

# DIVISION OF SCIENCE, MATHEMATICS, AND COMPUTING AT BARD

Bard College's programs in science, mathematics, and computing consist of biology, chemistry and biochemistry, computer science, mathematics, physics, and psychology. The curriculum provides students with hands-on opportunities to learn the concepts, methods, and practices of each field of study. Courses in complementary areas, such as mind, brain, and behavior; environmental and urban studies; experimental humanities; gender and sexuality studies; global public health; and science, technology, and society are offered through Interdivisional Programs and Concentrations.

Students learn by posing and solving problems. The Distinguished Scientist Scholars Program offers up to full-tuition scholarships for academically outstanding high school seniors committed to majoring in science or mathematics. Research possibilities include opportunities on campus and at affiliated institutions. Senior Projects typically consist of original experimental or theoretical research. Much science work at Bard is collaborative, involving faculty and students in cutting-edge research that has resulted in students being coauthors on published papers.

The Bard-Rockefeller Semester in Science is a New York City-based program designed for advanced science students, particularly those interested in neuroscience, biochemistry, molecular biology, developmental biology, biophysics, or genetics. Students spend a semester working with faculty from Rockefeller University (RU) and taking specially designed classes at RU and at the Manhattan headquarters of Bard's Globalization and International Affairs Program.

Facilities include the state-of-the-art Gabrielle H. Reem and Herbert J. Kayden Center for Science and Computation (RKC), a 70,000-square-foot facility that includes nearly 17,000 square feet of dedicated laboratory space. Biology equipment includes DNA and protein electrophoresis instruments, digital gel imaging system, an array of standard PCR machines, a Real-Time PCR machine, a confocal microscope, two fluorescence microscopes, and a wide range of ecology field equipment.

Instruments in the Chemistry and Biochemistry Program include a 400-MHz NMR; ICP-OES; fluorimeters; potentiostats; GCMS; LCMS; HPLC; UV-Vis; ITC; combiflash; microplate readers; dedicated lab for isotopic labeling of DNA, RNA, and proteins; microwave reactors; and Raman and FTIR spectrometers in addition to an ultrafast Ti:sapphire laser incorporated into two-photon microscope and direct-laser-writing setups. The computer science space includes a cognitive systems lab and a robotics lab. Physics equipment includes a scanning electron microscope, scanning probe microscopes, and an optical inspection microscope in Bard's Nanofabrication Lab (in Rose Laboratories), a clean room incorporated into the Gravitational Wave Optics lab (RKC), machine shop (Hegeman Hall), and computer design/fabrication shop (Rose). RKC features the László Z. Bitó '60 Auditorium, geothermal heating and cooling, and an advanced energy recovery system.

The Bard College Field Station is on the Hudson River near Tivoli South Bay and the mouth of the Saw Kill. Its location affords research and teaching access to freshwater tidal marshes, swamps and shallows, young and old deciduous and coniferous forests, and other habitats.

# BIOLOGY

The Bard College Biology Program offers courses and research opportunities in the most exciting areas of biology research today—biodiversity, neuroscience, infectious diseases, conservation, evolution, and more. Our program prepares all students to be critical thinkers in the world of science, and gives them hands-on experience in designing and conducting biological research. About 80 percent of graduates are involved in science or math as graduate students, health professionals, teachers, writers, or researchers. Bard students who apply to medical schools have had a 78 percent placement rate (the national average is 50 percent). Their scores on the MCAT are in the 96th percentile or above.

Resources in the Reem-Kayden Center for Science and Computation include a confocal microscope, DNA and protein electrophoresis instruments, a digital gel-imaging system, standard PCR machines and a Real-Time PCR machine, two fluorescence microscopes, and ecology field equipment.

## RECENT SENIOR PROJECTS

**“Enterococcus as an indicator of fecal contamination in freshwater,” case study of Hudson River tributaries** Renad Bdair '19, Mas'ha, West Bank (concentration: Science, Technology, and Society)

**“Plant-soil negative feedbacks as drivers of spatial patterns of abundance in a successional landscape: A modeling approach”** Lucy Delphine Christiana '19, Portland, Oregon (concentration: Global Public Health)

**“Analysis of bacterial membrane structures, which alter the effectiveness of violacein's antibacterial function”** Michael Nicolao Kucky III '19, New Orleans, Louisiana

# CHEMISTRY AND BIOCHEMISTRY

The Chemistry and Biochemistry Program at Bard provides an experience that is designed primarily, but not exclusively, for students planning to pursue graduate work in chemistry, biochemistry, engineering, and related fields. Within our state-of-the-art facilities, students gain extensive hands-on experience with contemporary instrumentation and experimental techniques. Laboratory courses are small (typically no more than 15 students per section), which allows for individual use of research-grade instrumentation. The instruments include a 400-MHz NMR; GC/MS; LC/MS; HPLC; UV/Vis, Raman, and FTIR

spectrophotometers; as well as an ultrafast Ti:sapphire laser.

In addition to the program's core coursework, students have the opportunity to become involved in faculty-led research at early stages of their undergraduate careers. In the last five years, faculty in the Chemistry and Biochemistry Program have published 30 papers, which include more than 65 Bard undergraduate coauthorships. Recent alumni/ae have pursued graduate studies and/or obtained employment in academia, science editing, industry, and medicine.

## RECENT SENIOR PROJECTS

**“The metrology of two-photon polymerization”** Xiaofei Guo '19, Jiangsu, China

**“Synthesis of PEG-modified guanine for modulation of transcription via xpt-pbuX riboswitch”** Leah H. Santana '19, Louisville, Kentucky

**“Shining light on cyclobutane synthesis: Ir catalyzed [2+2] cycloadditions of vinylogous esters through energy transfer”** Alec Hopper Waters '19, Concord, Massachusetts (Chemistry and Biochemistry; Historical Studies)

# COMPUTER SCIENCE

The Computer Science Program at Bard offers courses on the fundamentals and applications of computers and algorithms. Thinking computationally—formally representing information and the procedures to manipulate that information (i.e., algorithms)—results in a unique and powerful lens through which to view the world. The program focuses on the foundations of computer science and introduces students to multiple programming languages and paradigms. It offers broad coverage of theoretical, applied, and systems-oriented topics, including the effects of computing on society.

At Bard's Laboratory for Algebraic and Symbolic Computation, Bard faculty, students, and staff work together to produce new theorems and algorithms, solve intricate problems with metadata design, and develop websites that integrate several complex software systems. The goal is to extend the capabilities of existing theorem provers, model searchers, and computer algebra systems through improved connectivity and knowledge management. Current domains of interest include universal algebra and the constraint satisfaction problem.

## RECENT SENIOR PROJECTS

**“Credit Risk Analysis in Peer-to-Peer Lending Dataset: Lending Club”** Mohammad Mubasil

Bokhari '19, Lahore, Pakistan (concentration: Science, Technology, and Society)

**“Tracking Pose Using Common Mobile Phone Sensors”** Andrew Lee Carlson '19, Sioux Falls, South Dakota (Computer Science; Viola Performance [BMus])

**“Self-Driving Cars: Exploring the Potential of Using Convolutional Neural Network to Overcome Road Variation”** Shida Wang '19, Shenzhen, China

# MATHEMATICS

The Bard Mathematics Program has three main functions: to offer students the opportunity to study the primary areas of contemporary mathematics; to provide physical and social science majors with the necessary mathematical tools for work in their disciplines; and to introduce all students to serious and interesting mathematical ideas and their applications. For mathematics majors, the program combines high academic standards and individual attention, both in the availability of faculty members for discussion and options for tutorials, independent study, and individualized Senior Projects.

The Bard Math Circle is a mathematical enrichment program for middle and elementary school children, organized by Bard students and faculty in the Mathematics Program. The Math Circle holds mathematical enrichment programs at local libraries, organizes math competitions for middle school students, and runs a math day camp in August.

## RECENT SENIOR PROJECTS

**“The Credit Scorecard Model”** Jintao Fang '19, Shanghai, China

**“An Algorithmic Approach to Detect Noninjectivity of the Partial Borda Count”** Jazlyn Jade Johnson '19, New Orleans, Louisiana (Mathematics; Economics)

**“Predicting How People Vote from How They Tweet”** Rao Bapeswara Vinnakota '19, San Jose, California

# PHYSICS

The Physics Program presents courses and research experiences in theoretical and experimental physics that provide a firm foundation for work in a variety of scientific areas. A majority of recent graduates have pursued advanced degrees in physics or engineering; others are working in fields such as technical support, computers, finance, and secondary

education. Most students take a core sequence of physics courses, but electives and tutorials are used to tailor a curriculum to reflect each student's interests and level of preparation. Faculty research currently focuses on extrasolar planets, loop quantum gravity, microhydroelectric power, precision optics for gravitational wave detection, and graphene-based nanofabrication, with students participating in these research programs as early as their first year.

#### RECENT SENIOR PROJECTS

##### **"The Invisible Sun: Building a Radio**

**Interferometer Telescope"** Isobel Curtin '19, San Francisco, California (Physics; German Studies)

##### **"Optimizing Glide-Flight Paths"**

Rory Cveta Maglich '19, Hastings-on-Hudson, New York (Concentration: Science, Technology, and Society)

##### **"Methane Sensing in the Field," attempt to measure methane over large areas via Arduino**

**and aerial drones** Kyle Zigner '19, Hyde Park, New York

## PSYCHOLOGY

Bard's Psychology Program aims to engage undergraduate students with the enormously broad and rich science of human behavior. Topics in the field range from neuronal and genetic mechanisms all the way up to the social systems that govern group behavior. Program faculty introduce students to psychology's subfields (social, cognitive, developmental, abnormal, and neuroscience); engage students in integrative, critical thinking about the mechanisms underlying human thought and behavior; educate students in the process of empirical science as it applies to behavior; and provide hands-on opportunities for data collection and analysis. Survey courses, laboratory courses, intensive seminars, and individually mentored research prepare students to excel in an interdisciplinary society.

#### RECENT SENIOR PROJECTS

##### **"A Test of Obedience or Patience? A Modified Replication of 'Nothing by Mere Authority,' by Haslam et al. (2014)"**

John Joseph Machen '19, Monkton, Maryland

##### **"Body Dissatisfaction: Searching for a Link between Depressive Symptoms, Body Image, and Eating Patterns," a study of 18- to 24-year-olds**

Lucy Elizabeth Sorrell '19, Kansas City, Missouri

##### **"The Corporeal Specificity of Women: Gender Perception along the Dimension of Mind and Body"**

Tong Su '19, Nanning, China (concentration: Mind, Brain, and Behavior)

## INTERESTED IN ENVIRONMENTAL AND URBAN STUDIES?

The interdependence of human societies and the physical environment is the focus of this wide-reaching major with regional, national, and international scope. Among the six focus areas that offer empirical experience are: agriculture and food systems; environmental science; and global perspectives on environment, society, and culture, including analysis of biocultural diversity and climate change. Majors pursue an internship in their field of interest.

## INTERESTED IN MEDICINE?

A dedicated health professions advising team provides advice and support for students interested in medicine or careers in other health-related fields. Guidance includes course selection to fulfill professional school requirements, and emphasis on relevant research and practical experience related to student interest. Outreach events, small-group workshops, and planning with academic advisers offer opportunities for academic and career-path evaluation.

## 3+2 AND 4+1 DEGREE OPTIONS

### ENGINEERING

Students spend three years at Bard, then two years at Columbia University's Fu Foundation School of Engineering and Applied Science or Dartmouth's Thayer School of Engineering. Students receive a BA from Bard and a BS from the other institution.

### ENVIRONMENTAL POLICY AND CLIMATE SCIENCE AND POLICY

Students complete their undergraduate studies, then proceed to the MS degree program at the Bard Center for Environmental Policy, receiving two degrees in five years.

### FORESTRY AND ENVIRONMENTAL MANAGEMENT

Bard offers 3+2 options with the master's degree programs in either of these fields at Duke University.

### TEACHING

A 4+1 option with Bard's Master of Arts in Teaching Program offers undergraduates a path to a BA, MAT, and New York State Teacher Certification for grades 7-12 (in biology, history, literature, mathematics, or Spanish) within five years of entering college.

## SUMMER RESEARCH

### BARD SUMMER RESEARCH INSTITUTE

Students receive stipends to work on campus over the summer, in Bard faculty laboratories, on projects related to the faculty's research. Areas of research in the sciences include: biology, chemistry and biochemistry, computer science, mathematics, physics, and psychology.

### CARY INSTITUTE OF ECOSYSTEM STUDIES

The Cary Institute, in nearby Millbrook, New York, offers summer internship positions to Bard students for research on Lyme disease, water quality, the Hudson River, and other topics.

### DISTINGUISHED SCIENTIST SCHOLARS SUMMER RESEARCH

Moderated scholarship recipients may apply for a stipend for off-campus summer research projects following the sophomore and junior years.

### RESEARCH EXPERIENCES FOR UNDERGRADUATES (REU)

Highly competitive, federally funded REU programs offer students the opportunity to participate in research at various institutions across the country. Bard students have spent summers in REU programs at Harvard University, Stanford University, Los Alamos National Laboratory, and elsewhere.

## NOTABLE ALUMNI/AE

**László Z. Bitó '60** (chemistry), professor emeritus of ocular physiology at Columbia University, conducted research that led to development of a breakthrough drug for the treatment of glaucoma; he received an honorary doctorate of science from Bard in 2007.

**Babacar Cisse '03** (chemistry), an award-winning neurosurgeon at Weill Cornell Brain and Spine Center, conducts research on how brain tumors develop and become malignant. **Megan Kerins '06** (physics) founded Solar Stewards, a solar-energy consulting company that concentrates on emerging economies. **Jason Mastbaum '10** (physics) is a technical analyst for the Rand Corporation. His work has included computer modeling support for the U.S. Air Force and a study of Army practices for supplying soldiers with potable water.

**Mariana Raykova '06** (mathematics and computer science) is a research scientist at Google; she received the College's 2017 John and Samuel Bard Award in Medicine and Science. **Eduardo Rozo '00** (physics) is a professor of experimental cosmology at the University of Arizona, utilizing large-scale structure probes to better understand the physics behind the accelerated expansion of the universe. **Karen**

**Saxe '82** (mathematics), who received both an honorary doctor of science degree from Bard and the John and Samuel Bard Award in Medicine and Science, is associate executive director of the Washington, D.C., office of the American Mathematical Society and is DeWitt Wallace Professor of Mathematics, Emerita at Macalester College. **Ilyas Washington '96** (chemistry) is cofounder of Alkeus Pharma, a clinical-stage biopharmaceutical company, and cofounder of biOOrg3.14, a pharmaceutical company that invents technologies to fight diseases ranging from age-related macular degeneration to diabetes.

## NOTABLE FACULTY

**Craig Anderson**, chemistry and biochemistry, research focuses on synthesis, characterization, and reactivity of heteromultinuclear anticancer metal complexes; winner of Chemical Institute of Canada's Award of Excellence and Society of Chemical Industry Award. **Hal Haggard**, physics, interests include quantum gravity, semiclassical analysis, symmetry and integrable systems; recipient of National Science Foundation research fellowship and visiting fellow at Perimeter Institute for Theoretical Physics in Waterloo, Canada.

**Swapan Jain**, chemistry and biochemistry, research centers on structure of nucleic acids, interaction of drugs with DNA and RNA, and RNA regulation. **Felicia Keesing**, biology, investigation of how loss of biological diversity influences tick-borne disease transmission; grants from National Geographic Society, National Science Foundation, National Institutes of Health, EPA; fellow, Ecological Society of America. **Antonios Kontos**, physics, research centers on terrestrial experiments that aid understanding of astrophysical processes; his recent work on precision optomechanical measurements was crucial to the first experimental detection of gravitational waves. **Emily McLaughlin**, chemistry and biochemistry, research interests include synthesis of complex molecules and development of new synthetic methods; recipient of U.S. Department of Education GAANN Fellowship. **Gabriel G. Perron**, biology, focuses on antimicrobials, antibiotic resistance, and genomic DNA; recipient of postdoctoral honors and fellowships. **Bruce Robertson**, biology/environmental and urban studies, research includes understanding the impacts of human activities on biodiversity, animal behavior, and species interactions; research grant from California Energy Commission.

# Bard

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Page 1: Citizen Science Class

Page 4: Students aligning a laser during the Bard Summer Research Institute

Both photos by Pete Mauney '93 MFA '00