THE ROCKEFELLER UNIVERSITY

Schedule of Courses 2026–2027



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 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, I & II

GREGORY M. ALUSHIN, SETH A. DARST, SHIXIN LIU, and MICHAEL P. ROUT

This course presents the fundamental principles of biochemistry and biophysics, with an emphasis on methodologies. In addition, case studies are discussed to examine how physical and chemical methods have been used to establish the molecular mechanisms of fundamental biological processes. The course is offered in two consecutive semesters. Part I introduces biological macromolecules and the experimental tools being used to dissect their three-dimensional structures and assembly principles. Part II covers methods aimed at delineating the conformational fluctuations, chemical turnovers, and kinetic trajectories of biological complexes at molecular, cellular, and evolutionary scales.

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

Recommended reading: *The Molecules of Life: Physical and Chemical Principles* by John Kuriyan et al., *Molecular Biology of the Cell* by Bruce Alberts et al., *Physical Biology of the Cell* by Rob Phillips et al.

Method of evaluation: Part I: A written specific aims page and a five-minute oral presentation of an original research proposal. Part II: A two-page written review and a five-minute oral critique of a topical preprint.

Bioinformatics

THOMAS CARROLL

In this course, the analysis of high-throughput sequencing using R and Bioconductor will be introduced. Students will learn the fundamentals of data handling in R, review the standard high-throughput sequencing data types, and manipulate this data using the Bioconductor R libraries. The course will then step through the processing and analysis of published RNA-seq, ChIP-seq, and ATAC-seq data.

The course will conclude with sessions introducing emerging AI-assisted approaches for bioinformatics analysis. Students will explore how these tools can support project organization, workflow development, code review, troubleshooting, documentation, and interpretation, while emphasizing best practices for reproducibility, transparency, and critical evaluation of computational results.

Class length and frequency: Three-hour session, twice weekly

Method of evaluation: Attendance and homework exercises twice weekly

Biology by the Numbers

AVI I. FLAMHOLZ

Beneath the surface of every diagram or fundamental concept in a biology textbook is an essential set of numbers: counts, concentrations, rates, sizes, and energies. What are these numbers, and what can we learn from them?

The goal of this course is to introduce students to quantitative reasoning about biological systems. While knowing numbers at an approximate level (e.g., typical rates of transcription and translation) is an important goal, equally important is learning to reason quantitatively using these numbers (e.g., learning to formulate problems such as: "How does diffusion constrain cell sizes?").

Mathematical knowledge required for this course will be mainly simple arithmetic – we will focus on formulating and assessing "order-of-magnitude" estimates about biological systems. The course will culminate in an open-ended project in which students take on an ambitious estimation problem from any area of biology and carry out a rigorous quantitative analysis. Students present these projects to the class and elaborate on them in a written report.

Class length and frequency: 1.5-hour session, twice weekly

Prerequisite(s): Some biology, chemistry, excitement for learning, willingness to do simple math and programming.

Required reading: *Cell Biology by the Numbers,* by Ron Milo and Rob Phillips

Recommended reading:

1. Bar-On, Y.M. et al. The biomass distribution on Earth. *Proc. Natl. Acad. Sci. U.S.A.* 115, 6506–6511 (2018).
2. Chure, G. et al. Anthroponumbers.org: A quantitative database of human impacts on Planet Earth. Patterns 3, 100552 (2022). https://doi.org/10.1016/j.patter.2022.100552

Method of evaluation: Students are expected to attend all lectures, participate in the discussions, complete homework, and submit the final project.

Cell Biology

SANFORD M. SIMON and TIM STEARNS

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, once weekly

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 Biology of Nuclear Processes

AGATA SMOGORZEWSKA

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, RNA processing and modification, the nuclear envelope and nuclear pore complexes, cell cycle control, DNA replication, DNA repair, DNA damage response and telomeres, genome organization, chromatin structure and function, and chromosome segregation. The course will be taught by the Rockefeller faculty (Titia de Lange, Bob Roeder, Mike O'Donnell, Mike Rout, Viviana Risca, Fred Cross, and Agata Smogorzewska) and invited speakers from Tri-Institutions, including John Maciejowski and Steven Josefowicz.

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

Learning Objectives

1. Have a general knowledge of replication, transcription, genome organization, nuclear import and export, and chromatin modifications
2. Be able to describe key concepts in DNA repair, cell cycle, chromosome segregation and checkpoint signaling during these events
3. Explain the role of different cellular RNAs

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 the 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 course directors and 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 (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, JIANKUN LYU, and EKATERINA V. VINOGRADOVA

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

Experiment and Theory in Modern Biology

SANFORD M. SIMON and TIM STEARNS

This course introduces first-year graduate students to the methods and principles of current biological research. Students discuss preselected papers that illustrate methods of biological deduction and, with guidance from their faculty mentors, 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, three times weekly in September

Required reading: To be assigned

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

Fundamental Immunology and Microbiology

MING LI

This course provides a comprehensive overview of basic immunology, beginning with innate immune responses, followed by a study of the main aspects of acquired immunity. Specific interactions of target cells and T cells that are regulated by the MHC molecule, and interactions between peptide antigens on the target cell and the antigen-specific T cell receptor, are studied. The generation and molecular structure of B and T cell antigen receptors, and signaling through immune receptors, are covered in detail. Additionally, the development of antigen-specific T and B cells, and specific roles for some cytokines/lymphokines, are explored. The latter part of the course covers T and B cell-mediated immunity in more depth, along with topics of clinical relevance, such as microbial immunity, allergy, autoimmunity, tumor immunology, congenital and acquired immunodeficiencies, transplantation immunology, and immunotherapy. All these topics are studied though lectures and in-depth review of selected articles.

Class length and frequency: Three-hour session, twice weekly

Required reading: *Janeway's Immunobiology*, ninth edition, by Kenneth Murphy and Casey Weaver

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

Genetics and Evolution

FREDERICK R. CROSS, DANIEL KRONAUER, and LI ZHAO

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

Introduction to Programming for the Life Sciences

SETH SYBERG

This course, which requires 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 take-home programming assignments

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

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

Microbial Pathogenesis

LUCIANO MARRAFFINI and JEREMY M. ROCK

Infectious diseases continue to be a leading cause of human morbidity and mortality worldwide, as well as a major contributor to economic loss and poverty in developing countries. This course focuses on the molecular mechanisms of host-pathogen interactions and the 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, the impact of the host microbiota during microbial pathogenesis, and the development of antimicrobials and vaccines. The course is taught by Rockefeller and Weill Cornell Medicine faculty and selected guest speakers.

Each class includes a lecture followed by one or two student presentations on a paper suggested by the speaker in which the students outline follow-up experiments, and an optional lunch with the speaker.

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

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 materials as assigned

Method of evaluation: Attendance, participation in the discussions, and a take-home final 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: Laptop with GraphPad Prism software (license will be provided for the duration of the course)

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

Responsible Conduct of Research

TRI-INSTITUTIONAL FACULTY and GUEST LECTURERS

Taught in collaboration with Memorial Sloan Kettering Cancer Center, this course raises awareness of ethical considerations relevant to the responsible conduct of research. It 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 and Diplomacy: Science Crossing Borders

JESSE H. AUSUBEL and MANDË HOLFORD

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 of the United States. This 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 acquaint them with the people, networks, and resources available for scientific cooperation, including nations with whom cooperation may be especially challenging. Some students will be invited to join a field trip in March to Washington, D.C., to meet with prominent science diplomacy practitioners and tour relevant institutions.

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

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 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 to four 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 of full-time participation

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 have lunch with student volunteers and lead a discussion with the entire class on preassigned papers relating to the research topic.

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

Required reading: To be assigned

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

Systems Biology: Process, Relation, and Scale

AMY E. SHYER and ALAN RODRIGUES

Systems biology has been defined as the study of biological systems whose behavior cannot be reduced to the linear sum of their parts. Today, systems biology has become synonymous with studies of large numbers of components. However, vast datasets are not sufficient for a systems approach. A systems biology approach also attempts to understand how the whole or system-level properties emerge from the interactions between the parts. Using this approach, this course will investigate the formation, maintenance, and breakdown of biological systems. Invited guests will participate in discussions grounded in specific research areas within the fields of developmental biology, regeneration, cell biology, cancer, and neuroscience.

Students are expected to absorb the fundamental principles of systems biology, including self-organization, emergence, complexity, and causality in networks. They will also be expected to articulate how such principles could play a role in defining contemporary research questions in the lab.

Class length and frequency: Two-hour sessions, once weekly for 12 weeks

Required reading: To be assigned

Method of evaluation: Participation in weekly discussions, as well as a written paper

Topics in Neuroscience

MEMBERS OF THE ROCKEFELLER UNIVERSITY FACULTY

In this course, Rockefeller neuroscience faculty will present a common core of concepts in modern neuroscience, including biological membranes, ions, and electrical signaling; synaptic function and plasticity; neuronal cell biology, neuroanatomy, neurogenesis, and neural degenerative diseases; and processing and coding of sensory information, neural integration, and evolution. The course emphasis is on reading and assessing primary literature to develop quantitative reasoning and experimental design skills to better understand mechanisms across levels of biological organization and functioning within the nervous system.

Class length and frequency: 1.5-hour lecture and discussion, twice weekly for 10 weeks

Required reading: To be assigned

Recommended reading: *Principles of Neural Science,* sixth edition, by Eric Kandel et al., *Neuroscience,* seventh edition, by George Augustine et al.

Method of evaluation: Attendance, participation in discussions, and a written project assignment

Virology

THEODORA HATZIIOANNOU

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 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.