

Science

Requirements:

Biology (SCI 210)

Chemistry (SCI 220) or Physics (SCI 311) or Physics Honors (SCI 312H)

Elective Courses Offered in 2020-21:

300-level

- Selected Topics in Physics (SCI 310)
- Physics (SCI 311)
- Physics Honors (SCI 312H)
- Biotechnology (SCI 320)
- Human Anatomy and Physiology (SCI 321)
- Experiments in Physics and Chemistry (SCI 322)
- Science Research 1 (SCI 323)

400-level

- AP Biology (SCI 401)
- AP Environmental Science (SCI 402)
- AP Chemistry (SCI 403)
- AP Physics (SCI 404)
- Biology 2A/2B: Molecular Genetics and Cell Physiology (SCI 410)
- Organic Chemistry and Its Applications in Biochemistry (SCI 420)
- Chemistry 2A/2B: Concepts and Applications (SCI 425)

Science

The Science Department believes (as Carl Sagan said) that science is more than a body of knowledge; it is a way of thinking and of skeptically interrogating the universe. The science curriculum is designed to build an understanding of science by doing science. Students learn to make observations through experiments, and they develop conceptual and analytical reasoning skills by relating observations to theories and by solving problems. We believe students should not only be knowledgeable about the ideas of science, but also have an understanding and appreciation of how we know what we know. Three introductory courses — Biology, Chemistry, and Physics — are taken by most students. These courses provide an overview of the core topics in each discipline, and emphasize developing the scientific literacy that is important for all students. All three introductory courses are required to take any of the college-level (AP) and 400 level electives. A variety of other upper-level electives allows students to explore topics of interest in more depth in both classroom and laboratory settings. In laboratory courses, one of the class meetings each week is a double laboratory period.

Requirements:

Biology

Chemistry, Physics, or Physics Honors

Introductory Courses

SCI 210 - Biology

Full credit, meets 4 days/week, including one double lab period, usually taken in Grade 9.

Prerequisites: None

The course provides a survey of the major areas of inquiry in biology including molecular biology, genetics, physiology, evolution, and ecology. Students design and test hypotheses, collect and analyze data, and draw conclusions during double laboratory periods every week to support their understanding of biological phenomena. Students also explore current research including cutting edge discoveries through reading, debate, and discussion.

SCI 220 - Chemistry

Full credit, meets 4 days/week, including one double lab period, usually taken in Grade 10.

Prerequisites: None

Chemistry concerns the composition and properties of matter. The topics discussed in the classroom are explored through demonstrations and reinforced through weekly laboratories. Topics include atomic and electronic structure, bonding, reactions, stoichiometry, gas laws, states of matter, solutions, reaction kinetics, thermodynamics, equilibrium, acid/base chemistry, and electrochemistry. In addition to traditional assessments, students will also complete one research-based project per semester. Both projects will include student collaboration, inquiry, and presentation.

SCI 311 - Physics

Full credit, meets 4 days/week, including one double lab period.

Prerequisites: Biology, Chemistry (recommended), usually taken in Grade 11.

Students who have not completed Algebra II and Trigonometry will require permission from the department - please consult with your advisor, your current science teacher and/or the Department Chair about whether this is a suitable program choice. Students who elect to enroll in Physics before or in place of Chemistry must have completed Algebra II and Trigonometry.

Physics is an introductory algebra-based course covering Newtonian mechanics, conservation of momentum and energy, electricity and magnetism, waves, and modern physics. This course focuses on developing both a conceptual understanding of the basic principles of physics and problem-solving skills. Weekly laboratory work provides an opportunity for students to explore the concepts learned in class and gain experience designing and conducting experiments.

SCI 312H - Physics Honors

Full credit, meets 5 days/week, including one double lab period.

Prerequisites: Biology, Chemistry (recommended), usually taken in Grade 11, departmental approval (see below).

Physics Honors is an introductory algebra-based college-level physics course. Topics are studied in greater depth than in Physics, and some additional topics, which vary from year to year, are covered. The concepts developed in this course are applied in a broad range of contexts, and the problem solving is designed to encourage creativity and to challenge students' conceptual and analytical reasoning abilities. Extensive use is made of advanced mathematical methods and students are expected to solve challenging problems with a high

degree of independence. The laboratory work places a greater emphasis on independent work, projects, and computer modeling.

Generally, students need to have earned grades of A- or better in all science and mathematics courses to be considered. All interested students must also complete a placement exercise in May, which is designed to assess the readiness of students for this course. Interested students are encouraged to talk with their current science teacher and/or the Department Chair prior to requesting Physics Honors. Given the significant demands of Physics Honors, the department does not generally give permission for concurrent enrollment in Physics Honors and an AP or a 400 level Science; students who are interested in doing so must discuss this with their current science teacher and the Department Chair before submitting their Course Request Sheet. Physics Honors may not be taken by students who have completed Physics.

Elective Courses

SCI 320 - Biotechnology

Full credit, meets 3 days/week, including one double lab period.

Prerequisites: Biology, Chemistry

This is an upper-level course in Biology that introduces students to the cutting-edge techniques used in contemporary molecular biology research. As well as emphasizing hands-on laboratory experience, students are challenged to consider the bioethical issues associated with advancing technology. This course builds on foundational Biology and Chemistry concepts learned in the 9th and 10th grades to further understand the molecular biology behind topics like infectious disease and immunology, antibiotic resistance, genetically modified organisms, advances in cancer biology, and human evolution. Students will learn important techniques in molecular biology including gel electrophoresis, restriction enzyme digests, primer design, DNA amplification by polymerase chain reaction (PCR), nucleic acid extraction and purification, genetic engineering, bacterial/yeast transformations, DNA sequencing, protein isolation, protein purification and visualization, and enzyme-linked immunoassays. Students will plan, conduct, analyze, and write reports or answer lab study questions on their own experiments. Students will also explore the historical, technical, and social issues influenced by advances in biotechnology by writing papers and making presentations to the class on these issues. Through the reading of research papers and discussion, students will explore the historical, technical, and social issues influenced by advances in biotechnology resulting in the writing of their own papers and presentations to the class.

SCI 321 - Human Anatomy and Physiology

Full credit, meets 4 days/week, including one double lab period.

Prerequisites: Biology, Chemistry

This upper-level course in biology examines the structures and functions of cells, tissues, organs, and organ systems found in the human body. The class will go through the complexity of many features found in body systems, such as the microscopic anatomy of bones in the skeletal system, the sliding filament model of the muscular system, action potential propagation in the nervous system, and the cardiac cycle of the cardiovascular system. The class will emphasize the relationship between the physiological aspects of the organ systems to one another. Additionally, students will complete research projects and presentations, where they will be able to focus on a specific topic, disorder, disease, treatment, or surgery related to the body systems discussed in class. Possible research topics include common skin disorders, knee replacement surgery, muscular dystrophy, and the impact of specific drugs on neurons. Laboratory investigations will include performing a variety of dissections, measuring bodily activity, and modeling physiological processes.

SCI 410 - Biology 2A and 2B: Molecular Genetics and Cell Physiology

Full credit, meets 4 days/week, including one double lab period.

Prerequisites: Biology, Chemistry, and Physics or Physics Honors, departmental approval. Particularly outstanding and interested students may be permitted to take Physics concurrently.

Molecular Genetics and Cell Physiology is an advanced biology course. During the first half of the course, we will learn about modern molecular genetics, from the classic experimental events that identified the proteins involved in DNA replication and repair, to cutting-edge assays and gene sequencing. Then, our focus will shift to the cell, the foundational building block for all living things, and we will learn about cellular structure and processes. This course will address cell structure, energy metabolism, cellular signaling, physiology of various types of cells including neurons, as well as the endocrine and immune system cellular responses. The vital role of cellular physiology in feedback mechanisms to maintain homeostasis will be a central theme across the course. The course will draw upon a solid foundation of basic chemical knowledge and integrate it into the understanding of how cells function within multi-cellular organisms. The course will include topics that will span both prokaryotic and eukaryotic organisms, but will focus on multicellular eukaryotic organisms.

SCI 401 - AP Biology

Open to seniors only in 2020-21

Full credit, meets 5 days/week, including one double lab period.

Prerequisites: Biology, Chemistry, and Physics or Physics Honors, departmental approval. Particularly outstanding and interested students may be permitted to take Physics concurrently.

The AP Biology course places a strong emphasis on overarching themes in biology, and is organized into a conceptual framework consisting of four big ideas. They are: 1) Evolution drives the diversity of life; 2) Biological systems utilize free energy and molecular building blocks to grow, to reproduce, and to maintain dynamic homeostasis; 3) Living systems store, retrieve, transmit, and respond to information; and 4) Biological systems interact with each other and with the environment. To bring these concepts to life we study detailed examples taken from human and plant physiology, molecular and cellular biology, genetics, ecology, and evolution. Class discussions incorporate the analysis and interpretation of primary data, and emphasize current areas of scientific research. Inquiry driven labs are used to support student learning. Many of these labs are multi-week and allow students the freedom to design an experiment within the context of the investigation, while learning a variety of techniques used in biological research. Students are required to take the AP Biology exam at the conclusion of the course.

SCI 402 - AP Environmental Science

Open to seniors only in 2020-21

Full credit, meets 5 days/week, including one double lab period.

Prerequisites: Biology, Chemistry, and Physics or Physics Honors, departmental approval. Particularly outstanding and interested students may be permitted to take Physics concurrently.

AP Environmental Science investigates the interconnectivity of the natural world and human activity, and is equivalent to a one-semester college course. Interdisciplinary in nature, students will learn to incorporate elements from an array of disciplines including ecology, geology, social sciences, chemistry, and physics to understand and evaluate environmental problems and solutions using scientific principles. Field and laboratory work, projects, presentations, and field trips are all integral aspects of this course. Pressing issues of today—global climate change, loss of biodiversity, overpopulation, overfishing, and water supply—will all be discussed. This course both prepares students for advanced study in the many fields of environmental science as well as provides a foundation in scientific and environmental literacy to understand the impact of humans on the environment and the complexity of the world around us. Students are required to take the AP Environmental Science exam at the conclusion of the course.

SCI 322 - Experiments in Physics and Chemistry

Full credit, meets 4 days/week, including one double lab period.

Prerequisites: Biology, Chemistry

This course is designed for those students who are interested in exploring topics in Chemistry and Physics from an experimental perspective. This elective explores topics in a way that encourages independent thought and provides direct experience with scientific investigation. It also stresses presenting scientific findings in oral and written form. The course consists of five to seven units investigating topics such as analytical chemistry; chemical synthesis; organic chemistry; forensics; novel materials; mechanics; waves, sound, and light; analog and digital circuits; energy; and atmospheric science. In the second semester, students will pursue an independent project on a subject of interest to the student, selected in consultation with the teacher. Although some library-based research will be involved, the major emphasis of the course will be explorations that involve data collection and analysis in the chemistry and physics labs.

SCI 425 - Chemistry 2A and 2B: Concepts and Applications

Full credit, meets 4 days/week, including one double lab period.

Prerequisites: Biology, Chemistry, and Physics or Physics Honors, departmental approval required (see below).

This course is comparable to an introductory college course in general chemistry. Considerable emphasis is placed on: the quantitative aspects of chemistry; the conceptual understanding of how compounds and molecules interact; how to design and execute sophisticated inquiry based experiments that support that understanding; and, the derivation of mathematical relationships through more complex experiments that follow the guided instruction model. This course will also focus on making connections to real-world applications of chemistry, for example, Atmospheric and Ocean chemistry, Lewis Acid-Base chemistry, Buffering, and Batteries. Semester I will focus on chemical structure and bonding, and semester II will focus on chemical equilibrium, free energy and reaction kinetics. Strong problem-solving skills are required to master this course.

Approval requirements: In addition to approval by the department, students must be enrolled in or have completed Precalculus. Particularly outstanding and interested students may be permitted to take Physics concurrently.

SCI 403 - AP Chemistry

Open to seniors only in 2020-21

Full credit, meets 5 days/week, including one double lab period.

Prerequisites: Biology, Chemistry, and Physics or Physics Honors, departmental approval required (see below).

This course is comparable to an introductory college course in general chemistry. Considerable emphasis is placed on the quantitative aspects of chemistry, the conceptual understanding of how compounds and molecules interact, and how to design and execute sophisticated experiments that support that understanding. The topics of Chemistry (SCI 220) are revisited here at a significantly deeper level and at a faster pace. Students are expected to draw on their previous understanding developed in Chemistry (SCI 220). Topics include chemical bonding, stoichiometry, gas laws, solutions, atomic chemistry, thermodynamics, reaction kinetics, chemical equilibrium, acid-base equilibrium, and electrochemistry. The laboratory portion of the course incorporates a variety of techniques supported by analytical equipment and allows for the opportunity to practice and improve scientific writing skills. Strong problem-solving skills are needed to master this course. Students are required to take the AP Chemistry examination at the conclusion of the course.

Approval requirements: In addition to approval by the department, students must be enrolled in or have completed Precalculus. Particularly outstanding and interested students may be permitted to take Physics concurrently.

SCI 420 - Organic Chemistry and its Applications in Biochemistry

Full credit, meets 4 days/week, including one double lab period.

Prerequisites: Biology, Chemistry, and Physics or Physics Honors, departmental approval. Particularly outstanding and interested students may be permitted to take Physics concurrently.

This rigorous, advanced elective course focuses on chemistry that bridges the fundamentals of carbon-based chemistry and biological applications. Students will have the opportunity to engage with advanced organic and biochemistry material in a collaborative environment and be challenged to think independently and creatively. The organic focused semester will build a foundation in Lewis acid-base theory, organic nomenclature, stereochemistry, and reaction mechanisms. In the biochemistry semester, students will focus on how the structure and function of macromolecules in biological systems interact. Students will explore the biochemical requirements and mechanisms of biological pathways. Many of the laboratory experiments are multi-week projects and require students to think critically while introducing essential organic chemistry and biochemistry laboratory skills.

SCI 310 - Selected Topics in Physics

Full credit, meets 4 days/week

Prerequisites: Biology, Chemistry

The class is intended to work as a seminar, emphasizing cooperative and collaborative learning as a means of carrying out research. Thus, there are no tests or quizzes except as diagnostic exercises. Assessment is based on contributions to class discussion as well as presentations and projects, individually and in small groups throughout the year. The informal tone of the course therefore demands a genuine interest in and dedication to both the material and the sincere learning dynamic. This course does not fulfill the Physics prerequisite for 400-level Science courses.

Each semester, students will explore one or more paired themes—a foundational one followed by a broader application to something more wide-ranging, which may include social, political, or even philosophical aspects. Some examples of thematic combinations are: Astronomy and Cosmology, Sound and Music, Energy and Climate Change, Technological Development and Ethics, Chaos Theory and Predictability. Students are encouraged to pursue topics within these themes that matter to them.

SCI 404 - AP Physics with Calculus [AP Physics C: Mechanics and AP Physics C: Electricity and Magnetism]

Open to seniors only in 2020-21

Full credit, meets 5 days/week, including one double lab period.

Prerequisites: Biology, Chemistry, and Physics or Physics Honors, department approval (see below).

AP Physics is a calculus-based treatment of physics concepts in mechanics and in electricity and magnetism. All calculus techniques are discussed before they are applied. Topics discussed include Newton's laws, conservation of energy, momentum and angular momentum, gravitation, rotational dynamics, oscillations, electric and magnetic fields (including Gauss's law and Ampere's law), static and moving charges, circuits, and electromagnetism (including Faraday's law). Ideas from introductory physics are amplified and more broadly applied, and new ideas are introduced. Laboratory investigations involve a variety of experimental techniques and methods of data analysis. Analysis of experimental error is emphasized and formal laboratory reports are required periodically. Students have substantial freedom in designing their own experiments, and many experiments are carried out over several weeks. Students are required to take the AP Physics C exams in Mechanics and in Electricity and Magnetism at the conclusion of the course. A final project may be assigned.

Approval requirements: In addition to approval by the department, students must be enrolled in or have completed AP Calculus AB (MATH 401) or Calculus Honors (MATH 422) or have earned a score of 4 or 5 on the AP Calculus BC exam.

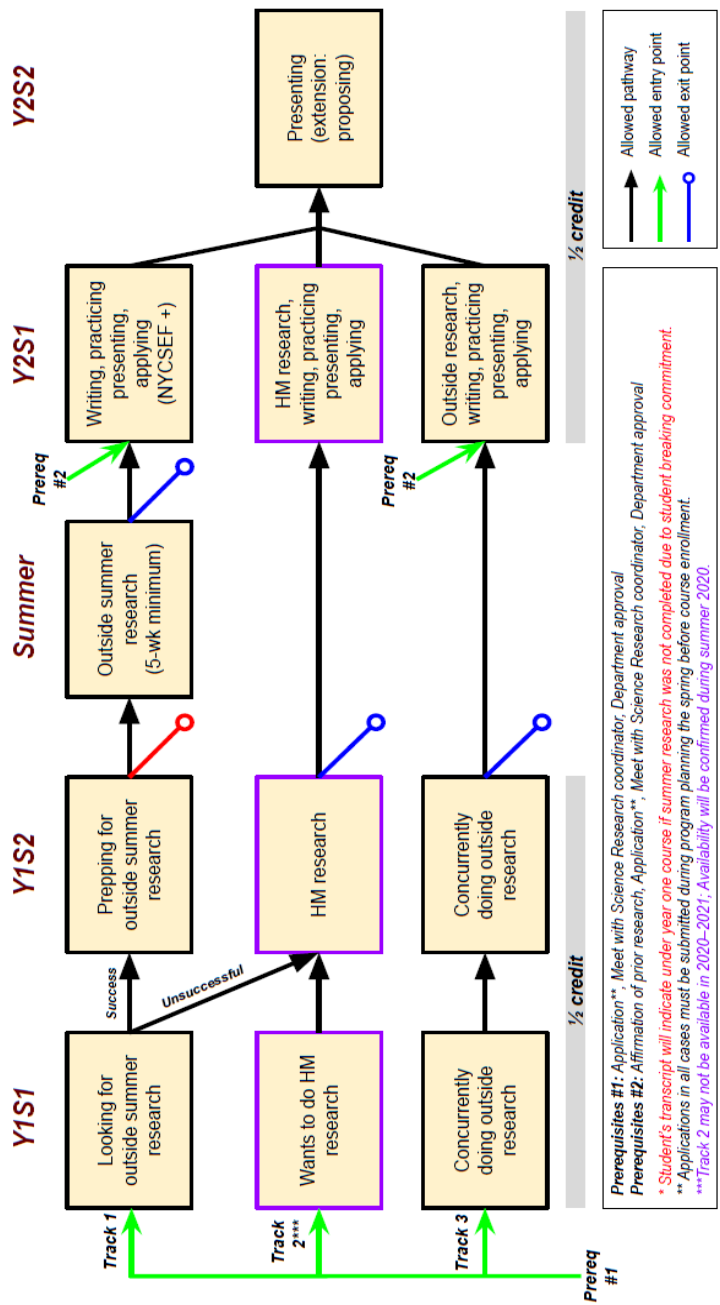
Science Research at HM

The goal of the Science Research Program at Horace Mann School is to prepare and support students through a science research experience. This support begins by providing students with the understanding of scientific method and skills necessary to perform research and continues through the research experience. Finally, students are supported as they present their research at local science competitions and symposiums and write a full research paper. A map of the different tracks is included in the Program of Studies. Students may choose to track (T1) by searching for an outside lab experience for the summer between Science Research I and Science Research II and will be coached through that process. Alternatively, students may choose to track (T2) and plan to join an ongoing research project at Horace Mann. This hands-on research project will be performed at Horace Mann in collaboration with an outside institution/lab. Finally, students who have already secured a steady research experience outside of Horace Mann may choose to track (T3), and will work consistently outside of school while working with the Science Research curriculum. Should a T1 student be unsuccessful in securing outside research, they may move to T2 by Spring of year one. Students of all tracks will be mixed within the same section, and will learn the same curriculum, with appropriate differentiation to help each student meet their science research goals. The course is scheduled every other day, with class meetings occurring once per week. Other scheduled periods will be used for one-on-one or small group meetings and experimentation.

Please note, we are currently in the process of forging a long-term relationship with an outside research institution/lab. This relationship would allow students to perform hands-on, high-impact research connected with that lab on the Horace Mann campus and would provide students with an opportunity to directly collaborate with active research scientists. However, this opportunity is in the early planning stages, so we are unsure at this time whether T2 will be available to students in the 2020-2021 school year. We will have this information by summer of 2020.

Approval requirements: Selection is at the discretion of the department. Before submitting their Course Request sheet on April 28th, 2020, interested students must meet with the Science Research Coordinator and submit an application to the program.

HM Science Research Course Overview



SCI 323 - Science Research 1: Research Theory and Skills

One-half credit, meets every other day

Prerequisites:

The curriculum of year one is focused on reading scientific literature, gathering background information on a science research project, to converse about the scientific research of others, specifying research interests, and developing research projects. An overview of the scientific method and practice of science research will be studied. Students will also learn how to build a resume, interview, and write emails to outside labs as they are supported in finding outside research opportunities. Some discussions will also center around ethics and science research.

COURSES NOT OFFERED IN 2020-21

SCI 301 - Advanced Topics in Biology

[Course not offered 2020-2021]

Full credit, meets 4 days/week, including one double lab period

Prerequisites: Biology, Chemistry

This is a second course in biology for students who wish to explore some topics in biology in greater detail and with greater freedom than in a traditional textbook-oriented course. A majority of class time will be spent in laboratory experiments, discussion, and presentations, rather than lecture. Students will design and conduct experiments and lead discussions on scientific articles, while incorporating aspects of other areas of study, such as engineering, ecology, physiology, physics, chemistry, and history. The course will focus on various topics of interest in biology, which will vary from year to year. Past topics include: the biology of food; biomimicry; urban ecology and biodiversity; exercise physiology; and bacteriology and microbiology.

SCI 411 - Biology 2A and 2C: Molecular Genetics, Evolution and Ecology

[Course not offered in 2020-2021]

Full credit, meets four days/week including one double lab period.

Prerequisites: Biology, Chemistry, and Physics or Physics Honors, departmental approval. Particularly outstanding and interested students may be permitted to take Physics concurrently.

Molecular Genetics, Evolution and Ecology is an advanced biology course. During the first half of the course, we will learn about modern molecular genetics, from the classic experimental events that identified the proteins involved in DNA replication and repair, to cutting-edge assays and gene sequencing. The second half of the course focuses on the processes and evidence of evolution as a means to study biological diversity and ecosystem structure. We will build a comprehensive

understanding of the fundamentals of life history, behavior, population dynamics, ecosystem processes and how evolution shapes ecological relationships. Finally, we will make connections between species diversity and ecosystem function in order to understand the importance of conserving biodiversity. Conceptual learning will be supported by hands-on inquiry-driven investigations that emphasize experimental design, data analysis and scientific communication.

SCI 440S - Science Research 2: Analysis and Presentation of Research
[Course not offered 2020-2021]

One-half credit, meets every other day

Prerequisites:

Students enrolled in year two would focus on written and oral presentations of their research. They will enter various competitions and symposiums, with the course requiring entry into NYCSEF (New York City Science and Engineering Fair), only. In addition, discussions about the scientific method and practice of research, data analysis, and research ethics will continue. Students will informally mentor year one students. For T1 students, experimentation must have taken place the summer prior to this course. For T2 students, experimentation will continue through the fall semester of this course. For T3 students, experimentation will occur through at least the fall of the course.

SCI 445S - Scientific Primary Literature Seminar
[Course not offered 2020-2021]

Full credit, meets 4 days/week

Prerequisites:

Most communication of new research occurs in the form of peer-reviewed research articles published in scientific journals. These papers generally follow a standard format that is quite distinct from how information is presented in textbooks or in popular media. In this course, students will learn how to read, critically evaluate, and present research from scientific papers. Papers will include both current and classic papers, and the specific topics will be based on the interests of the students in the class. Most classes will involve student-led discussion of selected papers, and the class will culminate in the writing of a review article based on papers read throughout the year.