Committee on Science Instruction (COSI)
Course Review for the Science Requirement

The Science Requirement

The Science Requirement is part of a set of general education courses referred to as the Core Curriculum. The mission of the undergraduate Core Curriculum is to help students "to understand the civilization of their own day and to participate effectively in it." The undergraduate Science Requirement, both in the College and General Studies, contributes to fulfilling this mission by helping undergraduates understand the role natural science plays in civilization in order to enhance the effectiveness of their participation in it.

The 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. A key part of this learning is to understand:

- how research findings and discoveries are vetted through modeling, simulation, and quantitative methodologies, including, statistical testing;
- how they are communicated through presentation and peer reviewed publication; and
- how scientific literature and findings are organized, archived, and searched.

To fulfill the Science Requirement, students will complete three courses (for a minimum of 9 points of credit). All three courses must be taken for a letter grade.

- Columbia College students take SCNC CC1000 *Frontiers of Science* as one of the three courses, taking it in their first year during the term in which they are not taking ENGL CC1010 *University Writing*. General Studies students may take *Frontiers of Science*, but they may also substitute another course from the list of approved science courses.
- Columbia undergraduates may also take SCNC UN1212 *Foundations of Science* as their first science course at Columbia. This course uses student-centered, active and collaborative learning techniques to engage students with a range of ideas and techniques designed to integrate and anchor scientific habits of mind.
- Beyond *Foundations of Science* and *Frontiers of Science*, students may choose any two courses from a list of courses approved by the Committee on Science Instruction. These courses may be

taken in the same department or in different departments. However, at least one course must be taken in the Departments of Astronomy; Biological Sciences; Chemistry; Earth and Environmental Sciences; Ecology, Evolution, and Environmental Biology; Physics; or Psychology.

The Committee on Science Instruction

The Committee on Science Instruction (COSI) is responsible for all matters relating to the Science requirement and for providing leadership on matters related to undergraduate science education. COSI is chaired by a faculty member and is composed of representative faculty members from each department in the natural sciences, as well as mathematics, statistics, and computer science. COSI also includes two student representatives from CC and GS each year, and is supported by the academic deans and certain administrators from CC and GS. Questions for COSI can be sent to cosi@columbia.edu.

The Committee on Science Instruction (COSI) is charged with shepherding the Science Requirement by identifying and approving courses suitable for the Science Requirement; maintaining the list of courses approved to fulfill the Science Requirement; and evaluating the suitability of courses transferred from outside Columbia.

Course Proposal Submission Process

When a course is submitted to the Committee on Science Instruction for consideration, the proposal should include the course syllabus and the Science Requirement Checklist. COSI would also appreciate seeing other supporting materials, including outlines of assignments or sample assessments. Faculty may submit the course proposal to the Committee on Science Instruction at cosi@columbia.edu or, if the course is a new course and thus requires CC-GS Committee on Instruction approval, the Science Requirement Checklist can be appended to the COI course proposal. In the latter case, once the course is approved by the CC-GS COI, it will be referred to COSI to be reviewed for the science requirement.

Science Requirement Checklist

Course title and number: ____

Course format:

- ☐ Seminar
- ☐ Lecture
- ☐ Laboratory

Estimated course enrollment: ____________________

Number of points___________ **and Contact hours** __________

Prerequisites?

- ☐ No
- ☐ Yes

If Yes, please explain:

Through the three courses taken in fulfillment of the Science Requirement, students should be able **to demonstrate competence in each of the following five categories of science learning outcomes**, each of which is based on a central or driving question. An overarching theme is for students to understand the importance of spatial and temporal scales of the origin and evolution of structure and function in inanimate and animate features of the natural world, from the history of our Universe to the emergence of our own species. Please provide a brief explanation of how the proposed course will fulfill the five learning outcomes listed below. Beneath each primary learning outcome and guiding question are subgoals that further elaborate the expected learning outcomes. While a single course may not fulfill all five learning outcomes, it is the expectation of the Committee on Science Instruction that each science requirement course will fulfill the first science requirement learning outcomes (scientific knowledge base) and at least two additional learning outcomes.

1. Scientific knowledge base. *What knowledge has been accumulated about the workings of science in our world?*

- Understand and synthesize key concepts, theories, and perspectives from one discipline or across multiple disciplines within the natural sciences.
- Identify contemporary and enduring questions in science and the issues of equity, inclusion, and ethics surrounding the evolving nature of scientific knowledge.
- Describe the iterative, sometimes non-linear nature of the scientific process and current theories, models, and empirical methods in one discipline or across multiple disciplines that are the bases for accumulating scientific knowledge.
- Describe historical advancements in technology, data science, and scientific computing that have contributed to this knowledge base.

2. The scientific method and its application. *What are the core elements of fundamental and applied scientific research?*

- Identify and develop testable hypotheses in science.
- Use theoretical, simulation, and empirical methods, both observational and experimental, to test scientific hypotheses.
- Understand the importance of units, scale, and quantitative and statistical approaches in evaluating empirical evidence and hypothesis testing and recognize the importance of quantifying uncertainties in reporting and evaluating scientific results.
- Understand the role of information sciences and computational tools in making observations, developing hypotheses, and applying theory. Design, develop or use computational tools (algorithms and software) to solve problems.

3. Scientific reasoning. *How does one understand science?*

- Recognize what qualifies as scientific evidence that supports or refutes scientific hypotheses.
- Evaluate different types of evidence, e.g., discriminating between causal and correlational evidence.
- Describe what constitutes strengths and weaknesses in research design.
- Evaluate the strengths and limitations of various technologies and computational tools to decide which would be best to address particular problems and understand the importance and utility of incorporating computing into scientific learning and research.

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

- Appreciate why data-driven descriptive and inferential statistics are important to scientific reasoning.
- Develop competencies in basic statistical methods and their application in evaluating observational and experimental data.
- Implement algorithms to process, analyze, and/or visualize data in a programming language.
- Be exposed to different concepts such as probabilities, probability distributions, likelihoods, univariate and multivariate approaches, Bayesian and machine-learning methods.
- Make estimates using back-of-the-envelope calculations, identify and state assumptions, check answer plausibility.
- Compare values by orders of magnitude.
- Understand the importance and utility of incorporating computing into scientific learning/research.

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

- Evaluate one or more articles from the scientific literature and be able to explain the motivation, objectives, and conclusions of the study and the importance of equations, tables, figures, or other supportive material the authors provide.
- Critically compare and contrast science in primary scientific literature with its coverage in popular media.
- Evaluate the use and misuse of scientific information in scientific development and in public- policy issues – recognize a valid and ethical scientific course of action and identify appropriate use of science to make decisions.
- Provide an oral or written communication about a scientific study or body of scientific knowledge in a manner that could be understood by a non-expert.
- Analyze ethical issues involving intellectual property; data ownership, system security and privacy; and the use of artificial intelligence.