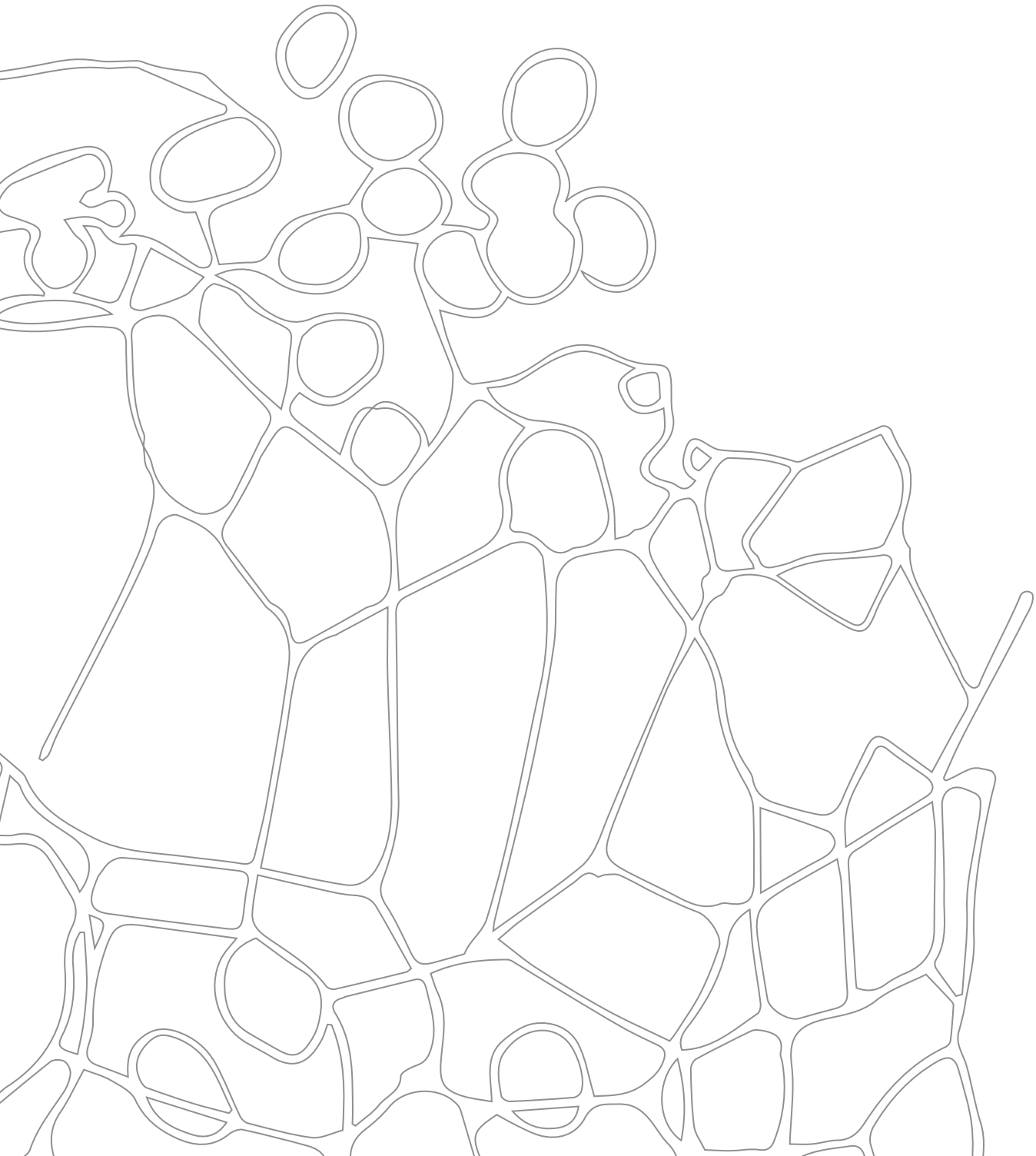
2017–2018

THE ROCKEFELLER UNIVERSITY



Schedule of Courses

The David Rockefeller Graduate Program offers a selection of courses, many of which students can choose based on their interests and area of thesis research. Organized by Rockefeller faculty, and taught by scientists at the top of their fields, both from within and outside of the university, these courses are designed to provide a stimulating and dynamic curriculum that students can tailor to fit their personal goals, in consultation with the dean of graduate studies.

Biochemical and Biophysical Methods

SETH A. DARST and MICHAEL P. ROUT

This course presents the fundamental principles of biochemistry and biophysics, with an emphasis on methodologies. It addresses issues of protein and nucleic acid structure and the forces that underlie stability and govern the formation of specific three-dimensional structures. In addition, case studies are discussed, examining particular processes—such as DNA replication and transcription—and how the application of different methodologies has been used to address specific biological questions.

Class length and frequency: Two-hour session, biweekly

Recommended reading: *Biochemistry* by Lubert Stryer et al.; *Molecular Biology of the Cell* by Bruce Alberts et al.

Method of evaluation: A written research proposal and an oral presentation of the proposal to the class

The Biology of Brain Disorders

GERALD FISCHBACH

This course emphasizes the biological and behavioral underpinnings of common neurological and psychiatric disorders. Subjects include disorders of excitation and conduction (including epilepsy and multiple sclerosis); perception, cognition, and memory problems (autism, schizophrenia, and Alzheimer's disease); consciousness (coma and persistent vegetative state); mood (depression and anxiety); motivation (addiction); sensation (pain); motor control (Parkinson's disease and ataxia); and trauma (brain or spinal cord injury and stroke).

Class length and frequency: Two-hour session, once weekly

Method of evaluation: Attendance, participation in the discussions, student presentations, and a final speculative paper relating a disordered trait to a specific brain circuit

Cell Biology

SANFORD M. SIMON and SHAI SHAHAM

This advanced course covering major topics in modern cell biology is taught by faculty and visitors who are specialists in various disciplines.

Class length and frequency: Three-hour lecture, once weekly; two-hour discussion, biweekly

Prerequisite(s): Good knowledge of textbook cell biology

Required reading: *Molecular Biology of the Cell* by Bruce Alberts et al.; *Molecular Cell Biology* by James E. Darnell et al.

Recommended reading: *Basic Histology* by Luiz Carlos Junqueira et al.

Method of evaluation: Attendance, participation in the discussions, student presentations, and a final oral exam

Cell Cycle Control

FREDERICK R. CROSS and HIRONORI FUNABIKI

This seminar explores the current understanding of eukaryotic cell cycle control. Topics include the construction of a biochemical oscillator and overall structure of cell cycle control; positive and negative control of DNA replication; spindle morphogenesis and function; chromosome cohesion control; surveillance mechanisms (checkpoints) monitoring spindle and DNA integrity; and control of proliferation (start/restriction point control). The seminar relies heavily on studies in model organisms, but the emphasis throughout will be on aspects of cell cycle control conserved among eukaryotes.

Class length and frequency: 2.5-hour lecture and discussion, once weekly

Required reading: *The Cell Cycle: Principles of Control* by David O. Morgan; other readings as assigned

Method of evaluation: Attendance, homework exercises, and participation in the discussions

Cellular and Organismal Metabolism

KIVANÇ BIRSOY and PAUL COHEN

This course will cover fundamental aspects of cellular and organismal metabolism, as well as exciting new applications for diseases such as obesity, diabetes, and cancer. Lectures will be given by the two course directors as well as by outside experts in the field.

Specific topics covered will include mitochondrial metabolism in the context of health and disease; lipids and non-polar metabolites in normal and disease physiology; signaling and metabolism; transcriptional regulation of metabolism; metabolic syndrome; exploiting metabolic pathways for cancer therapy; metabolomic approaches to studying cellular and organismal metabolism; and immunometabolism.

Class length and frequency: Two-hour lecture and discussion, once weekly

Prerequisite(s): Undergraduate Biochemistry course (recommended)

Required reading: Biochemistry textbook and discussion papers

Recommended reading: *Lehninger Principles of Biochemistry* by David L. Nelson and Michael M. Cox; *Navigating Metabolism* by Navdeep Chandel

Method of evaluation: Attendance, participation in the discussions, and presentations

Chemical Biology

TARUN KAPOOR

The spirit of this course is to explore the complexities of modern biology using the tools of chemistry. The lectures cover amino acid chemistry, nucleic acid chemistry, posttranslational modifications of proteins, discovery and use of chemical probes to examine cellular mechanisms, membrane chemistry, chemical tools for imaging, and natural product biosynthesis.

Class length and frequency: Two-hour lecture and discussion, once weekly

Recommended reading: *Posttranslational Modification of Proteins: Expanding Nature's Inventory* by Christopher Walsh; *The Organic Chemistry of Biological Pathways* by John McMurry and Tadhg Begley; *Chemical Biology: From Small Molecules to Systems Biology and Drug Design*, Volumes 1–3, by Stuart L. Schreiber et al.; *Structure and Mechanism in Protein Science: A Guide to Enzyme Catalysis and Protein Folding* by Alan Fersht; *The Molecules of Life: Physical and Chemical Principles* by John Kuriyan et al.

Method of evaluation: Attendance, participation in the discussions, and midterm and final exams

CNS Development

MARY E. HATTEN

This course focuses on the molecular and cellular mechanisms underlying the development of the mammalian nervous system. Topics include the induction of the nervous system, specification of neural cell fate, cell migration, axon guidance, and establishment of neuronal connectivity. A major emphasis is placed on the molecular mechanisms of cell patterning in the brain.

Class length and frequency: Two-hour lecture and discussion, once weekly

Method of evaluation: Attendance, participation in the discussions, and a final paper

Experiment and Theory in Modern Biology

SHAI SHAHAM and SANFORD M. SIMON

This course introduces first-year graduate students to the methods and principles behind current biological research. Students discuss preselected papers that illustrate methods of biological deduction. With guidance from their faculty mentors, students present and discuss papers and formulate conclusions about the experimental results. They also present a project based on one of the papers discussed in class. By the end of the course, students should be able to critically read a scientific manuscript and understand the principles used in interpreting scientific data.

Class length and frequency: Two-hour lecture and discussion, once weekly

Required reading: To be assigned

Method of evaluation: Attendance, participation in the discussions, and student presentations

Fundamentals of Neuroscience

A. JAMES HUDSPETH

This course serves as both an introduction to neuroscience and a refresher for those with a modest background in the field. It covers the nature of water and biological membranes; ions and electrical signals; ion channels, ion permeation, and channel gating; action potentials and their propagation; synaptic signaling and plasticity; sensory transduction and neural coding; neuronal cell biology and neuroanatomy; neurogenesis and the formation of neural connections; central processing of sensory information; and higher central nervous system processing.

Class length and frequency: Three-hour lecture, discussion, and laboratory demonstration, once weekly

Required reading: To be assigned

Recommended reading: *Principles of Neural Science*, Fifth Edition, by Eric R. Kandel et al.

Method of evaluation: Attendance, oral presentations, and participation in the discussions

Genetics and Evolution

FREDERICK R. CROSS and DANIEL KRONAUER

This seminar covers the basic mechanisms of genetics and evolution, including the generation of mutations and genetic segregation, linkage, and recombination (with an emphasis on linkage and segregation in eukaryotes). The course also considers changes in population genotypes when these basic genetic mechanisms are operating in the presence or absence of selective pressure. Changes in population genotypes can have effects ranging from polymorphism at neutral loci to the evolution of distinct species. Such changes are also used in historical analysis to trace migrations, evolution, and coevolution in diverse biological contexts.

Class length and frequency: 2.5-hour lecture and discussion, once weekly

Required reading: To be assigned

Method of evaluation: Attendance, homework exercises, and participation in the discussions

Immunobiology Tutorial

HOWARD C. HANG and DANIEL MUCIDA

This course is designed to explore current and exciting new areas of immunology. Major topics in cellular, molecular, and clinical immunology are covered. Each session consists of a discussion of the topic and a review of two or more papers. At the end of the course, students will write and present an original research proposal, as well as critique their peers in a mock study section.

Class length and frequency: Two-hour lecture and discussion, once weekly

Prerequisite(s): Undergraduate-level understanding of immunology

Required reading: *Janeway's Immunobiology*, Eighth Edition, by Kenneth Murphy (must be read prior to start of course)

Method of evaluation: Attendance, participation in the discussions, student paper presentations, and research proposals

Introduction to Programming for the Life Sciences

SETH SYBERG

This course, which assumes no previous programming knowledge, focuses on practical programming and data science skills using the Python programming language and associated scientific libraries. The course culminates in a final project directly applicable to the student's current research activities.

Class length and frequency: Two-hour lecture and lab, once weekly, and significant take-home programming assignments

Method of evaluation: Class participation, labs, assignments, and a final project

Mammalian Genetics

AGATA SMOGORZEWSKA

This course covers the genetics of bone marrow failure syndromes, cancer susceptibility, infectious diseases, obesity, diabetes, coronary heart disease, and neurodegenerative diseases. Also to be discussed are human gene mapping, disease modeling using mouse genetics, modern genetic tools including RNAi screening and genetic engineering using CRISPR, and ethical issues in modern human genetics.

Class length and frequency: Two-hour lecture and discussion, once weekly

Prerequisite(s): *Principles of Genetics*, Sixth Edition, by D. Peter Snustad and Michael J. Simmons (first six chapters)

Recommended reading: *Thompson & Thompson Genetics in Medicine*, Eighth Edition, by Robert L. Nussbaum et al.

Method of evaluation: Attendance, participation in the discussions, and take-home assignments

Math Review for Biologists

MARCELO O. MAGNASCO

This is an intensive skill-development course, starting with calculus and linear algebra and leading up to differential equations, Fourier transforms, and related computational methods for model simulation. A concurrent journal club explores the major historical papers as well as contemporary biological modeling papers proposed by the students in full line-by-line detail.

Class length and frequency: Two-hour lecture and discussion, once weekly; two-hour journal club, once weekly

Method of evaluation: Attendance and participation in the discussions and journal clubs

Membrane Biophysics

VANESSA RUTA and GABY MAIMON

This intensive course starts with an introduction to electrochemical dynamics, and then delves into the cellular and molecular biophysics of plasma membranes, with a focus on excitable membranes. Topics covered include gating, conduction, and selectivity of ion channels; mechanism of function of membrane pumps; and the origin of action potentials in neuronal and cardiac membranes. The course ends with a discussion of neuronal communication at synapses and biophysical explorations of sensory functions such as vision, hearing, and olfaction. All-day laboratories expose students to modern and classic preparations regarding cellular and molecular electrophysiology. Labs can accommodate up to 16 students.

Class length and frequency: Two-hour lecture and discussion, three times per week; five all-day labs within the six-week time frame

Recommended reading: *Ion Channels of Excitable Membranes*, Third Edition, by Bertil Hille; *Nerve, Muscle, and Synapse* by Bernard Katz; *Electricity and Magnetism Lectures* by Walter Lewin (available on iTunes U)

Method of evaluation: Attendance, participation in the class discussions, and labs

Microbial Pathogenesis

LUCIANO MARRAFFINI

Infectious diseases continue to be a leading cause of human morbidity and mortality worldwide as well as a major contributor to economic loss and the "poverty trap" in developing countries. This course focuses on the molecular mechanisms of host–pathogen interactions and pathogenesis of representative bacterial, fungal, and protozoan diseases. Topics include malaria, trypanosomiasis, toxoplasmosis, selected Gram-negative and Gram-positive bacterial infections, pathogenic mycobacteria, opportunistic mycoses, the evolution of pathogenicity and the impact of the host microbiota during microbial pathogenesis, and the development of antimicrobials and vaccines. The course is taught by Rockefeller and Cornell faculty and selected guest speakers.

Each class includes a lecture, followed by one or two 20-minute student presentations on a paper suggested by the speaker in which they outline follow-up experiments. Lunch with the speaker follows in the Abby Aldrich Dining Room for interested students.

Class length and frequency: Two-hour lecture and discussion, once weekly

Recommended reading: *Bacterial Pathogenesis: A Molecular Approach*, Third Edition, by Brenda A. Wilson et al.; *Foundations of Parasitology*, Ninth Edition, by Larry Roberts et al.

Method of evaluation: Attendance, participation in the discussions, individual presentations, and a three-page research proposal on one of the topics covered in the lectures at the end of the course

Molecular Basis of Cancer

SOHAIL TAVAZOIE

This course is designed to teach concepts pertaining to the molecular regulation of cancer formation and progression. Each lecture will be accompanied by a review and a research article to be discussed over lunch.

Class length and frequency: Three-hour lecture and discussion, once weekly

Required reading: *The Biology of Cancer*, Second Edition, by Robert A. Weinberg; other readings as assigned

Method of evaluation: Attendance, participation in the discussions, and a take-home final exam

Nuclear Cell Biology

TITIA DE LANGE

The eukaryotic cell nucleus is a highly specialized organelle that carries the cell's genetic information and coordinates biological activities such as cell growth, metabolism, protein synthesis, and reproduction. This course will cover various aspects of nuclear function, with sessions focused on gene transcription (led by Robert G. Roeder), chromatin biology (C. David Allis), RNA processing and modification (Sohail Tavazoie), the nuclear envelope and nuclear pore complexes (Michael P. Rout), cell cycle control (Frederick R. Cross), DNA replication (Michael O'Donnell), DNA repair (Agata Smogorzewska), DNA damage response and telomeres (Titia de Lange), and chromosome segregation (Hironori Funabiki).

Class length and frequency: Two-hour lecture and discussion, once weekly

Prerequisite(s): Basic understanding of molecular biology and biochemistry

Required reading: To be assigned

Recommended reading: *Molecular Biology of the Cell* by Bruce Alberts et al. (selected chapters)

Method of evaluation: Attendance, participation in the discussions, and a take-home exam

Quantitative Understanding in Biology Short Course

JASON BANFELDER and LUCE SKRABANEK

This course will prepare students to apply quantitative and statistical techniques to the analysis of experimental data. It emphasizes both practical and theoretical skills, and will involve hands-on exercises and homework using the GraphPad Prism program. Students will be well-positioned to meet the emerging requirements of funding agencies for formally planned experiments and fully reproducible and documented data analysis methods.

Specific topics include: graphical, mathematical, and verbal communication of quantitative concepts; selection of appropriate statistical tests and interpretation of their results; design of appropriately sized experiments; formulation, evaluation, and analysis of mathematical models of biological function with an emphasis on linear and nonlinear regression; determination of model parameters; and critical comparison of alternative models with regard to over-parameterization.

Class length and frequency: Nine two-hour sessions, once weekly

Required materials: Students need to bring a laptop to class to install free GraphPad Prism software.

Recommended reading: *Intuitive Biostatistics* by Harvey Motulsky; *The Art of R Programming: A Tour of Statistical Software Design* by Norman Matloff; *R for Everyone: Advanced Analytics and Graphics* by Jared P. Lander; *Practical Computing for Biologists* by Steven H.D. Haddock and Casey W. Dunn

Method of evaluation: Take-home problem sets and midterm and final exams

Responsible Conduct of Research

TRI-INSTITUTIONAL FACULTY and GUEST LECTURERS

Taught in collaboration with Memorial Sloan Kettering Cancer Center, this course promotes awareness of ethical considerations relevant to the responsible conduct of research, and is aligned with requirements issued by the National Institutes of Health and the National Science Foundation. Attendance is mandatory for all first-year graduate students.

Class length and frequency: One-hour lecture and one-hour workshop, four times in the fall semester

Method of evaluation: Attendance, participation in the discussions, and online coursework

Science Diplomacy: The Context for Thinking Globally about the Biological and Medical Fields

JESSE H. AUSUBEL, MANDË HOLFORD, and RODNEY NICHOLS

The shorthand term "science diplomacy" spans wide-ranging activities connecting science and technology with international affairs. In addition to global health and medicine, this course considers the larger context of dealing with nations in conflict, innovation in the public and private sectors, and views of science diplomacy from outside the United States. This six-week course will sample the current landscape of science diplomacy issues, programs, and organizations. Its goals are to help early-career biomedical scientists think more systematically about the global potential of their work, including ethical, political, and economic implications; and to make them acquainted with the people, networks, and resources available for scientific cooperation, including nations with whom cooperation may be especially difficult. Some students will be invited to join a field trip in March to Washington, DC, to meet with prominent science diplomacy practitioners and tour relevant institutions.

Class length and frequency: Two-hour lecture and discussion, once weekly

Required reading: To be assigned

Method of evaluation: Attendance and participation in the discussions

Seminars on Modern Biology

MEMBERS OF THE ROCKEFELLER UNIVERSITY FACULTY

This series of intensive, biweekly seminars is designed to give incoming graduate students a chance to interact with Rockefeller faculty. Participation is mandatory for and limited to first-year students. In each session, two or three faculty members give brief introductions to their research and engage in a student-led discussion.

Social Evolution and Behavior

DANIEL KRONAUER

This intensive course, held at The Rockefeller University Center for Field Research in Ethology and Ecology in Millbrook, New York, will include lectures, workshops, paper discussions, student presentations, and field outings. The course will explore complex questions from a variety of angles including genetics, behavioral ecology, ethology, neuroscience, and evolutionary and theoretical biology. It will cover

several biological systems, ranging from single genetic elements, social microbes, insects, and vertebrates to mutualistic interactions between species.

Class length and frequency: One week

Required reading: To be assigned

Method of evaluation: Participation in the discussions, student presentations, and hands-on workshops

Stem Cells in Tissue Morphogenesis and Cancer

ELAINE FUCHS and ALI H. BRIVANLOU

This course aims to present and discuss key concepts in stem cell biology, drawing on research from planaria to humans. It covers the basic principles of stem cells, from self-renewal and asymmetric cell divisions to tissue development, homeostasis, wound repair, and cancer. In addition to the basic lectures, there will be eight guest speakers who are world-renowned leaders in the field. Following each of these lectures, speakers will lead a discussion with the class over preassigned papers relating to the research topic.

Class length and frequency: Two-hour class lecture and discussion, once weekly; one-hour guest lecture, biweekly

Required reading: To be assigned

Method of evaluation: Attendance, participation in the discussions, and a final written mini-review

Systems and Cognitive Neuroscience

WINRICH FREIWALD and CHARLES D. GILBERT

This course aims to answer how the concerted action of neurons in the brain, organized at multiple scales, generates complex behaviors. It will discuss how the brain gives rise to perception, internal representations, cognition, and action, covering the structure and function of various neural systems. Topics will include the mechanisms of information processing (from the single neuron to ensembles of cells to behavior); the connectivity, functional architecture, and dynamic properties of neural circuits; the relationship between synaptic mechanisms and functional specificity; learning and memory; attentional mechanisms; and emotional and higher-order cognitive functions. With a focus on concepts, students will learn about a range of technical approaches as well as theoretical and computational tools for understanding brain function. Sessions will include overview lectures, student presentations of original papers and review articles, and group discussions.

Class length and frequency: Three-hour class lecture and discussion, once weekly

Required reading: To be assigned

Recommended reading: *Principles of Neural Science*, Fifth Edition, by Eric R. Kandel et al.

Method of evaluation: Attendance, individual student presentations, and participation in the discussions

Virology

CHARLES M. RICE and PAUL BIENIASZ

In this course, Rockefeller faculty and guests give lectures and lead discussions about virology, with a major emphasis on the cellular and molecular biology of animal viruses. Topics include virus structure, replication, molecular genetics and gene expression, interactions with host cells, immunology, pathogenesis, viral vaccines, antiviral therapy, and resistance. A number of model systems are discussed, including cytocidal, steady state, and tumorigenic virus–cell interactions.

Class length and frequency: Two-hour lecture and two-hour journal club lunch discussion, once weekly

Required reading: To be assigned

Recommended reading: *Principles of Virology*, Volumes 1 and 2, Fourth Edition, by Jane Flint et al. (selected chapters); *Fields Virology*, Sixth Edition, by David M. Knipe and Peter M. Howley

Method of evaluation: Attendance, participation in the discussions, journal club presentations, and a written grant proposal

Supplementary Seminars, Tutorials, and Support Courses

Seminars and tutorials additional to those listed here are offered on demand. Students are welcome to speak with the dean of graduate studies to arrange training in any areas not covered by existing courses.

In addition, Rockefeller faculty and service departments offer a number of practical support courses. For example, students can learn about various aspects of computing and receive instruction in the efficient use of common software as well as more complex computational tools.