently emerged through the interaction between life-ethics and system-neuroscience and consequently has two aspects. One is “the ethics of neuroscience,” which criticizes studies of neuroscience from the view point of ethics and morals. The other is “the neuroscience of ethics,” which investigates the neural mechanisms of ethical decision-making. In this course, we will read papers related to both aspects of neuroethics and we will consider how neuroscientific studies on ethics and moral influence our lives and society.
Pathological Neuroscience 病態神経科学	2	The aim of this course is to learn about symptoms of psychiatric disorder, such as schizophrenia, depression, autistic disorder, and neurological disorder. A further aim is to investigate appropriate methods to identify neuronal bases of psychiatric and behavioral symptoms using neuroimaging techniques.
Advanced Molecular Life Science 分子生命科学論	2	Modern neuroscience is on the verge of uncovering the mechanisms of the development of neurons and glial cells in the central nervous system, and also those of memory and learning at the molecular level. The final goal of this class is for the student to be able to acquire basic knowledge of molecular biology and the ability to apply this basic knowledge to neuroscientific research. The class is composed of two parts: the first part is focused on basic molecular biology; the second part provides information on processing mechanisms and their regulation in the nervous system. There will be an emphasis on studies of molecular mechanisms of synaptic transmission and signal transduction. Furthermore, the relationship between new genetic engineering techniques. including the technique of recombining DNA, and animal behavior are discussed.

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Brain Sciences Research Method Ⅰ (Research Survey) 脳科学研究法Ⅰ（研究サーベイ）	2	The goal of doctorate course research is to aim at a truly original study by seeking novel findings, innovative technique, or sophisticated theories in a specific field of brain science. To achieve this, students have to have broad knowledge of past and current researches, available and effective techniques, and most importantly, future directions of the field. In this class, students will obtain sufficient knowledge to design their own studies appropriately, by searching, reading, and understanding valuable literature in brain science.
Brain Sciences Research Method Ⅱ (Research Planning) 脳科学研究法Ⅱ（研究計画）	2	Scientific research is a methodology, which provides new experiences from which new knowledge is also deduced, by conducting well-organized experiments, analyzing their results and inspecting these results carefully. In order to clarify the differences between newly obtained knowledge and conventional knowledge, it is necessary to design a well-organized plan and to carry out experiments according to this plan for the achievement of one's own purposes. This class provides methodology that allows students to establish their own projects by themselves through discussion with instructors. It is required to complete the "Brain Sciences Method Ⅰ (Research Survey)" course to take this course.
Brain Sciences Research Method Ⅲ (Data Analysis) 脳科学研究法Ⅲ（データ解析）	2	Natural phenomena generally look stochastic unless all of the causes are controlled. There are uncontrollable internal states in the brain. Therefore, a stochastic view is inevitable to understand the brain through experimental data. Methods to infer objective conclusions from finite observations are required to understand stochastic phenomena. In this class, we discuss statistical methods to infer an objective conclusion from specific experimental data obtained by proper experiments in brain science and discuss approaches to construct testable hypotheses. It is required to complete the two courses: "Brain Sciences Research Method Ⅰ (Research Survey)" and "Brain Sciences Research Method Ⅱ (Research Planning)" to take this course.
Brain Sciences Research Method Ⅳ (Thesis Writing) 脳科学研究法Ⅳ（論文作成）	2	The goal of scientific study is to write an original paper, in which the experimental procedures and results have to be described clearly in order for the readers to realize its originality and usefulness. Without basic techniques of scientific writing, it is hard to show the scientific validity and originality in one's paper. In this class, the supervisor provides an individual with training on how to write scientific papers. Students are required to have completed the courses "Brain Sciences Research Methods Ⅰ" (Research Survey), "Ⅱ (Research Planning)" and "Ⅲ (Data Analysis)" to take this course.
Brain Sciences Research Method Seminar 脳科学研究法セミナー	2	This is a seminar for writing a doctoral thesis as a compilation of all professional skills, knowledge, and research findings the student has gathered, after mastering research surveys, research planning, data analysis. This is a literacy to advance scientific research and develop new technology. Students will also join in discussions of other students' research, and learn how to utilize what they learned from the discussions to their own researches. Before taking Brain Sciences Research Method Seminar, Students are required to have finished Brain Sciences Research Method Ⅰ, Ⅱ, Ⅲ, and Ⅳ.