Scientific Inquiry, Physical and Biological Sciences

These areas of IGETC and CSU GE Breadth call for three kinds of coursework: physical science lecture, life science lecture, and a lab associated with a lecture.

Courses in these subareas of Areas B and 5 emphasize the perspectives, concepts, principles, theories, and methodologies of the scientific disciplines. Those that have built-in laboratory activity may also qualify for Area B3 and Area 5C, as long as the course outline clearly distinguishes the laboratory activity from the lecture.

Some but not all course outlines submitted for these areas will refer to "the scientific method." Implicit inclusion of the scientific method is acceptable, especially for courses designed for students majoring in science. Area B and Area 5 courses should enhance students' appreciation of how scientists do science, not just what scientists have concluded.

Scientific Inquiry **CSU General Education Breadth Requirements**

In Subareas B1-B3, students develop knowledge of scientific theories, concepts, and data about both living and non-living systems. Students will achieve an understanding and appreciation of scientific principles and the scientific method, as well as the potential limits of scientific endeavors and the value systems and ethics associated with human inquiry. The nature and extent of laboratory experience is to be determined by each campus through its established curricular procedures.

It is expected that campuses could offer the laboratory experience within:

- a 3 semester (4 quarter) unit lecture course;
- a lecture plus laboratory course of 4 semester (6 quarter) units; or
- a standalone laboratory course of 1 semester (2 quarter) units.

Physical and Biological Sciences **IGETC Standards 2.3**

Courses in physical and biological sciences must emphasize experimental methodology, the testing of hypotheses, and the power of systematic questioning, rather than only the recall of facts. Courses that emphasize the interdependency of the sciences are especially appropriate for non-science majors.

The contemporary world is influenced by science and its applications, and many of the most difficult choices facing individuals and institutions concern the relationship of scientific and technological capability with human values and social goals. To function effectively in such a complex world, students must develop a comprehension of the basic concepts of physical and biological sciences, and a sophisticated understanding of science as a human endeavor, including the limitations as well as the power of scientific inquiry.

Laboratory Science **IGETC Standards 2.3**

The IGETC physical and biological science area requires a minimum of two courses, at least one of the two must include a laboratory. The intent of the IGETC laboratory science requirement is that students take at least one physical or biological science course incorporating a laboratory component. Since the experimental methodology and hypothesis testing taught in a lab builds on the principles presented in the lecture portion of the course, the two must be related. Therefore, the laboratory must correspond to one of the lecture courses taken to fulfill this IGETC requirement. A student cannot use lecture courses in two subjects and a laboratory in a third subject. It is expected that the lecture course is a prerequisite or co-requisite of the laboratory course. Lecture and lab courses may have separate course numbers. Lab science courses must include a clearly identified lab manual in the course outline.

Unit Requirement for Laboratory Science Courses **IGETC Standards 2.3**

Three semester or four quarter unit laboratory science courses may be used on IGETC to clear the laboratory science requirement as long as the minimum unit value is met for this area (*7 semester or 9 quarter units*). Stand-alone lab courses which have a prerequisite or co-requisite of the corresponding lecture course must be a minimum of 1 semester/quarter unit.

Laboratory Activity

Courses meeting the requirements of this subarea must be associated with a lecture component, either built into the laboratory section itself or connected as a co-requisite or prerequisite. In the course outline, it is especially important for colleges to *clearly delineate laboratory activity from the lecture topics.* A simple list of topics to be covered in the lab sections is seldom enough to tell reviewers whether the activity warrants the additional lab approval. Reviewers rely in particular on the choice of textbook, checking that it is appropriate for a course with lab activities. Lab science courses must include a *clearly identified lab manual*.

Stand-alone lab courses are designated B3 or 5C only, and *only* when associated with a lecture course as either a prerequisite or co-requisite.

Lab Manuals
Lab manuals are required, and must be explicitly listed on the COR, for all courses in IGETC Area 5C and CSU GE Breadth Area B3.
"Home-grown" lab manuals, created by CCC faculty, are also acceptable. Lab manuals are required and must be explicitly identified in the COR.

CSU GE Breadth Area B	**IGETC Area 5**
B1-B2 Physical and Life Sciences • students develop knowledge of scientific theories, concepts, and data about both living and non-living systems • courses emphasize the perspectives, concepts, principles, theories, and methodologies of the scientific disciplines • students will achieve an understanding and appreciation of scientific principles and the scientific method, potential limits of scientific endeavors, and the value systems and ethics associated with human inquiry	**5A-5B Physical and Biological Sciences** • one course in Physical Science (5A), one in Biological Science (5B), with at least one incorporating a laboratory (5C) • emphasize experimental methodology, testing of hypotheses, and power of systematic questioning, rather than only recall of facts • focus on teaching basic concepts of physical and biological sciences • sophisticated understanding of science as a human endeavor, including limitations and power of scientific inquiry

• courses should enhance students' appreciation of how scientist do science, not just what scientists have concluded	• emphasize major concepts of the discipline, including biochemical and physiological principles
B3 Laboratory Activity (lab course) • lab activity must be associated with a lecture component, or stand-alone laboratory course connected as a co-requisite or prerequisite • course outline clearly distinguishes the laboratory activity from the lecture component • lab manuals are required, and must be explicitly listed on the course outline	**5C Laboratory Science (lab course)** • must correspond to one of the lecture courses • lecture course is a prerequisite or co-requisite of the laboratory course • lecture and lab courses may have separate course numbers • lab manuals are required, and must be explicitly listed on the course outline

Scientific Inquiry, Physical and Biological Sciences
This distinction of learning not just the conclusions of scientists but also *how science is practiced* is the key to making review decisions in a few special cases:

- **Multi-disciplinary and interdisciplinary science courses.** Some community colleges have designed courses to meet California's credentialing standards for prospective elementary school teachers, who will need to know something about geology, astronomy, physics and chemistry. These "do-it-all" courses may be acceptable, *if they address science as a mode of intellectual inquiry and emphasize the major concepts of the discipline*.

  Organic chemistry courses may also strike reviewers as interdisciplinary, but are ordinarily categorized in Physical Science Subareas B1 and 5A, where the subject is frequently housed and taught.

- **Physical anthropology courses.** Depending on the emphasis, a course in physical anthropology may belong with other biological sciences in Subareas B2 and 5B.

- **Physical geography courses.** These are almost always accepted in Subarea B1 and 5A. Other kinds of geography course are closer to the Social Sciences and Social and Behavioral Sciences and are instead approved in Areas D and 4.

- **Lower-division major preparation courses.** These may work unless they are *too narrow*; the question is whether students will achieve the *"science literacy"* expected of educated citizens in any profession.

- **Lab manuals.** Lab manuals are required, and must be explicitly listed on the COR, for all courses in IGETC Area 5C and CSU GE Breadth Subarea B3.

In defining "science literacy" for an educated populace, science faculty from across the CSU agreed to this definition and course-scoring rubric, which reviewers of community college courses may find helpful:

> A student who achieves science literacy through a course that satisfies a general education science requirement must master literacy in understanding both:
> (a) science as the system of reasoning—the acquisition of testable knowledge of the physical world, including explanations of the phenomena and
>
> (b) the minimal foundational concepts and content of the science discipline(s) addressed by the course.

This rubric addresses "a":

Unacceptable	Minimally acceptable	Very Acceptable	Ideal
Item 13 only or Item 13 plus omission of any Items 1-7	Items 1-7, plus Item 13	Items 1-10 plus Item 13	Items 1-13

Learning Outcomes for Science Literacy in Science as a Framework of Reasoning in an Introductory Course

1. Student can articulate in her/his own words a reasonable definition for what constitutes science.
2. Student can describe, using at least two specific examples, how science literacy is important in everyday life to an educated person.
3. Student can explain why the attribute of doubt has value in science.
4. Student can explain how scientists select which among several competing working hypotheses best explains a physical phenomenon.
5. Student can explain how "theory" as used and understood in science differs from "theory "as commonly used and understood by the general public.
6. Student can explain why peer review generally improves our quality of knowing within science.
7. Student can explain how science uses the method of reproducible experiments to understand and explain the physical world.
8. Student can name one assumption that underlies all science.
9. Student can provide two examples of science and two of technology and use these to explain a central concept by which one can distinguish between science and technology.
10. Student can cite a single major theory from one of the science disciplines and explain its historical development.
11. Student can explain and provide an example of modeling as used in science.
12. Student can explain why awareness of ethics becomes increasingly important to a society becoming increasingly advanced in science.
13. Student can meet the minimal learning outcomes specified by the discipline that address the major ideas, concepts and content of the science discipline. *The arbiter of "specified by discipline" might range from locally at the scale of a department to internationally as specified by the larger profession.*