Examples – Natural Sciences in Undergraduate General Education
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Example 1 - Natural Sciences at the University of Maryland[1]

Part of a 4-area general education:

Fundamental Studies	Distributive Studies	Diversity	Signature Courses
Academic Writing (FSAW)	History and Social Sciences (DSHS)	Cultural Competency (DVCC)	I-Series (SCIS)
Analytic Reasoning (FSAR)	Humanities (DSHU)	Understanding Plural Societies (DVUP)	
Math (FSMA)	Natural Sciences (DSNS)		
Oral Communications (FSOC)	Natural Science Lab (DSNL)		
Professional Writing (FSPW)	Scholarship in Practice (DSSP)		

Courses in the Natural Sciences introduce students to the concepts and methods of the disciplines studying the natural world. It includes courses in the traditional physical and life sciences, environmental science, animal and avian science, and plant science, among others. It also includes a substantial, rigorous laboratory experience.

Courses in the Natural Sciences must address at least 4 of the 6 Learning Outcomes.

Learning Outcomes in **bold** are **required**.

On completion of a Natural Sciences course, students will be able to:

- Demonstrate a broad understanding of scientific principles and the ways scientists in a particular discipline conduct research.
- Apply quantitative, mathematical analyses to science problems.
- Solve complex problems requiring the application of several scientific concepts.
- Look at complex questions and identify the science and how it impacts and is impacted by political, social, economic, or ethical dimensions.
- Critically evaluate scientific arguments and understand the limits of scientific knowledge.
- Communicate scientific ideas effectively.

In addition to the Learning Outcomes above, on completion of a Natural Sciences course with a laboratory experience students will be able to:

- **Demonstrate proficiency in experimental science by: making observations, understanding the fundamental elements of experiment design, generating and analyzing data using appropriate quantitative tools, using abstract reasoning to interpret data and relevant formulae, and testing hypotheses with scientific rigor.**

[1] http://www.gened.umd.edu/documents/TransformingGeneralEducation.pdf; rubrics are here: http://www.gened.umd.edu/for-faculty/faculty-gened-assessment.html

Examples 2 & 3

Both the University of Kentucky and Indiana University use two common student learning outcomes for their "cornerstone" courses that all students take (math, science, arts/humanities, social sciences).

Example 2 – Learning Outcome I: Intellectual Inquiry [2]

- Students will demonstrate an understanding of and ability to employ the processes of intellectual inquiry.

Rubric specific to natural sciences:

	4	3	2	1	0
Explore multiple and complex answers to questions/issues within the natural, physical and/or mathematical sciences by identifying the dimensions of a good question	The question is described clearly, completely, fully and in great detail. The question is answerable by experiment or observation. The experimental design is appropriate and described in detail.	The question is described but some detail is missing. The question is answerable by experiment or observation but lacks clarity. The experimental design is appropriate but lacks detail.	The question is inadequate or incompletely described. The question is not answerable by experiment or observation. The experimental design is inappropriate.	The question is inadequate or incompletely described. The question is not answerable by experiment or observation The experimental design is missing.	The question is absent and the experimental design is missing.
Explore multiple and complex answers to questions/issues within the natural, physical and/or mathematical sciences by evaluating theses and conclusions in light of credible evidence; and judging the quality of information as informed by rigorously developed evidence	Provides a well-developed evaluation and analysis of the data and questions its accuracy, relevance, and completeness. Justifies key results and procedures, explains assumptions and reasons.	Evaluation and analysis of data contains minor errors/omissions. Justifies some results or procedures, explains reasons.	Evaluation and analysis of data contains major errors/omissions. Justification of results contains significant flaws.	Evaluation and analysis of data contains major errors/omissions. No justification of results.	Evaluation and analysis of data is missing. No justification of results.

[2] University of Kentucky. http://www.uky.edu/registrar/content/uk-core

Explore multiple and complex answers to questions/issues within the natural, physical and/or mathematical sciences by exploring alternative approaches and/or future study of the question	Critically evaluates major alternative points of view/ approaches. (and/or) Provides a detailed description of future studies. Makes suggestions related to the improvement of the existing experimental design.	Offers evaluations of obvious alternative points of view/approaches. (and/or) Makes suggestions for future research studies, which have minor flaws. Makes some suggestions for improvement of the existing experimental design, which are incomplete or have minor flaws.	Superficially evaluates obvious alternative points of view/ approaches. (and/or) Makes suggestions for future research studies, which have significant flaws. Makes some suggestions for improvement of the existing experimental design, which have significant flaws.	Superficially evaluates obvious alternative points of view/ approaches. (and/or) Does not make suggestions for future research studies, or for the redesigning of the existing procedure.	Fails to evaluate obvious alternative points of view/ approaches. (and/or) Does not make suggestions for future research studies, or for the redesigning the existing procedure.

Example 3 Student Learning Outcomes for "Scientific Ways of Knowing"[3]

- Access, use, and critically evaluate a variety of information sources.
- Apply principles of inquiry to define and analyze complex problems through reasoning and discovery.

Upon completion of inquiry in scientific ways of knowing, students will be able to:

- Upon completion, students will be able to:
- Explain how scientific explanations are formulated, tested, and modified or validated.
- Distinguish between scientific and nonscientific evidence and explanations.
- Apply foundational knowledge and discipline-specific concepts to address issues or solve problems.
- Apply basic observational, quantitative, or technological methods to gather data and generate evidence-based conclusions.
- Use current models and theories to describe, explain, or predict natural phenomena.
- Locate reliable sources of scientific evidence to construct arguments related to real-world issues.

[3] Indiana University East. http://www.iue.edu/catalog/policies/documents/IU_East_General_Education_Curriculum_2017.pdf

Example 4 – Revising Student Learning Outcomes[4]

"The 1997 Campus Learning Objectives were written by faculty, for faculty. The two examples below illustrate high aspirational goals with no clear path for attaining them within the university:

1. Educated persons should develop the skills to understand, accept, and relate to people of different backgrounds and beliefs. In a pluralistic world one should not be provincial or ignorant of other cultures; one's life is experienced within the context of other races, religions, languages, nationalities, and value systems.
2. Educated persons should be expected to have some understanding of and experience in thinking about moral and ethical problems. A significant quality in educated persons is the ability to question and clarify personal and cultural values and thus be able to make discriminating moral and ethical choices.

The new Campus Learning Outcomes are written purposefully in a clear and concise language, which helps students understand expectations of them:

1. Communicate clearly and effectively in written and oral forms
2. Access, use, and critically evaluate a variety of relevant information sources
3. Apply principles of inquiry to define and analyze complex problems through reasoning and discovery
4. Demonstrate the ability to relate within a multicultural and digitally connected world
5. Demonstrate a deep understanding of a field of study

Each new outcome comes with an explanatory paragraph to provide clarity, which helps faculty members, students, and stakeholders better understand the intent of each outcome. It is clear that the new outcomes are simpler, streamlined, and easier to assess compared with the old objectives."

[4] Excerpts from Alexander, R., Blakefield, M., Frank, K., & Pomper, M. (2016). State Mandates and General Education: One Campus Responds to Challenges and Opportunities. *The Journal of General Education*, 65(1), 36–47.