Learning Goals and Outcomes: General Science Concentration

Our departmental evaluation of the degree to which students are achieving our learning outcomes, which is intended primarily as a tool for us to assess the effectiveness of our program, will take place primarily during their involvement in GNSC 0383: Senior Seminar in General Science. In that course, each student will assemble a portfolio documenting their achievements during their college career. We anticipate that the portfolio will include a section related to each of the goals identified below, with each section being introduced by a narrative that describes the materials presented, links them to specific outcomes, and assesses the student's achievement of each outcome. While we expect that most students will be able to provide appropriate supporting evidence from their coursework, in some cases (e.g. if the student did poorly on assignments related to particular outcomes) it would be appropriate for them to include additional essays summarizing their understanding of the material related to a particular outcome. The tables below also include a description of the standard that will be used in determining whether or not students have met each outcome.

Goal #1: Students will have a solid understanding of the basic principles of astronomy, biology, chemistry, geology, meteorology and physics and be able to apply their knowledge in those areas across traditional subject-matter boundaries.

Learning Outcome	Method of Assessment	Standard for "Meets"	Courses (ELED)	Courses (5-8)
A Students will have demonstrated the ability to describe the components and overall structure of the Universe, including planets, the solar system, stars, the Milky Way and other galaxies, and the Universe at large.	Students will submit responses to exam questions, homework problems or class activities where they have utilized this knowledge.	Narrative and submitted work show clear understanding of the overall structure of the Universe (solar system, Milky Way, Local Group, Universe of galaxies), and include brief explanations of the nature of planets, stars, and galaxies.	ASTR 0101	ASTR 0101
B Students will have demonstrated the ability to describe the physical and chemical evolution of the Universe from the Big Bang to the present.	Students will submit responses to exam questions, homework problems or class activities where they have utilized this knowledge.	Narrative and submitted work provide an explanation of the Big Bang and the evidence supporting it (at least two of: cosmic background radiation, expansion of the Universe, elemental abundances), plus the formation of galaxies, and the formation of our solar system and provide a reasonable time scale for those events. Narrative and submitted work also shows a clear understanding of how nuclear fusion reactions inside stars have modified the original chemical composition of the Universe through time.	ASTR 0101	ASTR 0101

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C Students will have demonstrated the ability to describe basic cellular structure and cellular processes.	Students will submit responses to exam questions, homework problems or class activities where they have utilized this knowledge.	Narrative and submitted work show that the student can distinguish between prokaryotic and eukaryotic cells, and also demonstrate an understanding of the major features of prokaryotic and eukaryotic cells, including the differences between animal and plant cells and the roles of the organelles present in eukaryotic cells.	BIOL 0104	BIOL 0129
D Students will have demonstrated the ability to explain the process of genetic inheritance and the impacts of mutations and environmental conditions on that process.	Students will submit responses to exam questions, homework problems or class activities where they have utilized this knowledge.	Narrative and submitted work reflect an understanding of the mechanism by which genetic information is transmitted in the form of DNA. Evidence includes explanations of sexual and asexual transmission of genetic material, dominant and recessive genes, the importance of base pairing, and the role of mutation and environment.	BIOL 0104	BIOL 0128 BIOL 0129
E Students will have demonstrated the ability to explain the theory of evolution and to describe some of the evidence that supports it.	Students will submit responses to exam questions, homework problems or class activities where they have utilized this knowledge.	Narrative and submitted work demonstrate a clear understanding of the idea of "natural selection" operating to change the overall characteristics of species, and provide discussions of at least two kinds of evidence that support the idea that evolution can take place or has taken place (e.g. artificial selection, vestigial organs, homologous structures, fossil sequences).	BIOL 0104 GEOL 0106	BIOL 0128 GEOL 0106
F Students will have demonstrated the ability to explain the basic functions of ecosystems, including an understanding of the interactions between organisms and the factors that influence population sizes for various organisms.	Students will submit responses to exam questions, homework problems or class activities where they have utilized this knowledge.	Narrative and submitted work reflect an understanding of the functioning of ecosystems, including the interactions between different types of organisms (primary producers, herbivores, carnivores, decomposers, etc.) and between organisms and their physical environment.	BIOL 0102	BIOL 0128

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G Students will have demonstrated the ability to explain the structure of matter (including molecules, atoms, and nuclei), and to distinguish between solids, liquids, gases, and solutions.	Students will submit responses to exam questions, homework problems or class activities where they have utilized this knowledge.	Narrative and submitted work reflect an understanding of atomic and molecular structure, and the forces that determine whether a substance exists as a solid, liquid or gas.	CHEM 0101 PHSC 0101	CHEM 0109 CHEM 0111
H Students will have demonstrated the ability to describe some of the				

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O Students will have demonstrated the ability to describe Earth's physical

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S Students will have demonstrated the ability to explain the nature of conservation laws in physics and chemistry (e.g. energy, momentum, atoms), and to apply those ideas in a variety of situations.	Students will submit responses to exam questions, homework problems or class activities where they have utilized this knowledge.	Narrative and submitted work provide examples that illustrate the laws of conservation of momentum and energy, including familiarity with the concepts of work, kinetic energy, gravitational potential energy, and electrical potential energy.	PHSC 0101	CHEM 0109 PHSC 0115

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Goal #2: Students will develop effective laboratory skills and will understand safety issues related to laboratory and field work.

Learning Outcome	Method of Assessment	Standard for "Meets"

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Goal #3: Students will understand the methodology and processes of science, and will be able to explain the differences between scientific and other ways of knowing.

Learning Outcome	Method of Assessment	Standard for "Meets"	Courses (ELED)	Courses (5-8)
A Students will have demonstrated the ability to use the methodology of science, including the processes of observation, forming hypotheses, making predictions based on hypotheses, testing of those predictions, and evaluation of the results.	Students will submit laboratory reports where they have engaged in the various processes, along with a reflective narrative discussing the processes of science and linking their specific reports to each process.	Narrative and submitted work reflect a clear understanding of the methodology of science and submitted work includes laboratory reports that provide at least one example for each of the processes where the student successfully engaged in that process.	CHEM 0101 GEOL 0101 PHSC 0101	CHEM 0109 CHEM 0111 GEOL 0101 PHSC 0115 PHSC 0117
B Students will have demonstrated the ability to distinguish between hypotheses and scientific theories,	Students will submit a reflective paragraph in which they discuss the difference between hypotheses and theories.	Narrative demonstrates an understanding of the difference between hypotheses and scientific theories.	ASTR 0101 CHEM 0101 GEOL 0101 GEOL 0106 PHSC 0101	ASTR 0101 CHEM 0109 CHEM 0111 GEOL 0101 GEOL 0106 PHSC 0115
C Students will have demonstrated the ability to explain some of the evidence that underpins major theories from the physical sciences (e.g. plate tectonics, relativity, the Big Bang).	Students will submit responses to exam questions,			

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Goal #4: Students will be able to relate their scientific knowledge to both the natural and technological worlds around them, and will be able to apply those understandings to develop informed opinions about societal issues with a scientific component.

Learning Outcome	Method of Assessment	Standard for "Meets"	Courses (ELED)	Courses (5-8)
A Students will have demonstrated the ability to provide specific examples of situations where scientific principles can explain particular events in the natural world.	Students will submit responses to exam questions or homework problems that demonstrate their ability to make such explanations.	Narrative and submitted work demonstrate an understanding of at least five natural phenomena based on scientific principles.	ASTR 0101 BIOL 0102 BIOL 0104 CHEM 0101 GEOL 0101 GEOL 0106 GNSC 0330 PHSC 0101	ASTR 0101 BIOL 0128 BIOL 0129 CHEM 0109 CHEM 0111 GEOL 0101 GEOL 0106 GNSC 0330 PHSC 0115 PHSC 0117
B Students will have demonstrated the ability to provide specific examples of devices where certain scientific principles are utilized.	Students will submit responses to exam questions or homework problems that demonstrate their knowledge of such applications.	Narrative and submitted work demonstrate an understanding of at least three technological applications of basic principles of chemistry and/or physics.	GNSC 0330 PHSC 0101	GNSC 0330 PHSC 0115 PHSC 0117
C Students will have demonstrated the ability to defend positions on issues like global warming, the disposal of radioactive waste, acid rain, or the use of pesticides.	Students will submit responses to exam questions or papers where they have defended a position on an issue with a scientific component.	Narrative and submitted work identify at least two social/environmental issues with a scientific component, demonstrate an understanding of the basic scientific principles that are involved, and support a position on each of those issues with at least two plausible arguments.	GEOL 0101 GNSC 0330 PHSC 0101	GEOL 0101 GNSC 0330

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Goal #5: Students will be able to locate, evaluate and synthesize information on scientific topics that are new to them.

Learning Outcome	Method of Assessment	Standard for "Meets"	Courses (ELED)	Courses (5-8)
A Students will have demonstrated the ability to retrieve information effectively from libraries, electronic databases, and internet resources.	Students will submit copies of papers or other assignments where they retrieved information from a variety of sources.	Narrative and submitted work document at least one instance where the student has retrieved information from each of the sources listed.	ASTR 0349 or GEOL 0347 GNSC 330	ASTR 0349 or GEOL 0347 GNSC 330
B Students will have demonstrated the ability to evaluate the credibility and relevance of sources of scientific information.	Given a set of potential sources for information on a scientific topic, students will write a brief essay evaluating those sources.	Narrative documents an understanding of the likely reliability of different types of sources.	GNSC 0330	GNSC 0330
C Students will have demonstrated the ability to compare and synthesize information on a topic from a variety of sources.	Students will submit copies of papers or other assignments where they synthesized information.	Narrative and submitted work demonstrate at least one instance where the student has brought together information from a variety of sources to arrive at a more nuanced understanding of some topic.	ASTR 0349 or GEOL 0347 GNSC 330	ASTR 0349 or GEOL 0347 GNSC 330

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Goal #6: Students will be able to make effective use of mathematical reasoning, including the ability to apply algebraic skills to solve scientific problems or to make quantitative estimates.

Learning Outcome	Method of Assessment	Standard for "Meets"	Courses (ELED)	Courses (5-8)
A Students will have demonstrated the ability to construct graphs from available data and to use those graphs to analyze and understand the phenomenon being investigated.	Students will submit homework problems or laboratory reports where they have demonstrated these skills.	Narrative and submitted work include at least two examples of situations where the student has demonstrated the ability to construct a graph, reason about the phenomenon based on a graphical representation of data, and has interpreted characteristics of the graph (e.g. the slope of a best-fit line).	ASTR 0349 or GEOL 0347 PHSC 0101	ASTR 0349 or GEOL 0347 PHSC 0115 PHSC 0117
B Students will have demonstrated the ability to solve algebraic equations for an unknown quantity and to calculate that quantity given appropriate information.	Students will submit exam questions and/or homework problems where they have demonstrated these skills.	Narrative and submitted work include at least five examples (involving five different equations) of situations where the student has demonstrated these skills.	ASTR 0101 ASTR 0349	

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Goal #7: Students will develop effective written and oral communication skills, including the ability to compose summaries, develop research papers or persuasive essays, and present the results of their own scientific investigations.

Learning Outcome	Method of Assessment	Standard for "Meets"	Courses (ELED)	Courses (5-8)
A Students will have demonstrated the ability to write brief (1-page) summaries focused on the major points made in an article or during a presentation.	Students will submit examples of such summaries.	Submitted work (which includes the article being summarized) demonstrates an understanding of the article's major points and of the observations or arguments that the author has used to support those major points.	GEOL 0106 GNSC 0330	GEOL 0106 GNSC 0330
B Students will have demonstrated the ability to prepare clear and complete laboratory reports, including a description of their procedure, their data and an interpretation of that data.	Students will submit copies of laboratory reports demonstrating these qualities, along with comments/grades from their instructor.	Narrative reflects an understanding of the need for careful observation and record-keeping during experiments. Submitted work includes at least two examples of laboratory reports demonstrating these competencies.	CHEM 0101 PHSC 0101	CHEM 0109 CHEM 0111 PHSC 0115 PHSC 0117
C Students will have demonstrated the ability to write an informational research paper, summarizing what is known about a scientific topic, making appropriate use of in-text and bibliographic references.	Students will submit such a paper and relevant comments/grade from the instructor.	Submitted work includes at least one research paper (at least 3 pages in length), on a scientific topic, that includes appropriate bibliographic and in-text citations.	ASTR 0349 or GEOL 0347 GNSC 0330	ASTR 0349 or GEOL 0347

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Goal #8:

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The grid below summarizes how the major coursework contributes to the individual goals described above for students in the GNSC concentration, elementary-school track and GNSC concentration, middle-school track:

	Astronomy	Biology Courses	Intro to Chemistry	General Chemistry I	General Chemistry II	Physical Geology	Historical Geology	Meteorology	Intro to Physics	General Physics I	General Physics II	Science, Tech, Society	IIPS: Astronomy	IPS: Geology
1. Basic principles	X	X	X	X	X	X	X	X	X	X	X		X	X
2. Laboratory skills		X	X	X	X	X			X	X	X			