GRADUATE PROGRAM

Okinawa Institute of Science and Technology Graduate University

OIST

OIST OKINAWA INSTITUTE OF SCIENCE AND TECHNOLOGY GRADUATE UNIVERSITY
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OIST

OIST The Movie 2011

To watch and download introductory movie on OIST,
visit http://www.oist.jp/en/press-room/videos.html

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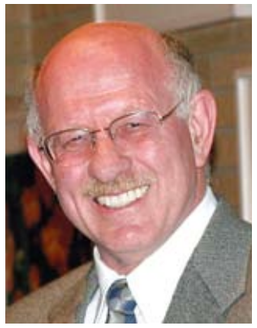
1. PRESIDENT'S MESSAGE

"OIST will transform the way that science and education is done globally."



The vision of the Okinawa Institute of Science and Technology (OIST) is simple. We will have the best international science and technology graduate students, working side by side with world-class faculty in modern well-equipped laboratories. We will rely on a cross-disciplinary approach, with an emphasis on creativity and exchange, to create unique, indiviualized graduate training.

The OIST Graduate University offers a flexible academic program leading to a PhD degree. World-renowned faculty provide excellent supervision of thesis research in an interdisciplinary setting. All students receive an internationally competitive support package, health insurance, and subsidized on-campus housing. Creativity is fostered by the location of the campus in an area of exceptional natural beauty.

With over half of OIST students and faculty coming from outside Japan, OIST offers the highest level of graduate education while embedded in a truly international environment. Equidistant from Japan, China, Korea, Taiwan, and the Philippines, Okinawa is the center of an area of dynamic economic and societal expansion. OIST will be a hub in the international network of scientists, building strong partnerships with leading universities and research institutions worldwide.

The OIST student intake will be small. We are looking across the inter-national academic landscape for the very best students, in particular those who will flourish in an atmosphere of encouragement for discovery and innovation.

I hope to be working with you at OIST.

Jonathan Dorfan
President, OIST

2. DEAN'S MESSAGE

"Every student is unique and will have a customized program of studies."

The graduate program at OIST is unique, leading the exciting and breathtakingly rapid evolution that is taking place across the spectrum of science. Because change is constant in modern day research, our program is innovative, flexible and multidisciplinary. Come to OIST for an education that will enrich and challenge you, and position you well for a future at the cutting edge of science and technology.

These are our principles:

Recruit the best students in the world. We search the globe for outstanding students who will become tomorrow's leaders in scientific research.

Treat every student as an individual. We work with you to design your individualized program of studies, taking account of your uniqueness, to make the most of the stellar opportunities for graduate study available at OIST.

Provide excellent conditions for thesis research. High quality advising during your thesis research is assured by low student to staff ratios. All our faculty members are leaders of cutting edge research groups. We encourage independence and excellence in research. Working with top researchers in well-funded laboratories, with state-of-the art facilities, and equipment will let you reach your full potential in research.

Give good support for living. At OIST you will be able to concentrate on your research and studies without worrying about living costs, health care, and housing. We will take care of the practical needs for your life and study in Okinawa.

Encourage creative thinking and interactions. The campus abounds in physically pleasant spaces designed for contemplation and discussion.

Facilitate global networking. We are at the hub of a global network. Our program is constantly enriched by visits from leading researchers from around the world, who participate as visiting faculty. We will help connect you with researchers from other leading universities and research institutes. Your visibility as an emerging researcher will help to launch your future career in science.

I look forward to welcoming you to OIST.

Jeff Wickens
Dean, Graduate School

“We want students who are interested in risk and will take chances that will push the frontiers of knowledge.”

Interactive, lab-based program

About 50 cutting-edge laboratories conducting research in a range of fields form the hub of the OIST Graduate University. Teaching is largely carried out in the laboratories where you will conduct your research. The language of instruction is English and around half of the faculty, researchers, and graduate students will come from outside Japan, providing excellent preparation for a career as a scientist in the international research community.

Interdisciplinary curriculum

Based on a firm foundation in the basic sciences, special emphasis is given to promote education that is highly interdisciplinary. There is a single academic program promoting collaboration and interaction across traditional barriers between disciplines. This emphasis on cooperation and interaction is built into the architecture of the state-of-the-art laboratory buildings, providing an outstanding environment for modern day research and education.

Individualized program

You will undertake a customized program leading to the PhD degree. With help from an experienced advisor, you can choose a flexible combination of courses that will prepare you for your thesis work, and extend you in new directions. Most coursework is completed in the first two years, but you will start doing research immediately. In the first year you undertake three laboratory rotations to gain exposure to different areas of research. In the second year you prepare your thesis proposal in the laboratory of your intended PhD adviser. Considerable freedom is provided in the choice of thesis topics. Additional seminars and courses are constantly available. At international workshops and courses held at OIST you will have many opportunities to interact with leaders in research from around the world and meet other students and postdocs on the courses.

Graduation requirements

Students with a Bachelor’s degree normally take five years to graduate. Those with a Master’s degree can finish in three or four years, depending on their level of preparation. At the end of your thesis research period you must submit your thesis for examination by a panel of experts in the field. To earn the OIST PhD degree, you must complete and defend a thesis comprising a coherent body of novel scientific work.

4. STUDENT SUPPORT

“We have world class infrastructure and the student packages are some of the best in the world.”

The student support package ensures that your basic needs are met. The practical needs of your life in Okinawa are taken care of so that you can concentrate on research in a supportive environment.

Financial Support

All students receive an internationally competitive financial support package. OIST offers financial support comparable to that offered by other leading research universities.

Students in the PhD program are expected to engage full-time in advanced study and research. Financial support of 2.5 million yen per year is provided for each year of approved full-time study, which is sufficient to ensure a comfortable standard of living. Course fees will also be covered. Students additionally receive a financial contribution towards a home visit once per year. Provision for personal computing costs and international travel to attend conferences is budgeted separately.

While the university guarantees support, students are strongly encouraged to apply for external fellowships. In order to reward success, financial support provided by the university will be used to supplement external fellowships, up to a maximum of 3.0 million yen total, which is 0.5 million yen above the standard level.

Health Care

OIST has a Campus Clinic service during working hours. If necessary, the clinic refers students to local health services. All OIST students have health insurance coverage. Excellent hospitals and clinics are available in Okinawa, and assistance with English and other languages is available.

Childcare

The OIST Childcare Association is working with the OIST administration to provide excellent on-campus early-childhood education facilities.

Housing

Subsidized accommodation is provided in an area called the Campus Village, which is situated on a lake and surrounded by natural forest on a hillside overlooking subtropical beaches. Students may choose among architecturally designed single, double, or family housing options that include kitchen and living rooms. Housing is located a short walk from amenities and close to the laboratory buildings. The apartments are all brand new with stunning sea views only a 5-minute walk from a beautiful beach. Student rents for unfurnished units in the Village are expected to range from 50,000 yen per month for a shared 2-bedroom apartment to 140, 000 yen per month for a 3-bedroom family apartment. Furnished units will be available at a surcharge.

“OIST is going to transform the way science and education is done in the global academic world.”

Many of the unsolved problems facing society today require an interdisciplinary approach. Interdisciplinary research combines the tools of different disciplines to work together on a common problem that cannot be solved by research within a single discipline.

Physics and chemistry

Physicists at OIST investigate fundamental questions in hard and soft condensed matter physics, atomic, molecular and optical science, material science, nanomaterials, nanostructures, quantum computation, quantum coherence, membranes, single molecule spectroscopy, structural molecular biology, computational physics, and fluid mechanics. Research in the physics of biological systems connects with biological areas. Chemistry research at OIST includes the study of catalysis and the chemistry of proteins and peptides, using techniques of organic chemistry and organic synthesis of peptides, enzymes, and small organic molecules.

Integrative biology

Cross-disciplinary studies are aimed at using field, laboratory and computational techniques for answering fundamental questions in ecology, evolution, and marine science. Much of the research leverages next-generation technologies in molecular biology, parallel computation, and DNA sequencing to test long-standing theoretical questions, and to generate novel data necessary for new theoretical synthesis. Principal lines of research include studies of genome evolution, theoretical ecology, experimental evolution, biogeography, and microbiology, as well as physical, ecological, and evolutionary oceanography.

Mathematical and computational sciences

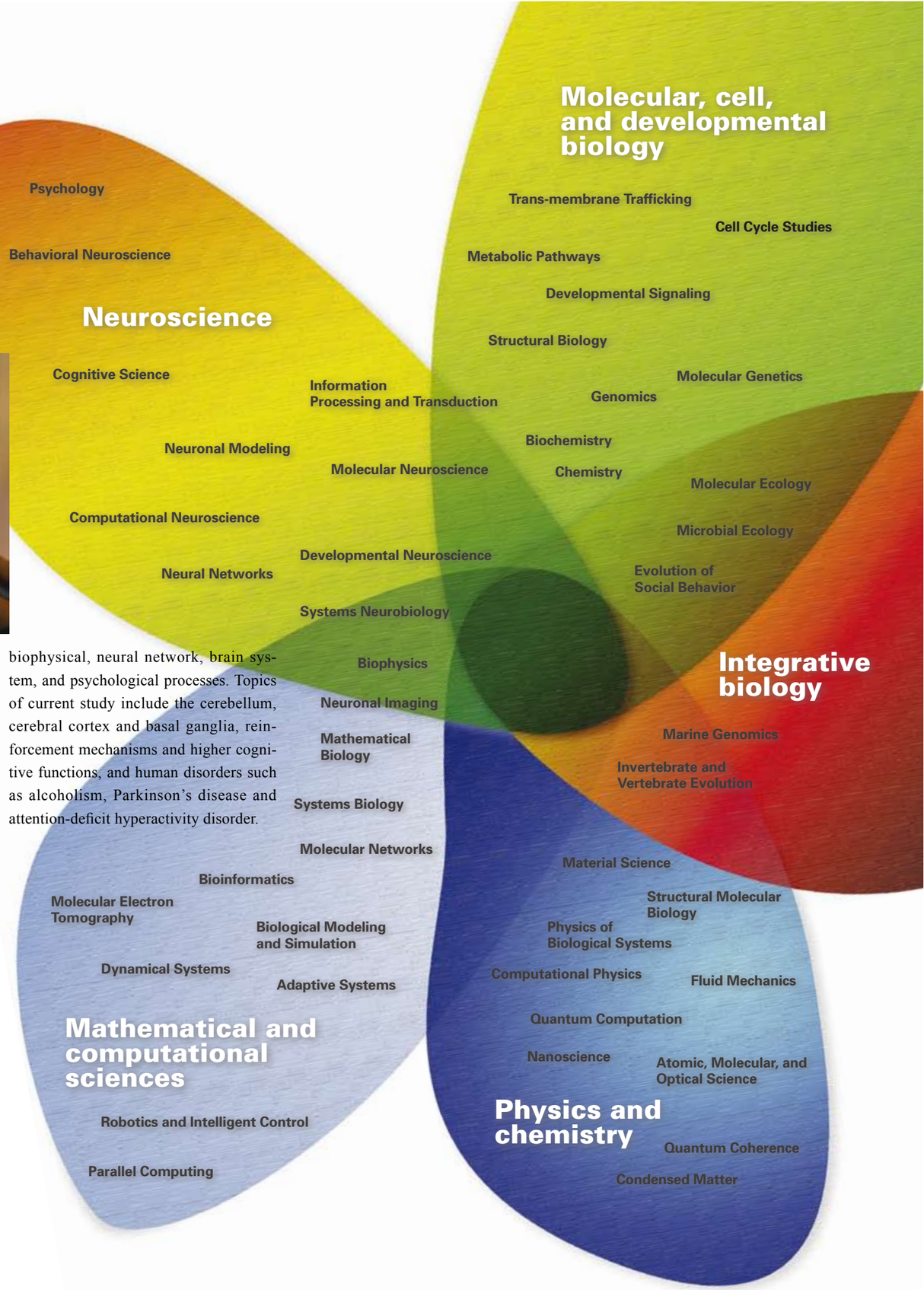
Mathematicians at OIST are extracting new mathematical structures from biology. They are also developing qualitative and quantitative analytical techniques for sequence analysis, fundamental areas of complexity, and modularity theory, using techniques of pure and applied mathematics and scientific computation. Computational approaches to science are increasingly important. A current aim is to integrate metabolic, signal transduction, and gene regulatory networks with possible protein-protein interaction networks.

Molecular, cell, and developmental biology

Fundamental cellular processes such as transcription, cell cycle, metabolism, and cytoskeletal dynamics are regulated by signals coming from, for example, nearby cells or the environment. This regulation is essential to the development of multicellular organisms and to cellular health in both multi- and unicellular organisms. OIST scientists study these mechanisms using genetic, biochemical, and molecular and cellular approaches at the level of single proteins up to whole organisms. Specific topics include cell signaling pathways and their relationship to development, genetic and epigenetic regulation, effects of nutrient content on cellular homeostasis, and structural analysis using X-ray crystallography, optical imaging, and advanced electron microscopy techniques.

Neuroscience

OIST neuroscientists work on the neural basis of behavior, cognition and learning from many perspectives spanning multiple levels of analysis from behavioral responses in humans and experimental animals, through cellular mechanisms of neural signaling and plasticity, to genetic and molecular levels, using electrophysiological, optogenetic, transgenic, and gene knockout approaches. Computational modeling of neuronal and metabolic networks provides insight into biophysical, neural network, brain system, and psychological processes. Topics of current study include the cerebellum, cerebral cortex and basal ganglia, reinforcement mechanisms and higher cognitive functions, and human disorders such as alcoholism, Parkinson’s disease and attention-deficit hyperactivity disorder.

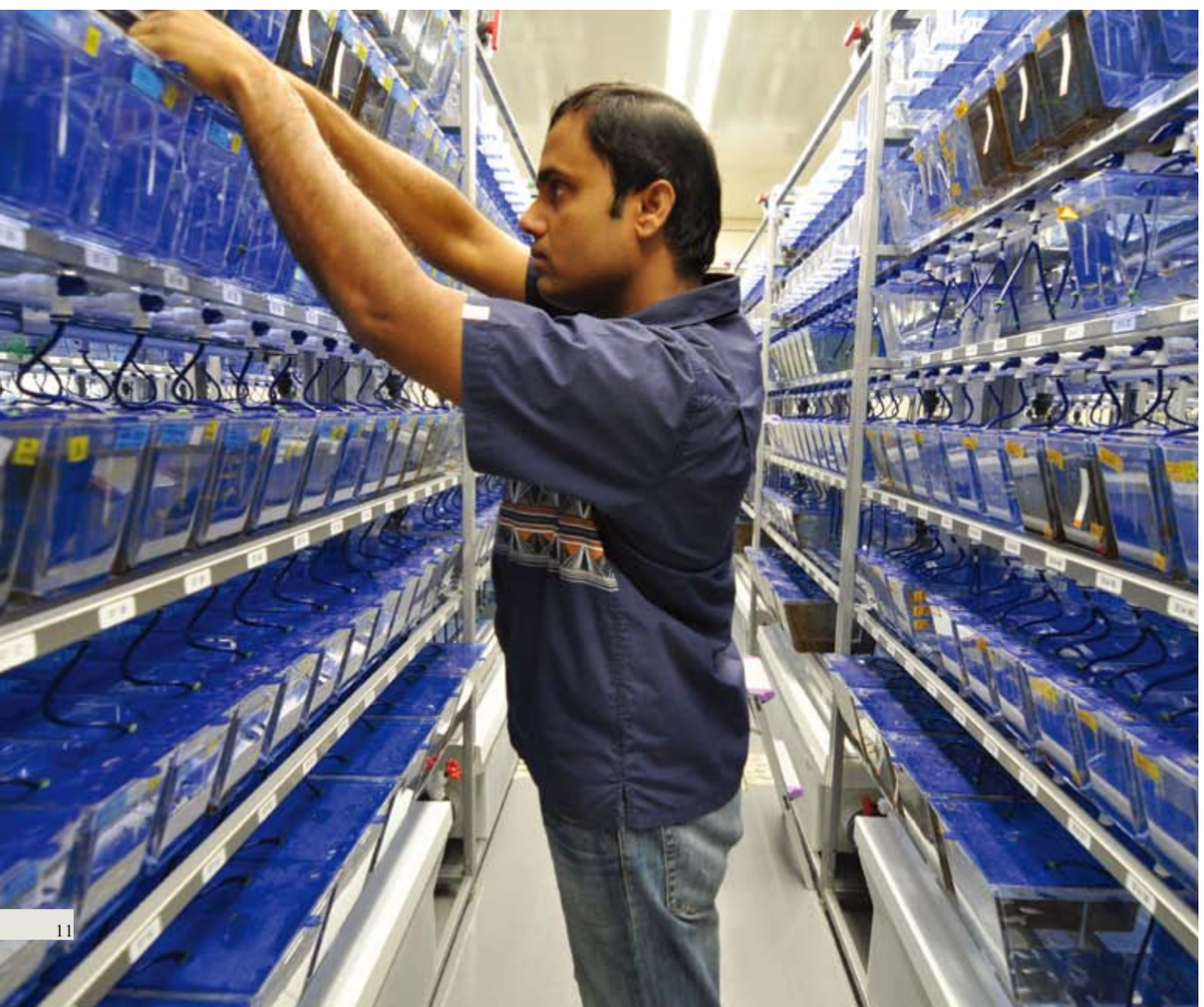


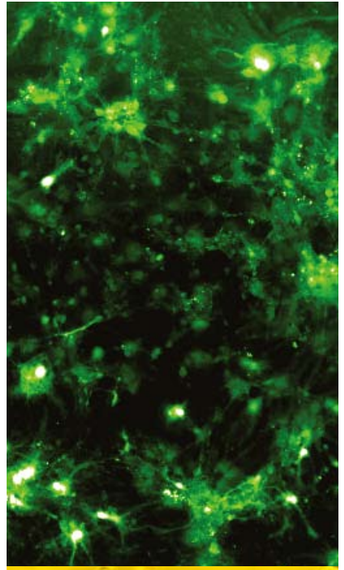
6. RESEARCH RESOURCES

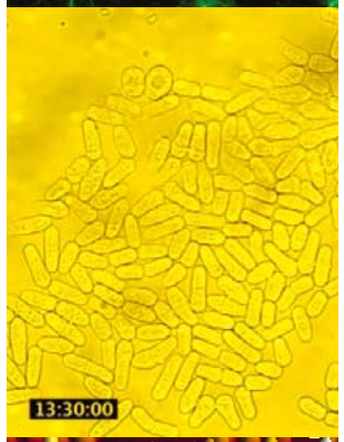
“OIST offers excellent, modern facilities; it is clearly attracting some of the best brains in the world.”

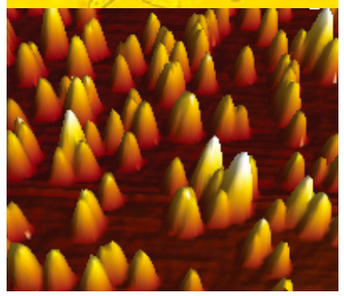
As a graduate student at OIST you have access to outstanding laboratory facilities and the equipment you need to get you to the cutting edge in your research area. Instrumentation is available for observation from nanoscale dimensions through to large ecosystems. You have ready access to instruments according to your research requirements. Facilities include state-of-the-art gene sequencers, light and electron microscopy with confocal and two-photon microscopes, and high-performance computing. Computing facilities provide general purpose computing resources as well as exotic architectures selected to provide a significant impact on scientific discovery. Plans for a tabletop synchrotron and a coastal ocean-observing system are well advanced.

Access to excellent laboratory facilities and advanced equipment is necessary for graduate student thesis research to be at the cutting edge. The newly completed laboratory buildings are state-of-the-art. Individual laboratories are very well equipped for all research requirements. These conditions ensure that students will have the opportunity to realize their full potential in research.









7. FACULTY RESEARCH INTERESTS

“OIST will become a model for change in education and research.”

The research at OIST defies easy categorization. Many scientists at OIST work in areas that bridge traditional boundaries between fields, using interdisciplinary approaches. The following list of faculty research interests is arranged alphabetically, since at OIST we avoid creating artificial departmental boundaries that might get in the way of interdisciplinary collaborations.

Gordon Arbuthnott
Brain Mechanisms for Behavior
Electrophysiology, imaging and culture of dissociated neurons, neuropharmacology, analysis of neural activity in basal ganglia networks.

Mahesh M. Bandi
Collective Interactions
Experimental investigation of macroscopic phenomena arising from collective interactions in the physical, chemical, and biological realms. Sample problems of current interest include understanding the mechanics and failure of disordered solids, or how local flow conditions control coral growth, among others.

Thomas Busch
Ultracold Quantum Gases and Quantum Information
Theoretical research into ultracold quantum systems with special emphasis on their suitability to realize and test ideas and concepts of quantum information.

Pinaki Chakraborty
Fluid Dynamics
Geological and environmental fluid dynamics, turbulence, scaling, foam mechanics, thermal physics, and granular flows.

Keshav M. Dani
Condensed Matter Physics and Materials Science
Fundamental studies of Dirac materials, metamaterials and correlated electron systems, with applications in nano-photonics and ultrafast photonic devices.

Erik De Schutter
Computational Neuroscience
Using computational methods to model the chemical and electrophysiological behavior of neurons and microcircuits, analysis of experimental data provided by external collaborators, and software development.

David Dorfan
Research Infrastructure and Education
Measurement techniques, analog electronics, very large scale integrated circuits, teaching the physics way of thinking to non-physicists.

Kenji Doya
Machine Learning and Computational Neuroscience
Building autonomous adaptive systems and understanding adaptive mechanisms of the brain. Theories and experiments of reinforcement learning, Bayesian inference, robotics, basal ganglia, dopamine, and serotonin.

Evan P. Economo
Biodiversity and Biocomplexity
Theoretical and empirical approaches to understanding biodiversity pattern and processes, ecological and evolutionary dynamics in networks, biodiversity and biogeography of Pacific island ants, and biological scaling phenomena.

Igor Goryanin
Biological Systems
Novel software platforms and computational forms of biological knowledge are under development.

Shinobu Hikami
Mathematical and Theoretical Physics
Based on the method of statistical field theory, we study random matrix models and superstring theory to understand sperconductivity, the quantum Hall effect, localization phenomena and complex sytems of genes.

Hiroki Ishikawa
Molecular Mechanisms of Host Defense Signaling
Molecular mechanism underlying host defense responses including antiviral innate signaling and neuronal regulation of innate and adaptive immune responses.

Masaki Isoda
Neural Systems and Behavior
Local and large-scale neuronal network mechanisms of action, attention and social cognition, recording from individual neurons in the cerebral cortex, basal ganglia, and related structures of awake, behaving non-human primates.

Holger Jenke-Kodama
Evolutionary Systems Biology
Analysis of evolutionary processes that drive secondary metabolism in both prokaryotic and eukaryotic microorganisms, biological roles of secondary metabolites, pathways to creation of secondary metabolites, and other functions and applications of secondary metabolites.

Hiroaki Kitano
Open Biology
Computational systems biology for drug discovery and therapeutic design, including development of software platforms for drug discovery and open collaboration. The group is also a hub of The Garuda Alliance, an international effort for software platforms and interoperability. Molecular and physiological modeling of cardiovascular and neuronal systems.

Denis Konstantinov
Quantum Dynamics
Experimental study of complex quantum phenomena in many-electron systems at ultra-low temperatures and far from thermal equilibrium, through microwave-induced magnetotransport and spin-resonance measurements.

Bernd Kuhn
Optical Neuroimaging
Information processing in single neurons and small neuronal networks correlates with behavior. Developing new methods for optically recording neuronal activity in behaving animals to overcome current experimental limitations.

Nick Luscombe
Genomics and Regulatory Systems
Genome-scale analysis of mechanisms of transcriptional regulation and how this system impacts on interesting biological behaviors.

Tatiana Marquez-Lago
Integrative Systems Biology
Multiscale modeling and simulation for systems biology. Stochastic analysis of complex biochemical networks. Experimental design for model calibration and synthetic biology.

Ichiro Maruyama
Information Processing by Life
Biochemical, cell biological, genetic, and structural studies on molecular mechanisms underlying sensory transduction by cell-surface receptors. Neural circuits regulating animal behaviors including learning and memory.

Ichiro Masai
Developmental Neurobiology
Neuronal differentiation mechanisms and signaling pathways, regulation of apoptosis in photoreceptor degeneration, retinal development, zebra fish mutation analysis.

Alexander Mikheyev
Ecology and Evolution
Understanding the interplay between ecological forces and genetic responses, with particular emphasis on the biology of social insects and fungi, using both field-based and lab-based systems.

Jonathan Miller
Physics and Biology
Comparative genomics, genome analysis and theoretical modeling of diversity and evolution, and mechanisms of sequence conservation and evolution.

Satoshi Mitarai
Marine Biophysics
Fluid dynamics, oceanography, coastal circulation dynamics and forecasting, and applications of these in evolution and ecology of marine organisms.

Síle Nic Chormaic
Light-Matter Interactions
Effects of non-linear optics including novel atom trap schemes using light fields, biophysics applications of optical nanofibers and whispering gallery mode resonators, and cavity optomechanics.

Mary Ann Price
Developmental Signaling
Mechanism of the developmentally and medically important Hedgehog signaling pathway, mostly in Drosophila, using molecular genetics, biochemistry, cell biology, functional genomics, and structural analysis.

Yabing Qi
Energy Materials and Surface Sciences
Organic electronics with emphasis on energy materials and devices. Molecular-level understanding of structure-property relationships in organic and inorganic nanomaterials.

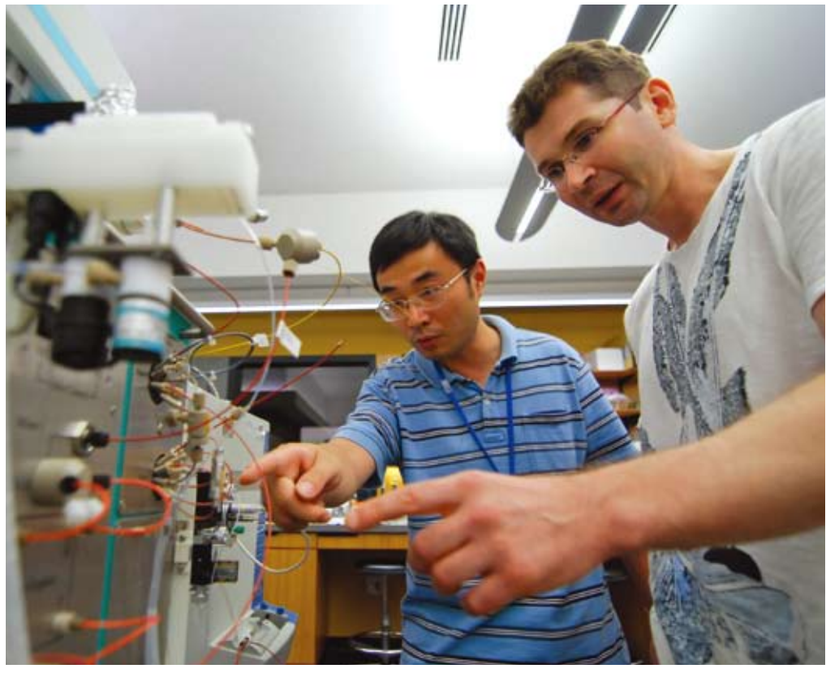
Fadel A. Samatey
Trans-membrane Trafficking
X-ray protein crystallography in combination with genetics and microbiology and molecular biology to understand bacterial secretory mechanisms and eukaryotic systems.

Noriyuki Satoh
Marine Genomics
Genomics, especially of marine invertebrates including corals, mollusks, hemichordates and chordates. Chordate and vertebrate evolution, gene regulatory networks of development, genetics of detection of and responses to environmental change.

Hidetoshi Saze
Epigenetic Regulation of Genes and Transposable Elements
Molecular mechanisms of epigenetic regulation of gene activity and transgenerational inheritance of epigenetic information in plants, using Arabidopsis thaliana as a model system.

Nic Shannon
Theory of Quantum Matter
Theoretical condensed matter physics, with the goal of understanding novel quantum phases and excitations. Much of this research is inspired by experiments on new materials developed in Japan.

Tsumoru Shintake
Electron Beam Physics
Circular and linear electron accelerator hardware development, free-electron laser (FEL) design and analysis, single bio-molecule imaging using X-ray FEL, and developing a new instrument for low energy electron microscopy.



Robert Sinclair
Mathematical Biology
Study of the relationship between mathematics and biology. The meaning of genomic memory, complexity and modularity. Geometry in biology. New methods of data analysis. Search for new structures in biology.

Ulf Skoglund
Structural Cellular Biology
Tomography with electron microscopy techniques to study individual macromolecular interactions, complex formations, and function both in tissue and in solution.

Mukhles Sowwan
Materials Engineering and Nanotechnology
Novel X-ray diffraction methods, molecular electronics, and bioorganic nanoparticles.

Greg Stephens
Theoretical Biophysics and Neuroscience
Quantitative analysis of natural behavior in C. elegans and other model systems, the exploration of human cognition in functional magnetic resonance imaging during natural experience.

Tomoyuki Takahashi
Cellular and Molecular Synaptic Function
Regulatory mechanism for neuro-transmitter release, simultaneous pre- and postsynaptic recording, presynaptic calcium channels, molecular mechanism of endocytosis. Developmental changes in synaptic molecules and synaptic function.

Fujie Tanaka
Chemistry and Chemical Bioengineering
Creation and development of molecules, such as small molecules, peptides, and proteins, and methodologies, such as catalytic asymmetric chemical transformations and bioconjugation methods, that contribute to the investigation and control of biological systems.

Akira Tonomura
Electron Holography
To gain a better understanding of microscopic behavior of materials through high-precision/high-resolution electron phase measurements using coherent electron wave techniques such as electron holography and Lorentz microscopy.

Gail Tripp
Human Developmental Neurobiology
Role of reinforcement mechanisms in human behavior and neuropsychiatric disorders, and mechanisms of attention deficit hyperactivity disorder.

David Van Vactor
Formation and Regulation of Neuronal Connectivity
Regulatory mechanisms of neural development and neurodegeneration using Drosophila melanogaster as a model system.

Jeff Wickens
Brain Mechanisms for Learning and Adaptive Behavior
Experimental and computational studies of basal ganglia mechanisms in reinforcement learning, dopamine, and synaptic plasticity, in relation to Parkinson's disease and attention deficit hyperactivity disorder.

Matthias Wolf
Structural Biology
Structure of macromolecular assemblies at near-atomic resolution using transmission electron microscopy of frozen samples. Extend the method from icosahedral viruses to objects with lower mass and symmetry.

Tadashi Yamamoto
Molecular Biology
Research on signal transduction and gene expression using gene-manipulated mice to study molecular and cellular mechanisms underlying the development of various human diseases such as cancer.

Mitsuhiro Yanagida
Cell Quiescence and Proliferation
Cellular strategy for starved G0 arrest and vegetative proliferation under genetic and epigenetic regulation. Metabolic response in fission yeast to nutritional alterations. Human longevity.

Yoko Yazaki-Sugiyama
Neural Mechanisms of Bird Song Learning
Neuronal mechanisms underlying shaping of motor output by sensory experience during the well-orchestrated developmental time-window known as the "critical period", using bird song learning as a model.

8. ADMISSIONS

"This is a huge opportunity for PhD students and an especially good start for their careers."

OIST trains researchers to play important roles in the international scientific community at leading scientific institutions. Our students have a high level of academic achievement with the potential and motivation to undertake independent research. OIST students have the intellectual ability to excel in their chosen areas of study.

English language requirements
English is the language at OIST. We ensure that all students are proficient in oral and written English. Students for whom English is a second language take part in an intensive immersion program in an English speaking country prior to starting their studies at OIST. Students who are not from Japan take a special program on Japanese Language and Culture.

Selection
A faculty committee representing a wide range of research interests screens the applications. Selected candidates are invited to visit the university in Okinawa for a formal interview and examination. During these visits, candidates have oportunities to meet faculty and students, to visit laboratories and housing facilities, to explore Okinawa and to experience the lifestyle of a sub-tropical Japanese island.

Eligibility
Admission is competitive. The basic requirement for admission is completion of a bachelor's degree. Students may apply early, but cannot be admitted until they have graduated.

Application process
Applicants must submit a personal letter describing their scientific interests, academic background, research expe-rience, and goals. They must complete a biographical data form and provide at least two letters of recommendation. Evidence of academic achievement must be provided, such as official college or university transcripts, and scores on standard international tests. Applicants whose native language is not English must submit evidence of their level of ability in the English language. Applications will be called for annually for entrance in September of the following year.

Important dates
For the latest information about important dates, please check the OIST website at www.oist.jp or send an email to study@oist.jp

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098-966-2094 (within Japan)
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9. COURSE OUTLINES

“OIST enables new projects that are crazy at first sight, that you would never dare to do anywhere else.”

PHYSICS AND CHEMISTRY

Analytical Mechanics
Jonathan Miller

Mastery of the concepts and techniques of analytical mechanics is essential to a deep understanding of physics. This course begins with basic principles and proceeds to the Newtonian equations of motion and laws of conservation. We use the Lagrange formalism to describe particle motion in multiple modes, before covering the equations of Euler and Hamilton, and canonical transformations. The calculus of variation is used to develop Maupertuis’s principle and the Hamilton-Jacobi equations, providing a starting point for the consideration of waves in later courses. This course is taught from the unifying principles of symmetry and least action.

Classical Electrodynamics
Tsumoru Shintake

An understanding of static electromagnetic fields is extended through Maxwell’s equations to a discussion of dynamic vector fields and electromagnetic waves. Along the way, numerous physical and technical applications of these equations are used to illustrate the concepts, including dielectrics and conductors, wave guides, and microwave engineering. Special relativity is introduced with discussion of relativistic and non-relativistic motion and radiation, using linear accelerators and synchrotron radiation as illustrative applications.

Physics for Life Sciences
Bernd Kuhn

Principles of physics of central relevance to modern biological analysis and instrumentation are introduced, with an emphasis on applications in practical research areas such as electrophysiology, optogenetics, electromagnetics, the interaction of light and matter, and brain recording, stimulation, and imaging.

Quantum Mechanics
Denis Konstantinov

A basic course in nonrelativistic quantum mechanics, the course begins with wave functions, the Schrödinger Equation, Hilbert space, and the Heisenberg picture. We move on to one-dimensional problems including particle in box, tunneling, and various harmonic oscillators, and the hydrogen atom. Other topics examined include the Pauli principle and electron spin, Dirac notation, matrix mechanics and the density matrix, and time-independent and time-dependent perturbation theory. We look finally at quantized radiation fields, the absorption and emission of radiation, and symmetry principles, entanglement, and information transfer.

Fluid Dynamics
Satoshi Mitarai

This course introduces students to the fundamental laws that characterize fluids at rest and in motion. The equations for the conservation of mass, for momentum balance, and for conservation of energy are analyzed in control volume and, to some extent, in differential form. Students will learn to select appropriate models and solution procedures for a variety of problems. Flow phenomena that occur in actual flow situations are also illustrated, so that students will learn to assess the strengths and limitations of the models and methods.

Advanced Optics
Síle Nic Chormaic

A course in modern classical and quantum optics, beginning from basic principles of the wave properties of light and geometrical optics, including Fresnel and Fraunhofer diffraction, transfer functions, coherence, auto- and cross-correlation. We next look at quantum properties of light such as the interaction of photons and atoms and examine quantum optics. A strong emphasis of this course is in actual applications of optics, including fiber optics, laser resonators, laser amplifiers, holography, acousto-optics, electro-optics, non-linear optics, optical switches, and ultrafast optics.

Condensed Matter
Thomas Busch

This topic explores an emerging interface involving strongly correlated systems in atomic and condensed matter physics. Topics include bosonic and fermionic Hubbard models, quantum spin systems, low dimensional systems, non-equilibrium coherent dynamics and system-bath interactions, Fermi surfaces, Bloch waves, the Ising model, and quantum computing. Special attention will be paid to the physics of ultracold atoms.

Quantum Field Theory
Shinobu Hikami

This course covers quantum electrodynamics and chromodynamics. Topics include canonical quantization, Feynman diagrams, spinors, gauge invariance, path integrals, identical particles and second quantization, ultraviolet and infrared divergences, renormalization and applications to the quantum theory of the weak and gravitational forces, spontaneous symmetry breaking and Goldstone bosons, chiral anomalies, effective field theory, non-Abelian gauge theories, the Higgs mechanism, and introductions to the standard model, quantum chromodynamics and grand unification.

Nanotechnology
Mukhles Sowwan

This course covers the nanotechnology revolution in science and engineering that is leading to novel ideas about the way materials, devices, and systems are designed, made and used in different applications. We cover the underlying principles of the multidisciplinary and very diverse field of nanotechnology, and introduce the concepts and scientific principles relevant at the nanometer scale. Then we provide a comprehensive discussion of the nanomaterials, including characterization techniques and the effect of size on their structural, physical, and chemical properties and stability. In addition we discuss the current and future applications of nanotechnology in different fields such as materials engineering, medicine, electronics, and clean energy.

Analog Electronics
David Dorfan, Yabing Qi

The course provides sufficient theory to design and analyze analog electronic circuits, with extensive project work to enable students to become familiar with circuit construction. The introductory portion will diverge from the text, as voltage and current sources will be stressed and will be used to motivate the need for transistors. Although very little device physics will be taught, since the course focuses on analog circuit design, sufficient physics will be taught from an unconventional standpoint to reinforce the concepts necessary to understand the interaction of components in real circuits.

Chemistry
Fujie Tanaka

The course introduces basic concepts of chemistry with a focus on topics that are relevant for life sciences. It provides the foundations necessary to understand basic and advanced courses in life sciences. The course covers general chemistry, physical chemistry (in particular, thermodynamics and reaction kinetics), inorganic chemistry, organic chemistry, and biochemistry. A focus on catalysis and catalytic mechanisms in modern biochemical engineering will reinforce the central concepts.

BIOLOGICAL SCIENCES

Biology
Alexander Mikheyev

This course will provide a broad introduction to the processes of life. Topics will range from biochemistry and molecular biology, to the structure and evolution of organisms, to the structure of ecosystems. The goal of the course will be to provide a general survey of fundamentals, and then to focus on topics of particular interest, such as genetic engineering and the interactions between life and climate.

Microbiology and Biotechnological Applications
Holger Jenke-Kodama

The course introduces the students to modern microbiology with a focus on its applications in environmental science and biotechnology. The combination of modern high-throughput sequencing and various “omics” technologies with new computational approaches are offering completely new applications in different fields of biotechnology. The first part of the course deals with the principles, concepts and methods necessary for understanding applied microbiology. In the second part, we concentrate on a selection of environmental and biotechnological topics, using original research literature as much as possible.

Ecology and Evolution
Alexander Mikheyev
This course focuses on patterns in the distribution and abundance of living organisms, and on their interactions with the environment. It provides an overview of the theory and principles of evolutionary biology, with emphasis on recent advances in the field. Starting with a discussion of evolutionary genetics, including the phenomena of natural selection, drift, and population genetics, we then look at adaptation, species, and taxonomy. Systems aspects such as biodiversity and population dynamics in ecosystems are then examined, before we look more specifically at animal and human evolution, and comparative evolutionary biology.

Evolutionary Developmental Biology
Noriyuki Satoh
The course presents the most recent theory and techniques in evolutionary and developmental biology with an emphasis on the underlying molecular genomics. Recent advances in decoding the genomes of various animals, plants, and microbes will be followed, with discussion of comparative genomics, the evolution of transcription factors and signal transaction molecules, and their relation to the evolution of the various complex body plans present through history.

Signal Transduction
Mary Ann Price
In this course, students will develop the concepts of cell signaling first seen in Cell Biology and Genetics, by studying recent advances in the field of signal transduction, such as the roles of ubiquitination, membrane trafficking, organelle targeting, cytoskeleton, and cilia in cell signaling. Students will also learn about state-of-the-art methods for studying cell signaling. Lectures will focus on several papers from the current literature. The course will also present different special topics from year to year.

Developmental Biology
Ichiro Masai
This course introduces fundamental principles and key concepts in the developmental processes of animal organisms, by focusing on Drosophila embryonic development and vertebrate neural deve-lopment as models, and will facilitate graduate students to reach a professional level of understanding of developmental biology. Genetic tools for live imaging of fluorescence-labeled cells using Drosophila and zebra fish embryos will be introduced as practical exercises. The course also includes debate on specific topics in developmental biology by students and a writing exercise of mock-grant application.

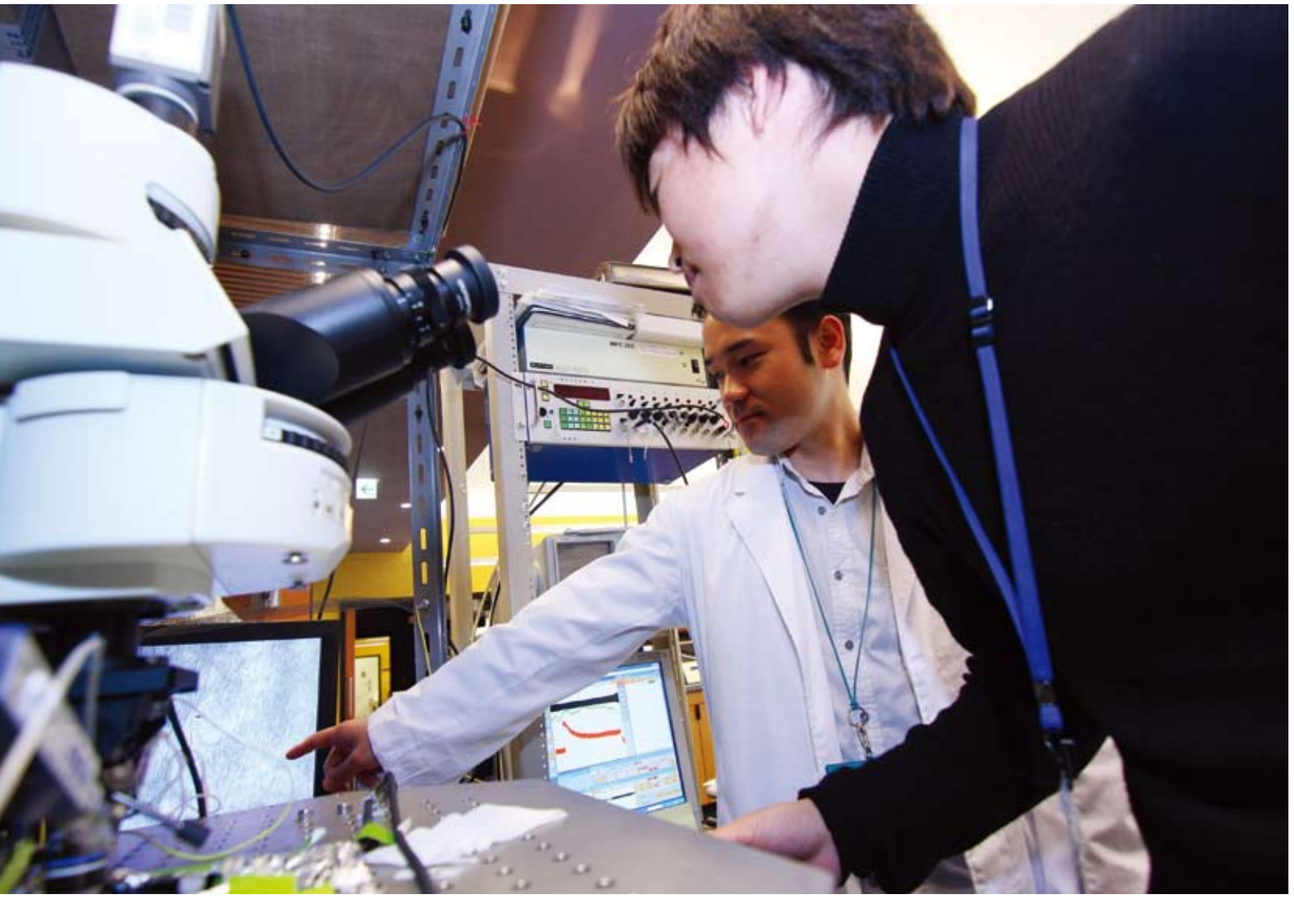
Cell Biology and Genetics
Mary Ann Price, Mitsuhiro Yanagida
Molecular cell biology is a vast and growing field, and this course covers the esential principles required to understand the regulation and functioning of the living and dying cell, the fundamental unit of life. Lectures cover classical and molecular genetics, including genetic regulation and mRNA, before moving on to describe the physical and chemical organization of the cell, and the way these various domains interact in the normal cell.

Structural Biology
Ulf Skoglund, Fadel Samatey
This course covers structure-function analysis by biophysical techniques. The aim of this course is to understand how to develop a 3D model of a macromolecule. After discussion of the notion of “biological samples”, we present the range of techniques currently used in structural biology, and the advantage of each technique in regard to the sample studied and to the desired structural goals. In-depth theory of the main techniques used in structural biology, electron microscopy, and X-ray diffraction, will be presented. To complement the theory, sample preparation and quality assessment, data collection and analysis will be done during practical sessions that will combine both wet-lab and dry-lab experiments.

Quantitative Evolutionary and Comparative Genomics Course
Jonathan Miller
The workshop is aimed at enabling students to design and implement methods of bioinformatics that are targeted to experimental data, rather than to apply off-the-shelf methods that may not be appropriate. Each year, the course will address different aspects of evolution, comparison, alignment, phylogeny, or homology of nucleic acid sequences, protein sequences, networks, or metabolic pathways. Tutorials, some aimed at students of biology and others aimed at those with quantitative backgrounds, will introduce approaches to inference from biological data, in particular Bayesian and mutual inference methods.

Neurobiology
Gordon Arbuthnott, Robert Baughman
In this course students learn about the cellular and molecular basis of neuronal functions, and how individual electrical signals are integrated into physiological functions. The course will stress connections between information, computations, and biological mechanisms in processes underlying motivated behavior, and will be taught by discussion of physiological mechanisms that contribute to such behaviors. Students will learn how to evaluate evidence obtained in laboratory studies conducted with animals.

Learning and Behavior
Gail Tripp
This course will describe the function of the brain at the macroscopic level, by discussing topics including reflexes, classical and operant conditioning, perception, adaptation, and attention, feedback and predictive control, procedural and declarative memory, motivation and emotion, thinking and reasoning, communication and language, psychological disorders, and clinical and experimental neuropsychology. Students will also gain practical experience in scientific presentation and communication, and in research methods and design during this course.



Neuronal Signaling
Tomoyuki Takahashi
In this course, students will learn about recent advances in the field of neuronal signaling, including synaptic transmission, intracellular signaling and neuronal modulation. Selected original literature will be read together with closely related papers and presented to the class, starting with a review of basic background. The audience will raise questions and discuss the presented literature, with stimulus, encouragement and further direction from instructors. Through this course, students will learn the current understanding of neuronal signaling and gain experience in scientific presentation and discussion.

Okinawa Computational Neuroscience Course
Erik De Schutter
The successful Okinawa Computational Neuroscience Course provides oppor-tunities for young researchers with theoretical backgrounds to learn up-to-date neurobiological findings, and those with experiment backgrounds to have hands-on experience in computational modeling. The course has run each year since 2004, with changing themes and faculty, all leading researchers in their fields. The course has achieved international recognition, and participants are selected from all over the world.

Developmental Neurobiology Course
Davie Van Vactor
This is an international workshop course with a significant laboratory component, presenting the latest techniques and discoveries in developmental neurobiology in Drosophila, zebra fish, and mouse models. Lectures from a variety of top experts in various topics in developmental neurobiology are brought together with a number of postgrad and postdoc students from many countries, facilitating interaction and developing networks vital to future careers. A wide range of histological and microscopic techniques are covered, with demonstrations of the latest state-of-the-art microscopes from major scientific microscope manufacturers.

MATHEMATICAL AND COMPUTATIONAL SCIENCES

Mathematics I
Robert Sinclair
This course introduces necessary background and fundamental mathematics for graduate biologists. The course emphasizes relevant topics calculus, probability, and numerical methods with their applications in biology, and provides reinforcement of existing knowledge, with extension to new applications, and the tools necessary for further fundamental research.

Mathematics II
Robert Sinclair
Students will be introduced to some more advanced mathematical topics, but without proofs. Linear algebra, vector fields, dynamical systems, stochastic differential equations and numerical methods for these will be covered. Vector fields will be discussed with a view to motivating fluid dynamics, meaning conservation of mass, compressibility and divergence will be discussed. Systems of differential equations and their solution using Euler's and Heun's methods will be introduced. Dynamical systems will include fixed points, their stability, and bifurcation. The meaning of stochastic differential equations and their solutions will be discussed.

Statistical Methods
Kenji Doya
This course introduces basic principles and practical methods in statistical testing, inference, validation, and experimental design. The lectures contrast the frequentist and Bayesian views, and discuss various kinds of probability distribution and statistical dependence and independence. Other topics include stochastic processes, information theory, and statistical testing, as well as maximum likelihood and Bayesian models of statistical inference. Model validation and selection and good experimental design are covered, with an emphasis on the assumptions behind standard statistical methods and the mathematical basis for finding the right one.

Mathematical Methods of Natural Sciences
Jonathan Miller
This course develops advanced mathematical techniques for application in the natural sciences. Particular emphasis will be placed on analytical and numerical, exact and approximate methods, for calculation of physical quantities. Examples and applications will be drawn from a variety of fields. The course will stress calculational approaches rather than rigorous proofs. There will be a heavy emphasis on analytic calculation skills, which will be developed via problem sets.

Adaptive Systems
Kenji Doya
This course aims to provide common mathematical frameworks for adaptation at different scales and to link them with biological reality of control, learning, and evolution. We will look at different classes of adaptation problems using real-world examples of robot control, web searching, gene analysis, imaging, and visual receptive fields.

Computational and Mathematical Biology
Hiroaki Kitano, Igor Goryanin
Computational approaches to biology, are increasingly important. However, understanding the concepts behind such approaches is particularly difficult due to discrepancies in the methodologies and languages that are used. This course will introduce the use of computational approaches to science, engineering, and biology, with abundant examples. Basic concepts, methodologies, and tools will be introduced to develop this approach and enhance practical skills. A series of numerical computation, statistical, and intelligent systems approaches will be shown in the context of computational biology. The course will also introduce standards used in the field such as SBML, SBGN, BioPAX, and MIRIAM, along with standard tools such as CellDesigner, and Cytoscape, so that students can acquire practical knowledge and skills.

INTERDISCIPLINARY TOPICS

Emerging Technologies in Life Sciences
Ichiro Maruyama
This course introduces the cutting-edge techniques being developed for use in the life sciences. Many of these will be useful for research projects by graduate students at OIST. Such techniques include nucleotide sequencing, microarray, and confocal laser scanning microscopy, microfluidics and neuroimaging. Each session will be composed of a lecture relevant to the technique. Where possible, hands-on training or research laboratory visits will also be provided, and technical presentations will be invited from leading experts.

Measurement
Denis Konstantinov
Measurement is fundamental to scientists in all disciplines. This course will look at ways to make measurements and to avoid many of the pitfalls encountered in common and unusual measurements. A sound theoretical basis will be provided to allow students to go on to make their own choices with confidence and experience. Topics will include instrumentation, physical noise processes, signal transduction, models of small signal amplification, as well as modulation, detection, synchronous and lock-in detection, signal sampling techniques, digitization, signal transforms, Fourier analysis. Theoretical techniques centered around probability, probability theory, probability distributions, statistical inference, information theory, exact cases, Gaussians.

Controversies in Science
This course aims to develop critical thinking and argument, essential skills for effective independent scientists. The course will be flexible in content and presentation. Invited lecturers will present topics of some controversy or recent interest in science and lead debates by the students. We will also look at some historical controversies in different fields such as neuroscience and genetics.

Independent Study
This course will foster the development of independent study and research skills such as reading and critiquing the scientific literature, formulating scientific questions, and integrating knowledge into a coherent synthesis. Students will undertake a program of reading and synthesis of ideas.

“We have this international community, this fabulous laboratory and the research is just going ahead.”

Special Topics
The course Special Topics will provide an opportunity for students to study topics concerning recent scientific breakthroughs, cutting edge research of topical interest, novel, technologies and techniques, with leading international experts in those topics or technologies.

PROFESSIONAL DEVELOPMENT AND COMMUNICATION

Professional Development I
Jeff Wickens
The course covers essential information on laboratory procedures and safety, and introduces concepts of research ethics and basics of scientific communication. For safety reasons, students will be required to complete this course before access to laboratories is granted. Topics covered will relate directly to use of laboratories, particularly care and use of equipment, identification and avoidance of hazards, and ethics and requirements of research conduct. Principles of scientific communication, including record keeping and the ethics of writing, will be included.

Professional Development II
Gordon Arbuthnott
This course will comprise a series of seminars and workshops designed to prepare OIST graduates to function effectively and responsibly in their scientific career. Beyond the initial focus of research, a responsible scientist should be able to communicate their research to the informed public, to make the most effective use of the public and private funds entrusted to them, and to understand the place of their science in its social and ethical context. Communication, media, and presentation techniques will be developed, including the tools to present and manage one’s profile online and in person. Ethical considerations of life as a scientist will be addressed by discussion, debate and case studies. Invited experts from industry, science, patent and contract law, funding bodies, and so on will share their experience in generating and securing funding, typical intellectual property and industrial cooperation concerns, the business of running a research laboratory, and working in industry.

English for Higher Education in Science and Technology
Academic technical English is a specialized area with particular requirements for clarity in the communication of difficult concepts. English for Higher Education in Science and Technology provides training and practice in technical and scientific English, allowing students to participate more effectively in the OIST program, and beyond. Topics include as academic vocabulary, critical reading and understanding of academic text, listening skills, paraphrasing and summarizing scientific text, delivery of presentations, participation in academic debates and discussions, research skills including electronic research and presentation of results, and structuring an argument for academic texts and essays.

Essential Japanese for Foreign Researchers
Research students from countries other than Japan may have limited ability in the Japanese language. While the teaching and research language used at OIST is English, the availability of English outside the OIST campus is limited. Essential Japanese for Foreign Researchers is an optional course for students from non-Japanese-speaking countries. This course aims to ensure competence in Japanese language sufficient for working in a laboratory in Japan. It includes basic Japanese language equivalent to at least the Japanese Language Proficiency Test level N5. In addition, it will include a course on reading Japanese for laboratory safety, including important signs and labels found on scientific instruments in laboratories. Students will learn beginner to intermediate level Japanese in an immersive learning environment, focusing on practical Japanese for foreigners in Japan.

Laboratory Experience
Some students may come to OIST with little experience of a laboratory research environment. To develop such experience so that they may benefit more rapidly from the laboratory component of the OIST program, such students will be placed in a laboratory appropriate to their specific needs in terms of language and location. They will participate in laboratory life on a full-time basis to learn the skills and techniques of that laboratory, to become familiar with laboratory behavior, and to receive training in scientific practice and routine.

10. ABOUT OIST AND LIFE IN OKINAWA

“An exciting adventure that can take you places where nobody had an opportunity to go before”

Location

Okinawa is situated east of Asia, at the southwest end of the great arc of the Japanese archipelago. Strategically located at the crossroads of Asia, Okinawa has a 600-year history of international exchange. Okinawan people have long cultivated relations and interactions with other countries and are renowned for their hospitality and tolerance. There is an international airport in Naha with excellent connections to mainland Japan, China, Hong Kong, Taiwan, Korea and other destinations.

Climate and Geography

With its subtropical climate and lush nature, its special history and culture, Okinawa is a fascinating environment in which to live and work. It is regarded as a premier vacation destination, attracting visitors from mainland Japan and abroad. Surrounded by clear blue seas with schools of brightly colored tropical fish, Okinawa’s coral reefs support a rich profusion of life and accordingly some of the best diving in the world.

Culture

Okinawa has a unique and rich cultural heritage. International influences meld with local traditions and inspiration to produce a unique culture of music, dance and art. The widest range of contemporary culture can be found on the island and Okinawa musicians and artists are famous throughout Japan and worldwide. Whatever your interest, hip-hop dance, string quartets or traditional Irish dance, you can be fairly sure of finding it on the island.

Amenities

Okinawa is a hub of international exchange and cooperation. The island has 1.4 million inhabitants and has all the facilities and amenities of 21st century living, modern shopping centers, hospitals, excellent roads and infrastructure, high-speed internet, and a stable power grid. The incidence of earthquakes is very low. The island has no nuclear power stations. The cost of living is low in comparison to mainland Japan. There are hundreds of restaurants on the island offering cuisine from all over the world. The Okinawan diet has an emphasis on locally produced organically farmed vegetables and exceptional fish caught the same day from the water surrounding the island. The result is that Okinawan people have the world’s longest life expectancy.

Outdoor Life

Diving and snorkeling is a huge draw to Okinawa. Minutes from the OIST Campus you can dive in a wonderland of fish and coral. All marine activities like sailing, fishing, and kayaking, are easy to organize. The many smaller islands just off the coast of Okinawa offer wonderful opportunities for adventure. Cycling is very popular and there are dozens of outstanding golf courses. Horse riding and hiking are popular in the wild forests in the north of the island.

OIST Campus

The OIST campus is a unique piece of architecture - the buildings amaze. Set on 500 acres of subtropical paradise, the university has been designed from the start to provide the best possible environment to catalyze outstanding research and education. From the outside, the buildings evoke a science fiction version of a traditional Okinawan castle with soaring skywalks, shimmering lakes, ramparts overlooking beautiful forest and old Okinawan stone walls. Inside, everything has been calculated to maximize the efficiency of research and teaching activities with the credo that the more people share space and equipment, the more they share ideas. Look left, look right and you gaze through windows onto the turquoise lagoon and the deep blue of the East China Sea or the deeper greens of the forest. Everyone working at OIST comes up to the campus through the main gallery. From the entrance gallery, take a glass elevator through the light shaft, and then move out to the different buildings. It is not possible to work at OIST without meeting up with other people. The Campus has all the standard facilities: a library, many meeting rooms, a 500-seat auditorium, a café, a restaurant, and a health center.

Campus Village

The Campus Village has all the requirements for a comfortable and healthy life: a gym, a shop, a launderette, community rooms and landscaped gardens. Next to the village is the Child Development Center providing care and early learning for OIST children. Within 10 minutes of the Village zone there is a wide choice of restaurants, a range of beaches and forest trails, and ample shopping.

The OIST campus gives students an unrivalled living experience to complement the many opportunities for discovery and innovation.