**PROCESS OF SCIENCE**

**SCIENTIFIC THINKING**
- Explain how science generates knowledge of the natural world.
- Describe the iterative nature of science and how new evidence can lead to the revision of scientific knowledge.

**INFORMATION LITERACY**
- Locate, interpret, and evaluate scientific information.
- Evaluate claims in scientific papers, popular science media, and scientific journals.

**QUESTION FORMULATION**
- Formulate testable hypotheses and state their predictions.
- Formulate testable hypotheses and address gaps in knowledge.

**STUDY DESIGN**
- Plan, evaluate, and implement scientific investigations.
- Design controlled experiments, including plans for analyzing the data.

**DATA INTERPRETATION & EVALUATION**
- Interpret, evaluate, and draw conclusions from data in order to make evidence-based arguments about the natural world.
- Analyze data, summarize resulting patterns, and draw appropriate conclusions.

**DOING RESEARCH**
- Apply science process skills to address a research question in a course-based or independent research experience.

**QUANTITATIVE REASONING**

**PROGRAM-LEVEL LEARNING OUTCOMES**
- Compute basic mathematics (e.g., integrals, probability, unit conversion) in biological contexts.
- Use basic mathematics (e.g., integrals, probability, unit conversion) in biological contexts.

**COURSE-LEVEL LEARNING OUTCOMES**
- Perform basic calculations (e.g., percentages, frequencies, rates, means).
- Select and apply appropriate equations (e.g., Hardy-Weinberg, Nemst, Gibbs free energy) to solve problems.

**NUMERACY**
- Recognize gaps in our current understanding of a biological system or process and identify what specific information is missing.
- Design controlled experiments, including plans for analyzing the data.

**MODELING**
- Analyze data, summarize resulting patterns, and draw appropriate conclusions.
- Describe sources of error and uncertainty in data.

**PURPOSE OF MODELS**
- Recognize the important roles that scientific models, of many different types (conceptual, mathematical, physical, etc.) play in predicting and communicating biological phenomena.
- Give two models of the same biological process or system, compare their strengths, limitations, and assumptions.

**MODEL APPLICATION**
- Make inferences and solve problems using models and simulations.
- Use models and simulations to make predictions and refine hypotheses.

**MODELING**
- Build and evaluate models of biological systems.
- Build and review conceptual models to propose how a biological system or process works.

**INTERDISCIPLINARY NATURE OF SCIENCE**

**PROGRAM-LEVEL LEARNING OUTCOMES**
- Consider interdisciplinary solutions to real-world problems.
- Recognize the important roles that scientific models, of many different types (conceptual, mathematical, physical, etc.) play in predicting and communicating biological phenomena.

**COURSE-LEVEL LEARNING OUTCOMES**
- Build models or explanations of simple biological processes that include concepts from other STEM disciplines or multiple fields of biology.
- Build models or explanations of simple biological processes that include concepts from other STEM disciplines or multiple fields of biology.

**COMMUNICATION & COLLABORATION**

**PROGRAM-LEVEL LEARNING OUTCOMES**
- Work productively in teams with people who have diverse backgrounds, skill sets, and perspectives.
- Provide and respond to constructive feedback in order to improve individual and team work.

**COURSE-LEVEL LEARNING OUTCOMES**
- Evaluate feedback from others and revise work or behavior appropriately.
- Critique others’ work and ideas constructively and respectfully.

**COLLABORATION**
- Work effectively with teammates to complete projects.
- Elicit, listen to, and incorporate ideas from teammates with different perspectives and backgrounds.

**COLLEGIATE REVIEW**
- Reflect on your science learning, performance, and achievements.
- Assess personal progress and contributions to your team and generate a plan to change your behavior as needed.

**METACOGNITION**
- Reflect on your science learning, performance, and achievements.
- Assess personal progress and contributions to your team and generate a plan to change your behavior as needed.

**COMMUNICATION**
- Use appropriate language and style to communicate science effectively to targeted audiences (e.g., general public, biology experts, collaborators in other disciplines).
- Use a variety of modes to communicate science (e.g., oral, written, visual).

- Work with teammates to establish and periodically update group plans and expectations (e.g., team goals, project timeline, rules for group interactions, individual and collaborative tasks).
- Work effectively with teammates to complete projects.
- Use appropriate language and style to communicate science effectively to targeted audiences (e.g., general public, biology experts, collaborators in other disciplines).
- Use a variety of modes to communicate science (e.g., oral, written, visual).

- Reflect on your science learning, performance, and achievements.
- Assess personal progress and contributions to your team and generate a plan to change your behavior as needed.
**ETHICS**
Determine the ability to critically analyze ethical issues in the conduct of science.
- Identify and evaluate ethical considerations (e.g., use of animal or human subjects, conflicts of interest, confirmation bias) in a given research study.
- Critique how ethical controversies in biological research have been and can continue to be addressed by the scientific community.

**SOCIETAL INFLUENCES**
Consider the potential impacts of outside influences (historical, cultural, political, technological) on how science is practiced.
- Describe examples of how scientists’ backgrounds and biases can influence science and how science is enhanced through diversity.
- Identify and describe how systemic factors (e.g., socioeconomic, political) affect how and by whom science is conducted.

**SCIENCE’S IMPACT ON SOCIETY**
Apply scientific reasoning in daily life and recognize the impacts of science on a local and global scale.
- Use examples to describe the relevance of science in everyday experiences.
- Identify and describe the broader societal impacts of biological research on different stakeholders.
- Describe the roles scientists have in facilitating public understanding of science.

**HOW WAS THE BIOSKILLS GUIDE DEVELOPED?**
- Initial Drafting
- Literature review
- Interviews
- Workshop
- Surveys
- Workshops
- Validation
  - n=218 (~60/outcome)

**HOW CAN THE BIOSKILLS GUIDE HELP YOU?**
- Determine prerequisites
- Align assessments
- Design lessons
- Let students know expectations
- Form transfer agreements
- Plan and review curricula

A Tool for Interpreting the Vision and Change CORE COMPETENCIES

The BioSkills Guide comprises program- and course-level learning outcomes that elaborate what general biology majors should be able to do by the time they graduate. Building on the six core competencies of Vision and Change, the learning outcomes were developed and then nationally validated using input from over 600 college biology educators from a range of biology subdisciplines and institution types.