SCIENCE

The Core science requirement aims to develop critical awareness of the methods and limits of scientific inquiry, while fostering observational and analytical skills, particularly in reference to the natural and physical world. It offers students the opportunity to learn the foundations of scientific knowledge and the fundamentals of scientific inquiry. Students learn how scientific hypotheses are formulated and evaluated against the findings of empirical and theoretical research. An overarching theme is for students to appreciate how scientific research informs our understanding of the natural world, from the history of our Universe to the continued survival of our own species.

Science Requirement Learning Outcomes

The Committee on Science Instruction, which is responsible for all matters related to the science requirement and for providing leadership on matters related to undergraduate science education, further articulated five broad categories of learning objectives, organized by the following guiding questions:

1. ***What knowledge has fundamentally shaped our understanding of the workings of the natural world? (scientific knowledge base)***

    a. Understand and compare key concepts, theories, and perspectives across multiple disciplines within the natural sciences.

    b. Identify contemporary and enduring questions in science. Explain the importance of equity, inclusion, and ethics in investigating these questions.

    c. Describe the iterative, often non-linear nature of the scientific process.

    d. Describe current theories, models, and empirical methods across multiple disciplines that are the bases for accumulating scientific knowledge.

2. ***What are the core elements of fundamental and applied scientific research? (scientific research and application)***

    a. Identify and develop testable scientific hypotheses, recognizing and being able to explain the interplay among observations, experiments, and hypothesis foundation.

    b. Test scientific hypotheses using theoretical, simulation, and both observational and experimental empirical methods.

    c. Explain the importance of units, scale, and quantitative approaches in analyzing empirical data and hypothesis testing.

    d. Describe the importance of uncertainties in interpreting findings.

3. ***How does one understand science? (scientific reasoning)***

    a. Recognize what qualifies as scientific evidence that supports or refutes scientific hypotheses.

    b. Evaluate different types of evidence, e.g., discriminating between causal and correlational evidence.

    c. Describe what constitutes strengths and weaknesses in research design.

4. ***How does one use data and evidence to draw conclusions about the natural world? (data literacy)***

    a. Describe how data-driven descriptive and inferential statistics are important to scientific reasoning.

    b. Apply basic statistical methods to analyze data.

    c. Develop an understanding of probability and how concepts of probability can be used in scientific research.

    d. Assess the plausibility of results or claims by making estimates using back-of-the-envelope calculations, clarifying assumptions, and comparing values by orders of magnitude.

    e. Describe the importance and utility of incorporating computing into scientific learning/research.

5. ***How does one communicate science and use it for decision-making? (science communication and public policy)***

    a. Analyze one or more articles from the scientific literature and be able to explain the motivation, objectives, and conclusions of the study.

    b. Analyze the importance of equations, tables, figures, or other material in supporting authors' claims in scientific articles.

    c. Evaluating the accuracy of science coverage in popular media using primary scientific literature.

    d. Critique the use of scientific information in scientific development and in public-policy decision-making, describing appropriate and ethical uses of scientific evidence.

    e. Generate an oral or written communication about a scientific study or body of scientific knowledge for an audience without that disciplinary expertise.

Science Requirement

To fulfill the science requirement, students must successfully complete three courses selected from the following Columbia departments or from the list of approved courses below, no more than two of which should be from the same department:

- Astronomy
- Biological Sciences
- Chemistry
- Earth and Environmental Sciences
- Ecology, Evolution, and Environmental Biology
- Physics
- Psychology (Columbia department only, excluding courses numbered at the 2600, 3600, or 4600 level)

When choosing a science course, students should make sure they have reviewed and met the specified prerequisites for the course prior to enrollment.

Students who are considering careers in science-related fields, including health-related professions, are urged to begin their study of science within the first two semesters after matriculation at GS.

Students who matriculated in spring 2023 or earlier may also use international high school leaving exams for which they received at least

three transfer credits on the Entrance Credit Report (ECR) in one of the disciplines listed above to fulfill **one** of the three science requirement courses. Students who matriculate in fall 2023 and later will not be able to receive science credit for international leaving exams.

List of Approved Science Courses

The list of approved courses that fulfill the science requirement includes recommended sequences, science courses for non-science majors, and approved courses from departments not listed above and Barnard.

The following two courses may satisfy both the quantitative reasoning (QR) requirement and one science requirement when passed with a letter-grade of C or above. The P/D/F grading option is not available for either of these two courses.

- Foundations of Science (SCNC UN1212)
  Using modern, student-centered, active and collaborative learning techniques, students will engage — through field observations, in-class experiments, computer simulations, and selected readings — with a range of ideas and techniques designed to integrate and anchor scientific habits of mind. Topics covered will include statistics, basic probability, a variety of calculations skills, graph reading and estimation, all aimed at elucidating such concepts as energy, matter, cells, and genes in the context of astronomy, biology, chemistry, earth sciences, neuroscience, and physics.

- FRONTIERS OF SCIENCE (SCNC CC1000)
  The principal objectives of Frontiers of Science are to engage students in the process of discovery by exploring topics at the forefront of science and to inculcate or reinforce the specific habits of mind that inform a scientific perspective on the world. Sample topics include the evolution of human language, brain dynamics, global climate change, the nanoworld, and biodiversity, among others. On Mondays throughout the semester, some of Columbia's leading scientists present a mini-series of lectures. During the rest of the week, senior faculty and Columbia postdoctoral science fellows lead seminar sections to discuss the lecture and its associated readings, and to debate the implications of the most recent scientific discoveries.

GS students interested in taking Frontiers of Science should have earned a minimum score of 16 on the GS Quantitative Reasoning Exam and/or meet the specific criteria listed in the Quantitative Reasoning section of the website by the specified timelines.

Courses Designed For Nonscience Majors

Astronomy

ASTR UN1234	UNIVERSAL TIMEKEEPER
ASTR UN1403	EARTH, MOON, AND PLANETS
ASTR UN1404	STARS, GALAXIES # COSMOLOGY
ASTR UN1420	Galaxies and Cosmology
ASTR UN1453	ANOTHER EARTH
ASTR UN1610	THEOR-UNIVERS:BABYLON-BIG BANG
ASTR UN1836	STARS AND ATOMS
ASTR BC1753	LIFE IN THE UNIVERSE
ASTR BC1754	Stars, Galaxies, and Cosmology
Recommended Sequences:	
ASTR UN1403 - ASTR UN1404	EARTH, MOON, AND PLANETS and STARS, GALAXIES # COSMOLOGY
ASTR UN1403 - ASTR UN1420	EARTH, MOON, AND PLANETS and Galaxies and Cosmology
ASTR UN1403 - ASTR UN1836	EARTH, MOON, AND PLANETS and STARS AND ATOMS
ASTR UN1403 - ASTR BC1754	EARTH, MOON, AND PLANETS and Stars, Galaxies, and Cosmology
ASTR BC1753 - ASTR UN1404	LIFE IN THE UNIVERSE and STARS, GALAXIES # COSMOLOGY
ASTR BC1753 - ASTR BC1754	LIFE IN THE UNIVERSE and Stars, Galaxies, and Cosmology
Biology	
BIOL UN1002	Theory and Practice of Science: Biology
BIOL UN1130	GENES AND DEVELOPMENT
BIOL UN2300	Interpreting Scientific Evidence
Computer Science	
COMS W1001	Introduction to Information Science
COMS W1002	COMPUTING IN CONTEXT
Earth and Environmental Engineering	
EAEE E2100	A BETTER PLANET BY DESIGN
Earth and Environmental Sciences	
EESC UN1001	DINOSAURS AND HISTORY OF LIFE
EESC UN1003	Climate and Society: Case Studies
EESC UN1011	Earth: Origin, Evolution, Processes, Future
EESC UN1030	OCEANOGRAPHY
EESC UN1053	Planet Earth
EESC UN1201	Environmental Risks and Disasters
EESC UN1401	DINOSAUR # HISTORY OF LIFE-LEC
EESC UN1411	Earth: Origin, Evolution, Processes, Future: Lectures
EESC UN2330	SCIENCE FOR SUSTAINABLE DEVPT
Ecology, Evolution, and Environmental Biology	
EEEB W1001	Biodiversity
EEEB UN1010	HUMAN ORIGINS # EVOLUTION
EEEB UN1011	BEHAVIOR BIOL-LIVING PRIMATES
EEEB S1115S	The Life Aquatic
Recommended Sequences:	
EEEB UN1001 - EEEB UN3087	Biodiversity and CONSERVATION BIOLOGY
EEEB UN1010 - EEEB UN1011	HUMAN ORIGINS # EVOLUTION and BEHAVIOR BIOL-LIVING PRIMATES
Electrical Engineering	
ELEN E1101	THE DIGITAL INFORMATION AGE
Food Studies	
FSEB UN1020	Food and the Body
FSPH UN1100	FOOD, PUBLIC HEALTH # PUBLIC POLICY
Philosophy	
PHIL UN3411	SYMBOLIC LOGIC
PHIL GU4424	MODAL LOGIC
Physics	
PHYS UN1001	PHYSICS FOR POETS
PHYS UN1018	WEAPONS OF MASS DESTRUCTION
Recommended Sequences:	
PHYS UN1001 - PHYS C1002	PHYSICS FOR POETS and Physics for Poets
Psychology**	
Columbia Department only:	
PSYC UN1001	THE SCIENCE OF PSYCHOLOGY

PSYC UN1010	Mind, Brain and Behavior (Effective Fall 2018, this course is no longer offered. For students who took this course before Fall 2018, it may be used to partially satisfy the Science Requirement.)
PSYC UN1021	Science of Psychology: Explorations and Applications
Science	
SCNC UN1212	Foundations of Science
SCNC UN1800	ENERGY # ENERGY CONSERVATION
Statistics	
STAT UN1001	INTRO TO STATISTICAL REASONING
STAT UN1010	Statistical Thinking For Data Science

*   **Note:** Students electing to take Human Origins and Evolution (EEEB UN1010) and Behavioral Biology of the Living Primates (EEEB UN1011) as a sequence are recommended, but not required, to take EEEB UN1010 before EEEB UN1011.

** **Note:** 2600-, 3600-, or 4600-level psychology courses may not be used to fulfill the science requirement.

*****Note:** The Science of Psychology (PSYC UN1001) or an equivalent introductory course approved by the Psychology Department must be taken as a prerequisite to any psychology course numbered 22xx or 24xx.

****Students may not receive credit for both PSYC BC 1101 and PSYC UN 1001. Psychology majors should consult the Psychology department for additional restrictions on overlapping courses.

Additional Courses Approved for the Science Requirement

Most of the following courses have required prerequisites and/or require instructor approval. Prerequisite and instructor approval requirements can be found in the course descriptions for each course or on the department website.

Astronomy	
Any 3-point course numbered 2000 or higher	
Biology	
Any 3-point course numbered 2000 or higher	
Chemistry	
CHEM UN1403	GENERAL CHEMISTRY I-LECTURES
CHEM UN1404	GENERAL CHEMISTRY II-LECTURES
CHEM UN1500	GENERAL CHEMISTRY LABORATORY
CHEM UN1604	2ND TERM GEN CHEM (INTENSIVE)
CHEM UN2507	Intensive General Chemistry Laboratory
Any 3-point course numbered 3000 or higher	
Computer Science	
COMS W1004	Introduction to Computer Science and Programming in Java
COMS W1005	Introduction to Computer Science and Programming in MATLAB
ENGI E1006	INTRO TO COMP FOR ENG/APP SCI
COMS W1007	
Any 3-point course numbered 3000 or higher	
Computing Science - Philosophy (CSPH)	
CSPH G4801	Mathematical Logic I
CSPH G4802	Math Logic II: Incompletness
Earth and Environmental Sciences	
EESC UN2100	EARTH'S ENVIRO SYST: CLIM SYST

EESC UN2200	EARTH'S ENVIRONMENTAL SYSTEMS: THE SOLID EARTH
EESC UN2300	EARTH'S ENVIRO SYST: LIFE SYST
Any 3-point course numbered 3000 or higher	
Ecology, Evolution, and Environmental Biology	
EEEB UN2001	ENVIRONMENTAL BIOLOGY I
EEEB UN2002	ENVIRONMENTAL BIOLOGY II
EEEB UN3087	CONSERVATION BIOLOGY (Any 3-point course numbered 3000 or higher except EEEB GU4321 or EEEB GU4700)
History-Applied Math	
HSAM UN2901	DATA:PAST, PRESENT AND FUTURE
Mathematics	
Any 3-point course numbered 1100 or higher	
Physics	
PHYS UN1201	GENERAL PHYSICS I
PHYS UN1202	GENERAL PHYSICS II
PHYS UN1401	INTRO TO MECHANICS # THERMO
PHYS UN1402	INTRO ELEC/MAGNETSM # OPTCS
PHYS UN1403	INTRO-CLASSCL # QUANTUM WAVES
PHYS UN1601	PHYSICS I:MECHANICS/RELATIVITY
PHYS UN1602	PHYSICS II: THERMO, ELEC # MAG
Any 3-point course numbered 2000 or higher	
Psychology*	
Any 3-point course numbered 22xx, 24xx, 32xx, 34xx, 42xx, or 44xx **	
Statistics	
Any 3-point course except STAT W3997	

*   **Note:** 2600-, 3600-, or 4600-level psychology courses may not be used to fulfill the science requirement.

** **Note:** These courses may serve as a second term of a recommended sequence starting with The Science of Psychology (PSYC UN1001).