

SCIENCE

Our objective in the Science Department is to give students a better understanding of, and a deeper appreciation for, the natural world. We are confident that the insights they gain through their study of science will contribute to their lives in a variety of important ways: it will improve their skills in critical thinking and problem solving; it will inform their decision making about scientific issues; it will give them confidence and resources to tackle an array of global problems related to resources and technology; and ideally, it will enhance their enjoyment of nature's marvels and encourage them to pursue further study in those areas of science which most excite them. Through our varied curriculum we train students to think critically and communicate clearly about scientific topics, we encourage curiosity and experimentation, and we teach techniques and technologies that are most useful in scientific research.

The study of physical sciences (physics and chemistry) acquaints students with the laws governing the inanimate universe and promotes quantitative scientific thinking and problem-solving skills. The study of biology introduces students to principles that connect all life on our planet and gives an important perspective on the human species. Because we view both areas of learning as critical for students at the secondary school level, we require that all students take a full year of a physical science (either physics or chemistry) and a full year of biology. These courses include a rich laboratory program, as direct, hands-on experience with measurement and data analysis helps students become fully aware of the challenges, limitations, and the excitement of doing scientific research.

Although only two years of science are required, we strongly recommend that students take all three core science courses – physics, chemistry and biology – in that order. This sequence puts the most fundamental topics first, so that later courses can build upon central concepts taught in earlier ones. We work with students who enter Choate Rosemary Hall in the fourth, fifth, or sixth form year to place them appropriately into our science sequence.

Introductory (first-year) courses are offered at regular and honors levels in physics, chemistry, and biology, and laboratory work is an integral part of these courses. Honors courses are designed for students with particularly strong aptitude and interest, and entrance into these courses requires permission of the department. Elective courses are offered in each of these three areas as well as in geology and environmental science. These elective courses cover a wide variety of specific topics and run the gamut from year-long college-level courses to one-term introductory courses at regular, advanced, and honors levels. For sixth formers who wish to pursue intensive course work in one particular area and then devote themselves to a project of their choosing, the Capstone Program is available by application. For rising fifth formers who wish to involve themselves in serious, original scientific investigation, the Science Research Program and the Environmental Immersion Program provide an amazing opportunity. Viewed as a whole, the courses and opportunities available in the Science Department enable students to design programs with the balance, rigor, and depth appropriate for all levels of ability and interest.

– Benjamin Small, Department Head

Note: Students planning to study biology during a year when they will also participate in a Study Abroad Program should read the note at the beginning of the Biology course listing and consult the head of the Science Department if there are any questions.

THE PHYSICAL SCIENCES: PHYSICS

PHYSICS: MECHANICS TO WAVES

Year; 3 course credits

PH200

This introductory laboratory course introduces students to the fundamental principles that describe the physical universe. Mathematical equations are used to further students' understanding of relationships and physical laws. Regular lab exercises emphasize data collection, analysis, and hands-on experimentation. Topics include motion, forces, energy, waves, light, electricity, magnetism, and atomic physics. Problem sets are used throughout the year to supplement a largely conceptual textbook. Due to a difference in the sequence of topics, changes between PH200 and PH203 are not allowed after the second week of the fall term. Open to third and fourth form students who have completed Algebra I and have the permission of the department.

PHYSICS: WAVES TO MECHANICS

Year; 3 course credits

PH203

A parallel course to PH200, this introductory laboratory course is designed specifically for students who are not as far along in their algebra studies or who are not confident in their algebra skills. PH203 uses the same textbook and covers essentially the same topics as PH200, but in a different order. The fall and winter terms focus on the more conceptual topics of waves, light, electricity, magnetism, and atomic physics. The more quantitative topics of motion, forces, momentum, and energy are covered in the spring term, when students are further along in their mathematical study. Regular lab exercises emphasize hands-on experimentation and application. Due to a difference in the sequence of topics, changes between PH200 and PH203 are not allowed after the second week of the fall term. Both PH200 and PH203 prepare students to move on to CH300. Open to third and fourth form students who are enrolled in Algebra I or at the recommendation of the department.

PHYSICS, HONORS

Year; 3 course credits

PH250H0

This first-year laboratory course in physics is designed specifically for students with a keen interest in science and strong mathematical ability. The major areas of physics, such as motion, forces, energy, waves, light, electricity, magnetism, and nuclear reactions are explored. Regular lab exercises focus on data collection and analysis, experimentation, and real world applications. Open to third and fourth form students who have completed Algebra I and have the permission of the department.

PHYSICS

Three terms; 1 course credit (each term)
PH401 (Fall); PH402 (Winter); PH403 (Spring)

This laboratory course, taught as three consecutive term courses, is designed for students who enter Choate in their fifth or sixth form year. Taken sequentially, these courses cover a full-year of introductory physics. The emphasis of this sequence of courses is an investigation into the fundamental principles of physics and how they relate to the students' own real world experiences. Topics include motion, forces, energy, waves, light, electricity, magnetism, and nuclear physics. Open to fifth and sixth form students who have completed Algebra I and who have not previously taken introductory physics at a high school level.

Note: Students who have completed PH200, PH203, or PH250HO are ineligible for PH401, PH402, and PH403.

REVERSE ENGINEERING: HOW THINGS WORK

Spring term; 1 course credit
MD230

This course introduces students to general principles of product design and function and examines some of the engineered items all around us. Students learn to take apart various mechanical and electrical devices and examine how component parts work together. Engineering skills such as sketching, 3D modeling, prototyping, testing, and clear communication are emphasized. An introduction to microcontrollers and programming is included and students build several devices of their own design. Hands-on experimentation is emphasized and students learn to use some 3D modeling software (Google SketchUp), 3D printers, and Arduino microcontrollers. Third and fourth formers have priority enrollment for this course; fifth and sixth formers may enroll with permission of the department.

TOPICS IN ENGINEERING

Winter, Spring terms; 1 course credit
MD310

This introductory course is designed to provide students with an overview of some major engineering principles and applications, as well as an opportunity to implement those principles through experimentation, design-based projects, and presentations. Topics to be covered include graphical communication and drafting, basic material science, beam mechanics and deformation, and micro-engineering. The course will provide an interdisciplinary outlet for the mathematical skills and general scientific knowledge students have already acquired and also introduce new mathematical concepts to improve their understanding of how real-world systems are designed, modeled, and fabricated. Open to students who have completed one year of physics and Algebra II.

ASTRONOMY: THE SOLAR SYSTEM

Fall, Winter term; 1 course credit
PH320

This course is a descriptive study of the historical and modern developments in astronomy that pertain to the solar system. Topics studied emphasize the historical growth of modern astronomy, the observed characteristics of the planets (also the minor members of

the solar system), and the theories that account for them. Students have the opportunity to view the night sky with the School's telescopes. This course does not satisfy the physical science requirement. Open to all students.

ASTRONOMY: STARS AND GALAXIES

Winter, Spring term; 1 course credit
PH330

This course is a descriptive study of historical and modern developments in astronomy with particular emphasis on stellar and galactic astronomy. The observed characteristics of stars and galaxies, the basic types and functions of telescopes, and the theories and physical laws of stellar evolution and stellar groupings are investigated. Students have the opportunity to view the night sky with the School's telescopes. This course does not satisfy the physical science requirement. Open to all students.

ELECTRONICS

Winter term; 1 course credit
PH460AD

This laboratory course introduces students to both the principles and the techniques of electronics. Resistors, capacitors, inductors, diodes, transistors, and other electronic devices are investigated in the classroom and in the laboratory. Students develop their experimental skills with multimeters, breadboards, oscilloscopes, and soldering irons, and practice building and analyzing circuits. Each student finishes the course with a modest project of their own choosing. Open to students who have completed one year of physics.

ASTROPHYSICS, HONORS

Spring term; 1 course credit
PH480HO

The interrelation of the fundamental laws of physics and the behavior of the universe is examined in this laboratory course. More specifically, students investigate gravity, electromagnetism, nuclear reactions, light, and quantum mechanics and their relationship to such phenomena as orbits, stellar spectra, stellar energy generation, stellar evolution, galactic dynamics, the "Big Bang," and the evolution of the universe. Open to students who have completed one year of physics.

ADVANCED PHYSICS (TRIGONOMETRY), HONORS

Year; 3 course credits
PH550HO

This second-year laboratory course builds on the conceptual understanding attained in a first year physics course and provides a rigorous, trigonometry based study of fundamental principles and natural laws. Emphasis is placed on problem solving and experimentation. Topics include: motion and Newton's laws, (including angular and rotational topics), gravitation, momentum and energy, mechanical waves and sound, electromagnetic waves, and some electricity and magnetism topics. This course is designed for students who had a good experience with first-year physics but who are not yet ready for a calculus-based study. Open to students who have completed one year of physics and Algebra II, and have the permission of the department, and are at least concurrently enrolled in Precalculus.

ADVANCED PHYSICS (CALCULUS), HONORS

Year; 3 course credits
PH650HO

This advanced laboratory course provides a thorough, college-level, calculus-based study of introductory classical mechanics, electricity, and magnetism. Open to students who have completed Physics, have completed or are currently enrolled in Calculus with Infinite Series (MA561HO-MA564HO), and have permission of the department.

THE PHYSICAL SCIENCES: CHEMISTRY**CHEMISTRY**

Year; 3 course credits
CH300

This introductory laboratory course in inorganic chemistry explores fundamental principles of the discipline, including atomic theory, periodic law, chemical bonding, acid-base behavior, chemical equilibrium and electrochemistry. Laboratory experiments reinforce what students learn in the classroom and demonstrate principles of the scientific method and laboratory experimentation. Contemporary techniques for gathering and analyzing data are stressed as a means of obtaining evidence and verifying its reliability. By searching for regularities and patterns observed in the laboratory, students explore the behavior of many substances common to everyday life. Open to fourth, fifth, and sixth formers who have completed Algebra I.

CHEMISTRY, HONORS

Year; 3 course credits
CH350HO

For students with a keen interest in science and with strong quantitative ability, this first-year laboratory course explores the principles of inorganic chemistry, including atomic theory, stoichiometry, thermochemistry, chemical bonding, periodic law, acid-base behavior, kinetics, reaction equilibria, and electrochemistry. Students are involved in an intensive laboratory curriculum. Through experiments and lab-based projects students acquire extensive experience with computer-assisted monitoring and analysis of experimental data. Open to fourth, fifth, and sixth formers who have completed one year of physics and have the permission of the department.

CHEMISTRY OF FOOD

Spring term; 1 course credit
CH430AD

Have you ever wondered why chili peppers burn your tongue or what the difference is between saturated and unsaturated fats? What happens when bread rises, when eggs cook, or when a banana ripens? All of these involve structural chemical changes or chemical reactions. Students who enjoyed chemistry the first time around will benefit from the chance to explore these real applications of chemistry that are centrally important to our daily lives. In this course students study the components of food, explore commercial and home processing of food, and learn how food is transformed by various cooking techniques. Readings, tastings,

field-trips, and lab activities will be used to enhance student understanding of this vitally important part of life. Open to students who have completed one year of chemistry.

ADVANCED CHEMISTRY, HONORS

Year; 3 course credits
CH550HO

This rigorous study of chemistry digs deeper into topics covered in a first year chemistry course including: atomic theory, bonding, reactions, stoichiometry, equilibrium, thermodynamics, and kinetics. Many applications of chemistry are explored, with a goal of understanding current events and the environment. Extensive lab work is required, including several inquiry-based exercises. Students develop the ability to work collaboratively in the lab by designing and conducting several project-length experiments. Students also complete a research project or group project on a topic of their choosing during the spring term. Open to students who have completed one year of chemistry (CH300/CH350HO or equivalent), have completed Algebra II, and have the permission of the department.

ADVANCED TOPICS IN CHEMISTRY**ADVANCED INORGANIC CHEMISTRY I, HONORS**

Fall term; 1 course credit
CH651HO

This course provides a thorough study of advanced stoichiometry and equilibrium systems with a focus on laboratory analysis. Topics include advanced acid-base theory, solubility equilibria, and thermodynamics. Students spend several weeks synthesizing and analyzing a coordination compound. Open to students who have completed one year of chemistry (CH300/CH350HO or equivalent), have completed Algebra II, have strong analytical skills (quantitative and reasoning) and have the permission of the department.

ADVANCED ORGANIC CHEMISTRY, HONORS

Winter term; 1 course credit
CH652HO

A study of the molecular structure and behavior of carbon compounds, this laboratory course explores the basic molecular patterns of the large organic molecules which are critical to life on earth. Molecular bonding and structure are examined with an eye towards understanding the physical and chemical properties of organic molecules. Kinetics and synthetic pathways of elementary organic reactions are examined in and out of the laboratory. Extensive experimental work is an integral part of the course. Projects include the isolation of orange oil and the synthesis of a soap from nutmeg. This course is the second term of the three-term Advanced Topics in Chemistry sequence; however, it may also be taken by an interested student as a stand-alone course. Open to students who have completed one year of chemistry (CH300/CH350HO or equivalent), have completed Algebra II, have strong analytical skills (quantitative and reasoning) and have the permission of the department.

ADVANCED INORGANIC CHEMISTRY II, HONORS

Spring term; 1 course credit
CH653HO

Not offered in 2018-2019

Students complete a review of thermochemistry, thermodynamics, and electrochemistry. Students also undertake an individual or group research project in the spring term. Past projects have included preparation of biodiesel fuel from Dining Hall vegetable oil, poster projects of historically significant molecules, and design and presentation of unique chemical demonstrations. Open to students who have completed either: CH651HO or CH652HO and have the permission of the department.

THE BIOLOGICAL SCIENCES

A note for students participating in a Study Abroad Program who wish to take biology: *Students who wish to study abroad for a term generally are not able to sustain their study of biology during their term away from campus. The policies of the Science Department are intended to achieve a balance between supporting students who participate in a program abroad and maintaining the integrity of our courses and our requirements.*

Fall term away

A fifth form student who studies abroad during the fall term has two options:

1. The student can enroll in the BI401 / BI402 sequence upon returning to Choate. With permission of the department, a strong student in BI401 may fulfill the final term of the requirement by taking Cell and Molecular Biology, Honors (BI581HO) or Genetics, Honors (BI590HO) in the sixth form year. There is no honors-level equivalent to BI401 or BI402.

Note: Depending on enrollment, the BI401 / BI402 sequence does not always run.

2. A student who has the permission of the department and who does some independent work before winter term (under the guidance of the teacher) can join BI450HO for the winter and spring terms. This option must be planned well in advance of the student's term abroad. The student must complete the biology requirement with a one- or two-term elective in either biology or environmental science in the sixth form year.

Winter term away

A fifth form student who studies abroad during the winter term may take BI401 upon returning in the spring and BI402 in the fall of the sixth form year or could take the winter and spring terms of BI400 in the sixth form year.

Spring term away

A fifth form student who studies abroad during the spring term can take BI400 or BI450HO in the fall and winter before going away. The student fulfills the third term of the biology requirement in one of the following ways:

1. A BI400 student takes BI402 the following fall term or, with the permission of the department, may take either Cell and

Molecular Biology, Honors (BI581HO) or Genetics, Honors (BI590HO).

2. A BI450HO student must complete the requirement the following year with any one- or two-term laboratory-based elective in either biology or environmental science.

BIOLOGY

Year; 3 course credits

BI400

This introductory laboratory course explores fundamental topics of biology, ranging from cellular biochemistry to the study of ecosystems. An understanding is developed by investigating the flow of energy through biological systems, studying changes within populations due to evolution, reproduction and genetics, and by examining the ability of organisms to respond to their environment. Open to fifth and sixth formers who have completed physics and/or chemistry; open to fourth formers who have completed physics and/or chemistry, with permission of the department.

BIOLOGY

Three terms; 1 course credit each term

BI401 (Winter, Spring terms); BI402 (Fall term)

This two-term sequence, designed for fifth formers who go abroad for one term, is similar in content to BI400 but begins in the winter and is staggered behind BI400 by one term. Those who study abroad in the fall can begin the sequence in the winter; those who are abroad in the winter return to BI401 in the spring, and those who are abroad in the spring finish the sequence with BI402 in the fall of their sixth form year. Open to fifth and sixth formers who have completed physics and/or chemistry.

Note: The series is strictly for students who are off-campus for one term.

CURRENT TOPICS IN BIOLOGY

Winter term; 1 course credit

BI410AD

Newspapers, news reports, weekly magazines, best-selling books, and hit movies increasingly address current issues in biology: the ethics of genetics research; advances in reproductive technology; the controversy surrounding global warming; increasing bacterial resistance to antibiotics; the many uses and manipulations of DNA; HIV and AIDS incidence and research; the emergence of new diseases; and human impact on the environment, to name a few. This course draws on the current literature to study some of these important and interesting topics. The course stresses both individual and group work, with each student responsible for two significant projects during the term. Open to fifth and sixth formers who have completed or are currently enrolled in biology. *This course fulfills the requirement in contemporary global studies.*

BIOLOGY, HONORS

Year; 3 course credits

BI450HO

Designed for students with demonstrated interest and ability in science, this first-year laboratory course presents topics of basic biochemistry, cell structure and function, comparative anatomy

and physiology, genetics, and ecology. All of the subject matter is presented within the context of modern evolutionary theory and human interaction with the environment. Reading and discussion of current scientific literature are also an integral part of the course. Open to fifth and sixth formers who have completed physics and chemistry, and have the permission of the department.

Note: BI450HO is not open to students who have previously completed a year of high school biology.

ANIMAL EVOLUTION/COMPARATIVE PHYSIOLOGY

Spring term; 1 course credit

BI465AD

This laboratory course considers the great variety of complex organ systems and physical structures that have evolved in animals through natural selection. Students investigate adaptations and variations in the major animal phyla, including an examination of different approaches to reproduction, embryological development, gas exchange, excretion, and skeletal structure. The evolution of vertebrates from invertebrates provides structure to the course. The course ends with a look at the comparative physiology of vertebrates, which allows students to see the evolutionary relationship among the major vertebrate groups: fish, amphibians, reptiles, birds, and mammals. Extensive laboratory work is done, including the study of preserved specimens, and the dissection of representative invertebrates and vertebrates. Open to students who are currently enrolled in biology or have completed one year of biology.

HUMAN ANATOMY AND PHYSIOLOGY, HONORS

Fall and Winter terms; 2 course credits

BI570HO (Fall and Winter)

This two-term laboratory course begins with a microscopic study of tissues and then explores the structure and function of several of the major systems of the human body. Laboratory work includes a dissection of a cat, plus a study of other specimens. Reading and discussion of current scientific literature, especially in the areas of health and disease, are an integral part of the course. Open to students who have completed one year of biology.

ADVANCED TOPICS IN ANATOMY AND PHYSIOLOGY, HONORS

Spring term; 1 course credit

BI575HO

This one-term laboratory course expands on the study of human anatomy and physiology begun in BI570HO. Students move into more complex topics such as immunity and the body's defensive systems, human reproduction, embryology, growth, and development. In addition to a body systems study, students will look further into diseases and modern treatments. Open to students who have completed BI570HO or have the permission of the department.

COGNITIVE NEUROSCIENCE, HONORS

Winter, Spring terms; 1 course credit

MD330HO

One of the fastest growing research areas in science is neuroscience. Cognitive and behavioral studies have attracted considerable popular and scientific attention in recent years and new techniques have opened up novel avenues for exploration. This

course provides an introduction to the cellular and molecular mechanisms of neuronal function, and examines how cognitive processes can be explained by the structure and function of the brain. Beyond foundational knowledge and empirical methodology in neuroscience, this class also explores data from current studies in neurobiology and cognitive sciences. Open to fifth and sixth formers who have completed Anatomy and Physiology or Introduction to Psychology.

CELL AND MOLECULAR BIOLOGY, HONORS

Winter and Spring terms; 2 course credits

BI581HO

The bedrock of disciplines ranging from medicine to bioengineering, modern molecular biology is the study of how genes in a cell guide the production of biomolecules needed for life. In this laboratory based course, students explore how molecular biology can be harnessed to understand the nature of disease, produce targeted therapies, and engineer new biotechnologies. Students gain hands on experience in modern experimental techniques including DNA and protein analysis, and genetic engineering, apply their knowledge of molecular biology to read primary scientific literature and complete a long-term project. Open to fifth and sixth formers who have completed one year of biology.

GENETICS, HONORS

Spring term; 1 course credit

BI590HO

Not offered in 2018-2019

The discovery that DNA is the blueprint for life was one of the great scientific advancements of the 20th century. Since then, improvements in DNA sequencing and analysis have revolutionized the field of genetics and opened the door to advances in both science and medicine. This course explores advances in genomic research, as well as the personal and societal risks that come with whole genome sequencing and genetic engineering. Additionally, students explore the interplay of genes and environment through non-Mendelian modes of inheritance. This course uses laboratory, seminar, and project-based methods. Open to fifth and sixth formers who have completed one year of biology.

THE ENVIRONMENTAL SCIENCES

GLOBAL SCIENTIFIC ISSUES: SEARCHING FOR SOLUTIONS

Spring term; 1 course credit

ES220

This course examines various scientific problems confronting the human species on our fragile planet and also looks at ideas for combating these problems. What sources of energy will best serve humankind in the future, while doing the least harm? How can we best employ water, for personal use and irrigation, without leading to health problems and soil degradation? What are the causes and effects of global warming, and how can the earth's temperatures be stabilized? What measures have proven effective, and what innovations may be employed in the future, in controlling AIDS, malaria and possible pandemics? How will the growing populations of the world obtain adequate nutrition and shelter? These

questions call upon students to consider various viewpoints as they seek ways to achieve sustainability for the human species. The course includes oral presentations or debates as well as writing and assessments. Open to third and fourth formers. *This course fulfills the contemporary global studies requirement.*

THE GEOLOGY SEQUENCE:

ES310, ES320 and ES330 introduce students to the dynamic processes and materials that are involved in the formation and ongoing remodeling of our planet. Open to all students.

THE DYNAMIC EARTH

Fall term; 1 course credit
ES310

This course examines the structures of the Earth and the mechanisms by which our planet evolves. Plate tectonics and the heat engine that is the earth's core are explored. Students also study earthquakes and volcanoes to understand these processes and their effects on our planet and on the human population. Open to all students.

THE EARTH'S MATERIALS

Winter term; 1 course credit
ES320

Minerals, rock types (igneous, sedimentary, metamorphic), and the rock cycle are studied in this course. Students examine the valuable geologic resources (fossil fuels, gems, precious metals) required by humans and look at the global impact of the exploitation of those resources. Open to all students.

THE EARTH'S LANDSCAPES

Spring term; 1 course credit
ES330

Students explore the geologic processes that have given rise to the physical geography of the planet's surface, answering the question—why does the Earth look as it does? Mountain belts, the ocean floor, and glaciers are studied as dynamic processes at work on the Earth's surface. Open to all students.

MARINE SCIENCE

All terms; 1 course credit
ES460AD

Combining a study of the biological, physical, and chemical aspects of the marine environment, this course stresses interrelationships and therefore focuses on specific ecosystems, including coastlines, estuaries, marshes, coral reefs, and the open ocean. A field trip provides opportunity to learn analytical techniques and to study the distribution of organisms. Open to fifth and sixth formers who have completed at least one year of a laboratory science.

ENVIRONMENTAL SCIENCE, HONORS

Fall and Winter terms; 2 course credits
ES550HO

This two-term laboratory course introduces the scientific principles underlying environmental processes and students develop the analytical skills required to evaluate various forms of evidence

in environmental study. Because appreciating environmental issues requires synthesizing scientific and social perspectives, this course provides a background in Earth's biological, geological and chemical systems and explores major environmental issues from historical, political, economic, and ethical viewpoints. Major course topics include population biology, biome ecology, energy flow and geochemical cycles, climate, pollution, biodiversity and resource use. Open to fifth and sixth formers who have completed (or are currently enrolled in) one year of chemistry and one year of biology, or have the permission of the department.

ADVANCED TOPICS IN ENVIRONMENTAL SCIENCE, HONORS

Spring term; 1 course credit
ES555HO

This laboratory course allows students to delve further into the study of select major environmental issues, begun in ES550HO. Topics may include global warming, recycling of materials, air pollution, drinking water, and various environmental toxins. Supplementing classwork are field studies and trips that emphasize a hands-on, interdisciplinary approach to environmental assessment. Experiencing and understanding the plant and animal life common to New England fields and forests, students spend much of the spring also studying the re-emergence of life near Choate's campus. Open to students who have completed ES550HO or have the permission of the department.

THE SCIENCE RESEARCH PROGRAM

The purpose of this program is to teach students the techniques and approaches used by professional scientific researchers as they carry out scientific investigations in the laboratory and in the field. The program consists of four consecutive term courses, beginning in the fall of the fifth form year and extending through the fall of the sixth form year, and includes a required summer component (between fifth form and sixth form years) during which students work as an intern and participate in supervised laboratory research. There are two sections of this program, one with a more biological focus and a second with a focus in the physical sciences. Students who wish to be considered for the program must submit an application in the winter of their fourth form year. Each section consists of eight students, who are selected based on their academic abilities and their potential to contribute successfully to the program.

THE COURSES

The goal of the on-campus course work is to teach students about various aspects of scientific investigation including research, experimental design, data collection, and data analysis, and to prepare them for their work in a research lab over the summer. Entry into the fifth form fall course is by application to the program only. All other courses have as a prerequisite the preceding course in the sequence.

EXPERIMENTAL DESIGN, HONORS

Fall term; 1 course credit
SR510HO

The focus of this laboratory course is developing experimental

methods. In the biological science-focused section, students gain hands-on experience with modern experimental techniques including DNA and protein analysis, as well as genetic engineering. In the physical science-focused section, students expand their knowledge of sensor technology, indirect measurement techniques, quantitative analysis, and data presentation through a series of intensive research projects and labs. In both sections, formal literature searches are carried out to support each experiment or project. Thus, significant time is spent mastering the use of database/search engines as well as reading through professional literature. Students also work on developing their presentation skills and begin the process of finding a summer mentor. Open to fifth formers by application in the winter of the fourth form year.

RESEARCH SEMINAR I, HONORS

Winter term; 1 course credit
SR520HO

The focus of this laboratory course is reading professional literature and formally presenting the work of professional scientists. The underlying goal is for students to learn how to critically read complex scientific literature, make scientific presentations, and assess others' presentations. Students learn how to use PowerPoint effectively and hone their presentation skills. The process of absorbing the literature and giving presentations also guides students towards the winter goal of securing summer positions in scientific laboratories. By developing a solid understanding of the current research in a particular area, students put themselves in a strong position to discuss the possibility of summer work with scientists investigating that topic. By the end of the term, students ideally should have secured a summer laboratory position. Open to fifth formers who have completed SR510HO.

PROTOCOL DEVELOPMENT, HONORS

Spring term; 1 course credit
SR530HO

The focus of the spring is preparing for the upcoming summer research. Securing a mentor at the beginning of the term is critical. Students then run a journal club based on an article written by their summer mentor and write a review article of the work done by their mentor and others in their field of research. The review article is a significant document that should not only prepare the student for the work they will complete in the summer, but also allow them to polish their scientific writing skills. Open to fifth formers who have completed SR520HO.

SUMMER RESEARCH

Having prepared fully for the experience, during the summer the student works full time in a laboratory setting under the guidance of their mentor scientist. Students must remain in contact with their SRP director at Choate during this summer research experience. As dictated by school policy, students do not get academic credit for this summer research and it does not count as a course on their transcripts. However, because this research is a required component of SRP, it is acknowledged in their college paperwork.

Note: As with all summer study undertaken by Choate students, any incurred costs are not covered by academic year tuition and fees. However, need-based financial assistance may be available to students who otherwise could not fulfill this component of the SRP.

RESEARCH SEMINAR II, HONORS: STUDENT-GENERATED TOPICS

Fall term; 1 course credit
SR600HO

The focus of the final term and the culmination of the program are a paper, oral presentation, and professional poster. The paper is a manuscript in the format of a publishable scientific work. The presentation is made in late fall to a large audience of interested members of the greater Choate Rosemary Hall community. The poster is of the quality one would find at professional scientific meetings, and will be placed on display in the Science Center. (The paper, presentation, and poster may help the student prepare for a local or nationwide competition, but the student would need to identify this goal early on in the program, as the timeline of some competitions requires paperwork to be filed well in advance of actual research. Additionally, the mentor would have to support this goal and the research would have to be worthy of submission. This is not a required aspect of the program.) In this final term of the program, sixth formers are encouraged to mentor the new fifth form students in all aspects of SRP. Open to sixth formers who have completed SR530HO and approved summer research.

THE CAPSTONE PROGRAM IN SCIENCE

Students who wish to pursue coursework on a focused topic and then undertake a project on that topic can devise a Capstone Program, in consultation with a teacher and the department head. Recent Capstone projects in science have investigated such diverse topics as chaos theory as applied to turbulence, diet physiology, Krebs cycle biochemistry, and the geology and chemistry of Mars.

DIRECTED STUDY IN SCIENCE

Advanced students who have been inspired by their work in a course and wish to study a particular topic in a depth beyond what is covered in our current curriculum may apply for a Directed Study in science. Students should speak with their current science teachers and/or the science department head early in the process of course selection, ideally with an idea of the directed study proposal they have in mind.