



# 2021-2022

## **COURSE CATALOG**

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# SCIENCE



## COURSE OFFERINGS: SCIENCE

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### GENERAL INFORMATION

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The Science Department at Springside Chestnut Hill Academy provides a rigorous, challenging, and exciting program for all students during each year in Upper School. Courses provide students with opportunities for using the most up-to-date equipment and technologies as they ask questions, design experiments, explore, collaborate, and become efficient and effective problem solvers. Students utilize a variety of sources, such as textbooks, primary sources, computer probes, image processing software, and Internet resources, that allow them to access the same information as “real scientists,” including real-time data, in critically analyzing and explaining scientific principles and phenomena. Students use 21st century skills as they effectively synthesize information and creatively present what they have learned from their problem and challenge-based projects. Many of the course materials and activities are designed and/or assembled by the SCH Science Department in order to enhance and supplement available materials. Teachers are guided by the Next Generation Science Standards, PA Science Standards, the National Science Teachers’ Association, and local curricular materials.

Our science courses are not geared to any specific standardized tests. The basic courses in physics, chemistry, and biology provide an excellent general background in the discipline along with other valuable experiences. Students wishing to take the SAT Subject tests in any discipline are encouraged to do additional, specific preparation for that test. AP courses are taught to the specific AP curriculum and will prepare the students for the AP examinations.

Electives in the 10th, 11th, and 12th grades that are offered on a semester basis may be selected separately.

### PHYSICS

*Grade 9; required; full-year course; 1 credit*

Students in Physics learn to ask their own questions about a topic and how to go about solving that problem using an active, laboratory-based approach to the understanding of matter and energy and the laws that govern their interactions. Students explore and learn physical concepts and ideas through experimentation and observation, often with the aid of computer-based lab interface equipment. Students frequently work in teams applying engineering design principles and problem-solving skills to design, build, and experiment.

Many units culminate in a design-based, real-world challenge project. Importantly, students apply their developing math skills to solve algebraic equations related to each principle covered. Where applicable, new math techniques will be introduced to assist in deeper understanding of concepts. The course is also designed to develop an appreciation for physics as it applies to everyday life.

## **HONORS PHYSICS**

*Grade 9; full-year course; 1 credit*

*Prerequisite: Departmental approval*

Students in Honors Physics learn to ask their own questions about a topic and how to go about solving that problem, using an active, laboratory-based approach to the understanding of matter and energy and the laws that govern their interactions. Problem solving and analysis are emphasized, but the course is also designed to develop an appreciation for physics as it applies to everyday life. Students explore and learn physical concepts and ideas through experimentation and observation, often with the aid of computer-based lab interface equipment. Students learn to ask their own questions about a topic and how to go about solving that problem. Students frequently work in teams applying engineering design principles and problem-solving skills to design, build, and experiment. Many units culminate in a design-based, real-world challenge project. Importantly, students apply their developing math skills to solve algebraic equations related to each principle covered. Where applicable, new math techniques will be introduced to assist in deeper understanding of concepts. All students design and complete an independent research project, which they will enter in the PJAS (Pennsylvania Junior Academy of Science) competition.

## **CHEMISTRY**

*Grade 10; required; full-year course; 1 credit*

This course provides a background in basic chemical concepts while enabling students to use their chemical knowledge to explore some of today's relevant problems and make informed decisions about personal and societal issues. It places less emphasis on the mathematical and analytical aspects of abstract problem solving than Honors Chemistry. It covers a wide sampling of the range of modern chemistry, including inorganic, organic, environmental, industrial, and biochemistry. It will provide an introduction to the experimental study of chemistry and the theoretical concepts of structure, bonding, energy, and reactions. The course stresses laboratory skills including observing, looking for regularities, collecting data, developing conclusions, and using standard laboratory equipment.

## **HONORS CHEMISTRY**

*Grade 10; full-year course; 1 credit*

*Prerequisite: Departmental approval*

This Honors course is geared to students with strong mathematical and analytical skills. The course provides an introduction to the experimental study of chemistry and the theoretical concepts of structure, bonding, energy, and reactions in a more traditional format. Topics include atomic theory, chemical reactions, solutions, kinetics, thermodynamics, equilibrium, and electrochemistry. Laboratory skills are stressed. These include observing, looking for regularities, collecting data, developing conclusions, and using standard laboratory equipment. Students in Honors Chemistry cover topics in more depth, move at a faster rate, and research and design a long-term, independent, experimental research project, which is entered in the PJAS (Pennsylvania Junior Academy of Science) competition. Students are selected into the Honors Chemistry section by the Science Department based upon their achievement in 9th grade Physics, their achievement in math, and their successfully meeting the criteria outlined in Criteria for Placement in Honors Science in Upper School.

## **BIOLOGY**

*Grade 11; required; full-year course; 1 credit*

This course introduces students to the fundamental topics in biology as well as those on the cutting edge of science, providing a solid background, the most current information, and personal relevance to the student. This course builds upon the major concepts introduced in Physics and Chemistry. Students learn to gather and critically analyze information from many resources, including web-based bioinformatics, scientific journals, and their own peers. Topics covered include environmental science; biochemistry; cell biology; energy flow; animal and plant reproduction and development; molecular, classical, and human genetics; biotechnology, including genetic engineering and gene therapy; evolution and taxonomy; and how the body fights disease, including a unique exploration of HIV/AIDS in conjunction with their reading of *Angels in America* in their English class. Students design, investigate, and analyze many of their own experiments using college-level equipment, including micropipettes, electronic balances, microscopes with digital cameras, and microcentrifuges. Project-based units, including designing public service announcements to help specific target groups reduce their chance of developing cancer, highlight our 21st century approach to biology education. The surrounding Wissahickon natural area provides local, tangible examples to enhance and clarify concepts that are often abstract or global in their nature.

## **HONORS BIOLOGY**

*Grade 11; full-year course; 1 credit*

*Prerequisite: Departmental approval*

This Honors course introduces students to the fundamental topics in biology as well as those on the cutting edge of science, providing a solid background, the most current information, and personal relevance to the student. This course builds upon the major concepts introduced in Physics and Chemistry. Students learn to gather and critically analyze information from many resources, including web-based bioinformatics sites,



scientific journals, and their own peers. Topics covered include environmental science; biochemistry; cell biology; energy flow; animal and plant reproduction and development; molecular, classical, and human genetics; biotechnology, including genetic engineering and PCR; evolution and taxonomy; and how the body fights disease, including a unique exploration of HIV/AIDS in conjunction with their reading of *Angels in America* in their English class. Students design, investigate, and analyze many of their own experiments using college-level equipment, including micropipettes, electronic balances, microscopes with digital cameras, and microcentrifuges. Project-based units, including designing fliers that provide other students with “healthy” eating options at fast food and chain restaurants, highlight our 21st century approach to biology education. The surrounding Wissahickon natural area provides local, tangible examples to enhance and clarify concepts that are often abstract or global in their nature. Students in Honors Biology cover topics in more depth, move at a faster rate, and research and design a long-term, independent, experimental research project, which is entered in the local George Washington Carver Science Fair and the regional Delaware Valley Science Fair. Students are selected into the Honors Biology section by the Science Department based upon their achievement in 10th grade Chemistry, along with successfully meeting criteria outlined in Criteria for Placement in Honors Science in Upper School.

## **ENVIRONMENTAL SCIENCE**

*Grades 10–12; elective; fall semester; ½ credit*

This one-semester course focuses on human ecology (humans and ecosystems); the human population and global problems; pollution, with special emphasis on local environmental concerns; and the politics, economics, and ethics surrounding society and environmental issues. Lab activities will include extensive fieldwork in the Wissahickon natural areas around the school, such as calculating the amount of carbon dioxide SCH campus trees sequester annually; identifying and researching local medicinal plants; and conducting monthly assays of biodiversity around school and at home to observe how the world around us changes with the seasons. Students will analyze food labels to discover ways that everyday product choices affect endangered species and the rest of the world. The class will have visits from beekeepers, local farmers that supply produce for the school, and a vermiculturist (worm and composting expert).

## **OCEANOGRAPHY**

*Grades 10–12; elective; fall semester; ½ credit*

Oceanography is an interdisciplinary science course that asks students to explore the physical, biological, and societal aspects of the ocean and the hydrosphere. Topics will include interactions between the biosphere, atmosphere, and lithosphere in the world’s oceans; marine geology and sediments; salinity and other aspects of ocean water chemistry; currents and other methods of ocean water circulation; waves and water dynamics; coastal processes; causes and effects of tides; marine biology, biodiversity, and sustainability; ecology of oceans; and the impact of humans. The majority of the students’

class time will be used for inquiry-based activities, while class lectures (in the form of podcasts) and readings will be reserved as homework. As part of their coastal processes unit, the class will take a full-day field trip to Island Beach State Park in Seaside Heights, New Jersey. Using resources from The Blue Ocean Institute and Whole Foods we will learn where the fish that we eat comes from, and how we can make choices as consumers that will promote sustainable fisheries and healthier ocean habitats. The unit will culminate with a sustainable fresh fish feast!

## **FORENSIC SCIENCE**

*Grades 10–12; elective; spring semester; ½ credit*

This interdisciplinary course deals with the application of the scientific principles of biology, chemistry, and physics in evaluating the physical evidence found at crime scenes. Topics will include drug testing; blood, fingerprint, and document analysis; arson and explosives; firearm identification; DNA profiling; forensic anthropology and autopsies; forensic technology and encryption; and forensic engineering. Students will explore how investigators use instrumentation such as spectrophotometers, gel electrophoresis, acoustical fingerprinting, and image processing to solve crimes. The course will make extensive use of database searches and “wet” labs in order to gain firsthand experience analyzing simulated samples of physical evidence. Extensive connections are made to real-life case studies, including historical cases like the analysis and identification of the remains of Czarina Anastasia Romanov and the kidnapping of the Lindbergh baby. Contemporary case studies are highlighted by the forensic experts who visit the course. These have included an anthropologist, an arson investigation specialist from the Philadelphia Police Department, a forensic toxicologist, and an FBI special agent.

## **AP BIOLOGY**

*Grades 11, 12; elective; full-year course; 1 credit*

*Prerequisites: Biology, Chemistry, and departmental approval*

The Advanced Placement Biology course is the equivalent of a first-year college biology course and is geared toward students with a particular interest in biology and who have demonstrated a willingness and ability to commit considerable time to studying and completing assignments outside of class. The goals of the course include helping students gain a conceptual framework for modern biology, helping students gain an appreciation of science as a process, and helping prepare students for the rigors of a college-level science course. These are accomplished through extensive text and journal readings; using web-based databases, bioinformatics tools and simulations; and student-designed laboratory investigations, utilizing the most up-to-date techniques and technologies. Students are expected to study beyond what they would for a typical course each night and attend extra sessions outside of class time several times each semester. The content of the

course is divided into four big ideas: Evolution; Energetics; Information Storage and Transmission; and Systems Interactions. Given the speed with which scientific discoveries and research continuously expand scientific knowledge, this course focuses on big ideas, consisting of enduring, conceptual understandings and the content that supports them. This enables students to spend less time on factual recall and more time on inquiry-based learning of essential concepts that will help them develop the reasoning skills necessary to engage in the science practices used throughout their study of AP Biology and advanced topics in subsequent college courses.

Students must complete approximately six hours of summer work in order to be adequately prepared to start the year with a solid knowledge of ecology. Students will be required to take and satisfactorily complete a cumulative examination at the end of the course that simulates the AP examination. Students are also strongly encouraged to take the national Advanced Placement examination in AP Biology.

## **AP CHEMISTRY**

*Grades 11, 12; elective; full-year course; 1 credit*

*Prerequisite: Chemistry Honors and departmental approval*

This course covers the equivalent of one full year of college-level general chemistry, comparable to a first-year science major's course at a college or university. The course is a rigorous math-based course, with a strong laboratory component. It is intended for students who have demonstrated a willingness to commit considerable time to studying and completing assignments outside of class, and who have successfully completed a prior course in chemistry during high school.

The course will develop the students' ability to incorporate mathematical skills in the solution of chemistry problems, both through the use of problems and laboratory activities. Significant emphasis will be placed on developing the students' ability to solve problems through dimensional analysis and estimation. Students will be required to do extensive writing and to keep a thorough and accurate ongoing laboratory notebook. The AP Chemistry course provides students with a foundation to support future advanced coursework in chemistry. Through inquiry-based learning, students develop critical-thinking and reasoning skills. Students cultivate their understanding of chemistry and science practices as they explore topics such as atomic structure, intermolecular forces and bonding, chemical reactions, kinetics, thermodynamics, and equilibrium.

Students must complete approximately six hours of summer work in order to be adequately prepared to start the year with a solid knowledge of basic chemistry. Students will be required to take and satisfactorily complete a cumulative examination at the end of the course that simulates the AP examination. Students are also strongly encouraged to take the national Advanced Placement examination in AP Chemistry.

## **AP PHYSICS**

*Grade 12; elective; full-year course; 1 credit*

*Prerequisites: Physics and Calculus taken concurrently and departmental approval*

This course is designed to prepare the student for the AP Physics C-level Advanced Placement examination in mechanics. It will cover thoroughly one half of the C-level syllabus, omitting the electricity and magnetism portion. The C-level program forms the first part of the college sequence that serves as the foundation in physics for students majoring in the physical sciences or engineering. Methods of calculus are used wherever appropriate in formulating physical principles and in applying them to physical problems. Topics covered in mechanics are kinematics; Newton's laws of motion (including friction and centripetal force); work, energy, and power; linear and angular momentum; and gravitation and oscillations. Laboratory work will be done to assist in understanding the concepts of mechanics being studied.

Students must complete approximately six hours of summer work in order to be adequately prepared to start the year with a solid knowledge of basic Physics. Students will be required to take and satisfactorily complete a cumulative examination at the end of the course that simulates the AP examination. Students are also strongly encouraged to take the national Advanced Placement examination in AP Physics, C-level.

## **HONORS CHEMISTRY 2**

*Grades 11, 12; elective; full-year course; 1 credit*

*Prerequisites: Honors Chemistry or Chemistry (with a A or better) and departmental approval*

This yearlong course will deepen your understanding of inorganic chemistry and also explore topics in organic chemistry and biochemistry. Among the themes to be studied in class are nuclear chemistry, intermolecular forces, polymers, acid and bases, reaction rates and equilibrium and redox reactions. These topics are covered as stand alone units or incorporated in the study of food chemistry and food safety, forensic chemistry including toxicology and environmental chemistry. Laboratory investigations explore the use of instrumentation to collect data in chemistry, including visible light spectrophotometers, gas chromatography, and polarimeters. During the spring semester, Chemistry 2 students have the opportunity to become teachers during a collaborative chemistry-based project with SCH's Middle and Lower School students. This project involves the development of multimedia lessons shared with the younger students. Classes in Chemistry 2 are highly discussion-based, and the laboratory portion will introduce techniques used in college-level courses.

## **HUMAN PHYSIOLOGY**

*Grades 11, 12; elective; full-year course; 1 credit*

*Prerequisite: Biology*

This course investigates the function and structure of the human body, in both health and disease. Students are exposed to the intricacies of their bodies at the molecular, cellular, and systems levels. In addition, the study of sports medicine, exercise physiology, and mind-body



connections highlights the interdependence and adaptability of all body systems. Laboratory experiments designed and investigated by students provide them with a solid understanding of how their body functions and responds to its environment. Extensive use of computer-based probes helps students explore their own muscle grip strength and fatigue rate, EKGs, heart rate, and respiratory rate. Students are able to visualize and measure the inner workings of the human body using National Institutes of Health image-processing software. Current issues related to health and medicine, such as organ donation, drug addiction, performance enhancing drugs, and health care, are researched and discussed.

## **PHARMACOLOGY**

*Grades 11, 12; elective; fall semester; ½ credit*

In this semester-long course, students develop an understanding of drugs as preventive, diagnostic, and therapeutic agents. Topics include the mechanism of action, side effects, drug interactions, and contraindications of a wide spectrum of drugs used in primary care practice. Lab investigations include the analysis of aspirin formulations; the effects of drugs on worm blood vessel size; and the examination of the effects of alcohol on fruit fly behavior. Other topics include an introduction to neuroscience emphasizing the molecular organization, chemistry, and physiology of the neuron, how neurons are organized into functional circuits, and how these functional circuits process information and control both normal and abnormal behavior. Students will also explore the biochemical and genetic basis of drug addiction and brain disorders, such as autism, depression, schizophrenia, and Parkinson's disease. Field trips include a visit to the Pennsylvania Hospital to see the first operating room in America, and to learn about the practice of medicine in the 18th and 19th centuries. Students also visit the Mütter Museum to learn how reference collections of different diseases and injuries continue to help physicians today.

## **H PHYSICS 2: ASTROPHYSICS**

*Grades 11, 12; grade 10 with departmental approval; elective; spring semester; ½ credit*

*Prerequisite: B in Honors Physics or A in Physics*

This semester-long course explores our universe by surveying introductory astronomy and astrophysics. The course is designed to engage students in the scientific process while fostering an appreciation for the majesty of our universe. Students will delve into the history of astronomy, size and scale of the universe, and observation and data collection techniques. Topics will include stars, planets, black holes, galaxies, orbital mechanics, and modern astrophysics and cosmology. The class will also include computer simulations, hands-on laboratory investigations, scientific debates, and independent research. To supplement our in-class learning, the course will have an observation component that will take place during evening observation sessions.

## **H PHYSICS 2: EXPLORATIONS IN PHYSICS**

*Grades 11, 12; grade 10 with departmental approval; elective; fall semester; ½ credit*

*Prerequisite: Physics*

Physics is all about looking at the world around us and asking questions. This semester-long course explores a handful of especially relevant physics topics in an in-depth, hands-on, inquiry-based fashion. Here's a brief summary of some of the questions we'll attempt to answer during this course: How does an airplane stay up in the air? Why does my microwave heat unevenly, and is it really bad to put metal in it? I love my cell phone so much and use it all day, every day... how exactly does it work? What changes can nanotechnology bring to everyday life and society? Along the way, we might make pinhole cameras that really work, build our own mini-radio stations, sink model boats and then rescue them using only ping pong balls, or conduct sports science research for the athletic department.

## **PSYCHOLOGY**

*Grades 11, 12; elective; spring semester; ½ credit*

Psychology introduces students to the systematic and scientific study of human behavior and mental processes. While considering the psychologists and studies that have shaped the field, students explore and apply psychological theories, key concepts, and phenomena associated with such topics as the biological bases of behavior, sensation and perception, learning and cognition, motivation, developmental psychology, testing and individual differences, treatment of abnormal behavior, and social psychology. Throughout the course, students employ psychological research methods, including ethical considerations, as they use the scientific method, analyze bias, evaluate claims and evidence, and effectively communicate ideas.

## **ZOOLOGY**

*Grades 11, 12; elective; spring semester; ½ credit*

Students will learn what makes animals, *animals*—from microzoology to blue whales, and almost everything in between! Labs include comparative dissections, investigating animal adaptations using simulations and board games, and observing native resident animals in the temperate deciduous forest surrounding SCH. Students will quantify how similar humans are to other species by utilizing comparative gene and protein databases operated by working scientists. This course culminates in a “behind the scenes” field trip to the Philadelphia Zoo and a comparative analysis of animal behavior.

## **INDEPENDENT RESEARCH FOR SCIENCE COMPETITIONS**

*Grades 9-12; elective; full-year course; ½ credit (meets 3 out of 6 days per cycle)*

*Prerequisite: Departmental approval*

This rigorous, independent study allows students to refine and enhance their scientific research abilities, while developing a project to be submitted to local and/or national science competitions. These include the George Washington Carver Science Fair, the PA Junior Academy of Sciences (PJAS) science competition, the International Science and Engineering Fair, and the Westinghouse Science Talent Search. Students will become proficient in the use of complex laboratory equipment, statistical analysis, and proper

research techniques. Students are expected to meet the challenge of formal guidelines and deadlines, perform in-depth research, and design and implement sophisticated laboratory procedures. Students may be required to complete some of their work in research facilities outside of school. Projects must be individually designed and proposed by the student and approved by a Science Department faculty member.