Science Department

The science program at BB&N aims to empower students to think critically and act ethically by instilling a systemic approach and scientific lens to problem solving. The curriculum employs a laboratory and project-based discovery model in the belief that insights are best developed in an exploratory and experimental setting. Objectivity in observation, accuracy in data gathering and recording, identification and control of variables, the manipulation and presentation of data, and the evaluation of the validity of experiments are lab skills emphasized as appropriate to the grade level and discipline. At all levels, themes of sustainable development, scientific research, and decision-making on a global scale are incorporated. The program challenges students to appreciate science as an imaginative, impassioned, human endeavor essential to preserving our world for generations to come.

Biology (Grades 9 – 10)
In this required foundational course, students are introduced to a variety of skills that provide an anchor for future coursework in the sciences. Emphasis is placed on the skills centering the development of data representation and analysis, argumentation, concept explanation, visual representation, and reflection using the topics of cell biology, genetics, ecology, and physiology as a lens. Correlated lab work and activities allow for opportunities of growth and development of these core practices. Students are also challenged to utilize their content and skill knowledge to think critically about how biology has and can be used to help and harm society. An understanding and appreciation of how personal identities and the identities of others shape scientific views and perspectives is explored.

Physics (Grades 10 – 12)
This is a lab-based course designed for students who have completed biology and who want to explore physical science with an emphasis on the practical nature of the physical world. The course includes mechanics, motion, and energy as well as electricity, simple circuits, and waves. Algebra is used in the interpretation of data and provides a link between the relationships elucidated by lab experiments and the practical applications of those principles. There are also various projects, including a science and art co-curricular photography project, integrated into the course and designed to allow students explore and apply the concepts learned in the course in a creative way.
Recommended Prior Course: Algebra 2

Physics (Honors) (Grades 10 – 12)
Physics (Honors) is a lab-based course that stresses the discovery of physical relationships through lab experiences. The year begins with a study of motion, proceeds through conservation of energy, electricity, circuits, simple harmonic motion, and ends with the examination of sound and light. Algebra 2 is a prerequisite for enrollment since Algebra is used extensively in the interpretation of data and in the expression of ideas.
Prerequisite: Algebra 2 and approval of the Science Department
Recommended Prior Course: Algebra 2 (Honors) or enrollment in Physics (Honors) as a third-year science course

Advanced Placement Physics (Grades 10 – 12)
Advanced Placement (AP) Physics 1 is an algebra-based, introductory college-level physics course. Students cultivate their understanding of physics through classroom study, in-class activity, and hands-on, inquiry-based laboratory work as they explore concepts like systems, fields, force interactions, change, conservation, and waves. Seniors who enroll in AP Physics 1 must continue in the course throughout Senior Spring Project.
Prerequisite: Algebra II and approval of the Science Department
Corequisite: Precalculus (Advanced) or higher level mathematics course
Recommended Prior Course: Algebra 2 (Honors)

Recommended Corequisite: Precalculus AB (Honors) or Precalculus BC (Honors)

Chemistry (Grades 10 – 12)
This course includes the standard college-preparatory material required for continued work in chemistry, biology, or pre-medical studies. Topics include the structure of atoms and molecules and principles of chemical reactions including energy, kinetics, equilibrium, and reactions between acids and bases. Laboratory work, observation, and data analysis are emphasized and used as a means of examining the scientific thought process. Strong math skills are essential. Recommended Prior Course: Algebra 2

Chemistry (Honors) (Grades 10 – 12)
Chemistry (Honors) includes the same topics as the Chemistry course but the pace is quicker and each subject is examined in greater depth. Strong math and science skills are essential. Enrollment can be limited.
Prerequisite: Algebra 2 and approval of the Science Department
Recommended Prior Course: Algebra 2 (Honors) or enrollment in Chemistry (Honors) as a third-year science course

Advanced Placement Chemistry (Grades 10 – 12)
Advanced Placement (AP) Chemistry is an introductory college-level chemistry course. Students cultivate their understanding of chemistry through inquiry-based lab investigations as they explore the four Big Ideas: scale, proportion, and quantity; structure and properties of substances; transformations; and energy. The AP Chemistry course provides students with a college-level foundation to support future advanced coursework in chemistry. Students cultivate their understanding of chemistry through inquiry-based investigations, as they explore content such as: atomic structure, intermolecular forces and bonding, chemical reactions, kinetics, thermodynamics, and equilibrium. The AP Chemistry course is designed to be the equivalent of the general chemistry course usually taken during the first college year. Seniors who enroll in AP Chemistry must continue in the course throughout Senior Spring Project.
Prerequisite: Algebra II and approval of the Science Department
Corequisite: Precalculus (Advanced) or higher level mathematics course
Recommended Prior Course: Algebra 2 (Honors)
Recommended Corequisite: Precalculus AB (Honors) or Precalculus BC (Honors)

SCIENCE ELECTIVES

Students who have completed the Science Department graduation requirement may request to enroll in one of the science electives described below. Science electives allow students to explore a topic of interest in depth with a continued emphasis on the development of critical thinking and scientific reasoning skills.

As schedules allow, juniors enrolled in science electives participate in an interdisciplinary study and project during the third trimester of the course. During these projects, juniors work collaboratively with students from other science electives and are taught by all science elective teachers. The regular course meeting block might be altered during the third trimester in order to allow students to work collaboratively with students from another elective, though changes will not affect the student's schedule in other courses. Students are expected to meet with the teacher and other student collaborators at least three times per week and have additional independent work to complete between class meetings.

Juniors and seniors enrolled in Engineering Principles and Practices, Infectious Diseases, Marine Ecology, or Scientific Ethics may complete the course at the Advanced level by maintaining a science portfolio and doing supplemental coursework during the first two trimesters.

Enrollment in the following courses is limited: Anatomy and Physiology (Advanced), AP Biology / Advanced Biology (Honors): Mechanisms of Biological Systems, AP Physics C: Mechanics, Biochemistry (Advanced), Current Topics and Research in Science and Technology (Honors), Engineering Principles and Practice (Advanced) / Engineering Principles and Practice, Environmental Studies (Advanced), Experimental Biology (Honors), Infectious Diseases (Advanced) / Infectious Diseases, Marine Ecology (Advanced) / Marine Ecology, Organic Chemistry (Honors), and Scientific Ethics (Advanced) / Scientific Ethics. Seniors are given priority for enrollment. A lottery may be used if a course is over-enrolled.

Anatomy and Physiology (Advanced) (Grades 11 – 12)
Anatomy and Physiology is a course in which lab work is used to study several major organs and organ systems of the body. The course covers cell, tissue, and organ structure with a focus on the muscular, circulatory, respiratory, and nervous systems. The interrelationships between various physiological systems are explored and applications related to clinical conditions are addressed, particularly in end-of-term projects. Field trips to local institutions, which in the past have included the Beth Israel Surgical Skills and Simulation Center and the Russell Museum of Medical Innovation, complement material discussed in class. Participation in dissection is a required part of this course.
Prerequisite: Biology

Advanced Placement Biology / Advanced Biology (Honors): Mechanisms of Biological Systems (Grades 11 – 12)
This course leverages the enduring understandings learned in introductory Biology to deeply explore a selection of topics from the Advanced Placement (AP) Biology curriculum. The course is divided roughly into thirds: evolution, cell biology, and genetics are discussed in the fall trimester; molecular and organismal biology in the second trimester; and animal behavior and ecology in the spring trimester. This course, when taken in conjunction with or following Experimental Biology (Honors) fully prepares students for the AP Biology exam. Seniors who enroll in AP Biology by taking this course in conjunction with or following Experimental Biology (Honors) must continue in the course throughout Senior Spring Project. Seniors who do not wish to remain enrolled in this course throughout Senior Spring Project must enroll in the Advanced Biology (Honors): Mechanisms of Biological Systems course.
Prerequisites: Biology, Chemistry, and approval of the Science Department
Recommended Prior Course: A yearlong chemistry course

Advanced Placement Physics C: Mechanics (Grades 11 – 12)
The focus of this course is on Newtonian Mechanics, which includes 1-D and 2-D kinematics, Newton's laws, work and energy, momentum, rotational motion, and oscillations and waves. Additional topics, including general and special relativity and electricity and magnetism, will be included, time permitting. Significant emphasis is placed on the development of strong lab skills, including error analysis and problem solving, both qualitatively and quantitatively. Because linear kinematics and dynamics form the foundation for much of this course, students must complete either Physics or Physics (Honors) before enrolling in this course.* Since trigonometry and calculus are used extensively throughout the year, a strong record in Precalculus is a prerequisite and Calculus (Advanced) is a corequisite.
Prerequisites: Physics or Physics (Honors) and Precalculus
Corequisite: Calculus (Advanced)
*With Departmental approval, this course can be a first-year physics course for juniors who have completed or are concurrently enrolled in Advanced Placement Calculus BC.

Biochemistry (Advanced) (Grades 11 – 12)
Biochemistry (Advanced) is an interdisciplinary science course designed to study topics in chemistry and biochemistry with the intention of applying those topics to modern scientific problems, such as the legality and ethics of the pharmaceutical industry, outbreaks of disease, and the effect of geography, culture, and nutrition on disorders throughout the world. The course includes a detailed review of key concepts from

biology and chemistry, specifically relating to living organisms, then delves into more complex topics such as pharmaceutical drug design, advanced metabolism, and modern techniques and equipment used for structure analysis of substances, such as spectrometry and crystallography. These topics are investigated through reading scientific journals and news articles, researching scientific concepts, and looking at medical case studies, both in the United States and throughout the world. The course culminates with an independent research project that investigates an issue in modern science, and includes a research paper and a presentation regarding findings.
Prerequisites: Biology and Chemistry
Recommended Prior Course: A yearlong chemistry course

Current Topics and Research in Science and Technology (Honors) (Grade 12)
This course is designed for students to explore topics in science and technology, both within and beyond BB&N, by critically reviewing current literature, understanding and presenting recent findings in science, visiting scientific destinations throughout the Greater Boston area, and undertaking an independent research project outside of BB&N during Senior Spring Project. The topics explored are both local and global in nature and are primarily chosen by the students. In past years, students have investigated the science and technology associated with drug development and discovery, proposed solutions to global medical emergencies or natural disasters, researched innovations in personalized medicine, and explored advances in robotic image-guided surgical techniques. Each topic is complimented by visiting local scientific institutions or videoconferencing with experts in the field. The course is taught in a blended format, where students meet synchronously during their regularly scheduled class time and asynchronously online to discuss and share their learning. As part of the course, students identify areas of scientific interest, develop their understanding of the topic, and work toward creating a symposium of current topics in science that is shared with the BB&N community in the winter. By the end of January, students are expected to establish a connection with a mentor outside of BB&N so they can undertake a research or technology related project during the spring trimester as part of their Senior Spring Project. Internships are typically 10 – 15 hours per week and students continue to share their learning in a blended format throughout this time.
Prerequisites: Successful completion of three years of science and approval of the Science Department.
Recommended co-requisite: Enrollment in a science elective at BB&N or through the Global Online Academy.

Engineering Principles and Practice (Advanced) / Engineering Principles and Practice (Grades 11 – 12)
Engineering Principles and Practice is a hands-on, project-based course that is designed for students who are interested in the applications of Engineering to current and evolving technologies. This course includes but is not limited to, the exploration of mechanical engineering, civil engineering, manufacturing engineering, electrical engineering, engineering ethics, and environmental engineering. Students become familiar with the design process and will be able to take an idea through the design, prototype, and build phases. Students learn by doing while receiving in-process support. They become creative problem-solvers as they overcome obstacles throughout the design-test-build process. Field trips to various manufacturing facilities complement classroom work and expose students to actual product realization. This course is based in math and science, but is designed for all students interested in learning more about the expanding field of engineering.
Prerequisites: Physics, Algebra 2, and Geometry
Recommended Prior Course: A yearlong physics course

Environmental Studies (Advanced) (Grades 11 – 12)
Learning Locally, Thinking Globally
In the early nineteenth century, German naturalist Alexander von Humboldt wrote, “In this great chain of causes and effects, no single fact can be considered in isolation.” Following Humboldt’s lead, this course combines science and history to consider the ways humans interact with the natural world. Units drawing

simultaneously from both disciplines emphasize systems thinking to examine how societies encounter the challenges of resource use, conservation and preservation, and population growth, from the twentieth century through present day. Through lenses ranging from local to global, this course examines how shifting perceptions of nature, facts, and values over time influence our choices. Field work and case studies enable students to utilize both scientific and historical thinking skills, gain practical tools for understanding the complexity of our world, and emerge with a contemporary understanding of ecology.
This is an interdisciplinary course offered through the Science Department and the History and Social Sciences Department. This course fulfills the Modern Global History requirement.
Prerequisite: Biology

Experimental Biology (Honors) (Grades 11 – 12)
This course includes many of the laboratory exercises and experiments normally contained in an introductory college biology course. The laboratory work is taken from widely used lab manuals and is correlated with reading assignments in the textbook used for the Advanced Placement (AP) Biology course. Students expand upon these topics by planning and executing their own experiments. Evaluation is based on lab work, including collaboratively designed and executed research projects presented using scientific posters, PowerPoint presentations, and lab reports. Additionally, there are lab-practical and written tests. This course, when taken in conjunction with or following Advanced Biology (Honors): Mechanisms of Biological Systems, fully prepares students to take the AP Biology exam.
Prerequisites: Biology, Chemistry, and approval of the Science Department
Recommended Prior Course: A yearlong chemistry course

Infectious Diseases (Advanced) / Infectious Diseases (Grades 11 – 12)
In this course, students are introduced to the epidemiology, clinical manifestations, immunity, diagnosis, and strategies for prevention and treatment of a variety of infectious diseases. They examine the social inequalities including systemic discrimination, economic status, and access to health care that can affect the severity of infection and influence the outcome for individuals and entire communities, both locally and globally. Although the key infectious diseases studied are HIV, malaria, and COVID-19, factors associated with other diseases (such as smallpox, SARS, Ebola, measles, cholera, tuberculosis, and influenza) are also addressed. The pathogenic microorganisms that cause these diseases, including bacteria, viruses, and parasitic eukaryotes, are also studied.

Marine Ecology (Advanced) / Marine Ecology (Grades 11 **–** 12)
Marine Ecology is designed for students who are interested in learning about the diverse marine environments, the biology of marine organisms, and the relationships between the ocean's inhabitants and their surroundings. Topics include: the ocean environment, the various ecosystems within and supporting the Earth's oceans, and the comparative physiology of the diverse species that inhabit the Earth's oceans. This course also affords students an opportunity to explore larger connections with a focus on global marine conservation issues. Field trips to local marine centers, which in the past have included the Northeastern University Marine Science Center and Woods Hole, as well as lab-based investigations and research projects, encourage the development of observational and research skills. The second trimester includes dissections as a method of studying marine life in a hands-on way.
Prerequisite: Biology

Organic Chemistry (Honors) (Grades 11 – 12)
This course is an advanced science elective designed to explore the fundamental concepts of organic chemistry and study how it has impacted and shaped modern society. The course focuses on material traditionally covered in first semester collegiate organic chemistry while providing students with an opportunity to further sharpen problem solving and critical thinking skills through the mastery of "orgo's" more conceptual approach to understanding matter. Students begin the year with an overview of organic molecular structure and isomerism before delving deep into organic reactions and mechanisms. Along the

way, students explore the history of the field and how synthetic organic chemistry is connected to and impacts a variety of modern topics, including clean energy initiatives, oral contraception, and cancer therapeutics. Students are given opportunities to research and present on organic chemistry's role in topics important to them through group projects and class discussions. The class culminates in a retrosynthetic analysis project, where students employ their acquired knowledge of chemical reactivity to design a synthetic approach to a complex organic molecule.
Prerequisites: Chemistry (Honors) (yearlong course), or a yearlong chemistry course with instructor approval

Physics 2 (Advanced)(Grades 11 – 12)
Having built a foundation in classical Newtonian physics, students are introduced to concepts on the frontiers of modern physics. Students cultivate their understanding of physics through classroom study, in-class activity, and hands-on, inquiry-based laboratory investigations as they explore these topics: fluids; thermodynamics; electricity, magnetism and electromagnetic induction; optics; geophysics, and quantum, atomic, and nuclear physics.
Prerequisites: Algebra 2 and either Physics, Physics (Honors), Advanced Placement Physics 1, or Advanced Placement Physics C: Mechanics.

Scientific Ethics (Advanced) / Scientific Ethics (Grades 11 – 12)
In an effort to further the mission of inspiring young scientists to "act ethically," this course explores how moral reasoning can be used to dictate choices in the scientific world, with a focus on both past and current issues. Through discussion, debates, labs, and other activities, students gain an overview of ethical theories before applying them to various scenarios of both instructor and student choice, while also gaining a stronger scientific background. Possible topics include those in bioethics, environmental ethics, nuclear ethics, and the ethics of technology. Throughout this course, students are challenged to reflect on their own reasoning as well as a variety of different perspectives, to utilize evidence and moral judgment to help shape opinions, to explain the "what" and the "why" of scientific beliefs, and to understand how an ethical view of science can help influence decision making on a national and global scale. In addition, this course develops students' ability to listen, especially to ideas different from their own, as well as students' understanding of the intersection of scientific ethics and equity in today's interconnected world.

Global Online Academy Courses: The following science courses are offered to students in Grades 11 and 12 through Global Online Academy:

- **Climate Change and Global Inequality** (Fall and Spring, History/Science Interdisciplinary Course)
- **Data Visualization** (Fall, Math/Science Interdisciplinary Course)
- **Global Health** (Fall)
- **Medical Problem Solving I** (Fall and Spring)
- **Medical Problem Solving II** (Fall and Spring)
- **Neuropsychology** (Fall and Spring)

For more information on these courses, please refer to the Global Online Academy section of this Program Planning Guide.

Courses Not Offered in 2023 – 2024

- Advanced Placement Physics C: Electricity and Magnetism / Advanced Physics: Electricity and Magnetism
- Biology (Honors)
- Environmental Science
- Forensics
- Principles of Chemistry