# Elements of the Assessment Process
# Form E-1-A for Boston College Departments/Programs

## Department/Program Biology Department Core

1) **Have formal learning outcomes been developed? What are they?** (What specific sets of skills and knowledge does the department expect its majors to have acquired before they graduate?)

The Boston College Natural Science Core Curriculum learning outcomes are listed below.

Students completing the Natural Science core will:

1. expand their understanding of the principles, body of knowledge, and investigative strategies that comprise science and its technological applications;
2. develop a scientific literacy that will promote curiosity, respect for the scientific method, and general awareness of the limitations of scientific conclusions;
3. recognize the role of scientific discovery, past, present and future, in interrelated concerns such as human health, societal well-being, and planetary sustainability; and
4. appreciate the role of science in defining their relationship with the natural world and their position within the cosmos.

The Biology department has identified the following learning outcomes for students majoring in Biology.

Learning outcomes for students who complete a B.S. or B.A. degree in Biology include the following:

- Students will understand the core concepts of Biology:
  - Evolution
  - Cellular Structure & Function
  - Information Transfer & Gene Expression
  - Energy Transformation
  - Systems & Organismal Biology
- Students will apply the process of science through observation, experimentation and hypothesis testing.
- Students will be able to use quantitative reasoning in the analysis of dynamic biological systems
- Students will use bioinformatics and databases to study biological processes.
- Students will understand and practice the ethics surrounding scientific research.

For students who complete the B.S./M.S. degree in Biology, they are expected to acquire the additional learning outcomes:

- Conduct original, publishable research in a field of Biology.
- Demonstrate an in-depth knowledge of a specific area of expertise.

2) **Where are these learning outcomes published? Be specific.** (Where are the department's learning expectations accessible to potential majors: on the web or in the catalog or in your dept major handouts?)

Natural Science core learning outcomes are available on the Arts and Sciences Core website.

Biology department major learning outcomes are available on the biology department website undergraduate webpage.

3) **Other than GPA, wheat data/evidence is used to determine whether graduates have achieved the stated outcomes for the degree?** (What do you use to assess which of the student learning outcomes are being achieved more or less well?)

Each year, different aspects of the curriculum were assessed in different sections of our introductory/core courses. These two courses (Molecules and Cells and Ecology and Evolution) are major requirements, and also satisfy the Natural Science core requirement.

## Ecology and Evolution with Prof. Heather Olins - Fall 2022

**Student Perceptions of Learning**

In Professor Olins' section of Ecology and Evolution course, three likert-scale agree/disagree statements were added to student course evaluations, to assess the extent to which students perceived the course addressing the core learning objectives. The statements are listed below as they were presented to students.

1. This course has increased my understanding of the biological sciences.
2. After taking this course, I am more confident in my ability to interpret the results of scientific experiments.
3. This course has increased my understanding of the role that science plays in society and the human condition

The responses from 170 Fall 2022 students are summarized in Figure 1. Students overwhelmingly agreed or strongly agreed (95% of respondents) that the course increased their understanding of the biological sciences. Similarly, 96% of students agreed or strongly agreed that the course increased their understanding of the role that science plays in society and the human condition. 72% of students felt more confident in their ability to interpret the results of scientific experiments after taking the course, while 19% were uncertain about statement #2 above. This represents an area of the course where additional focus on data analysis and metacognition could benefit students, and may be an area where we can strive for more explicit, direct, and/or transparent instruction. These percentages are very similar to the results of the previous year when these questions were asked of students in all of the intro courses.

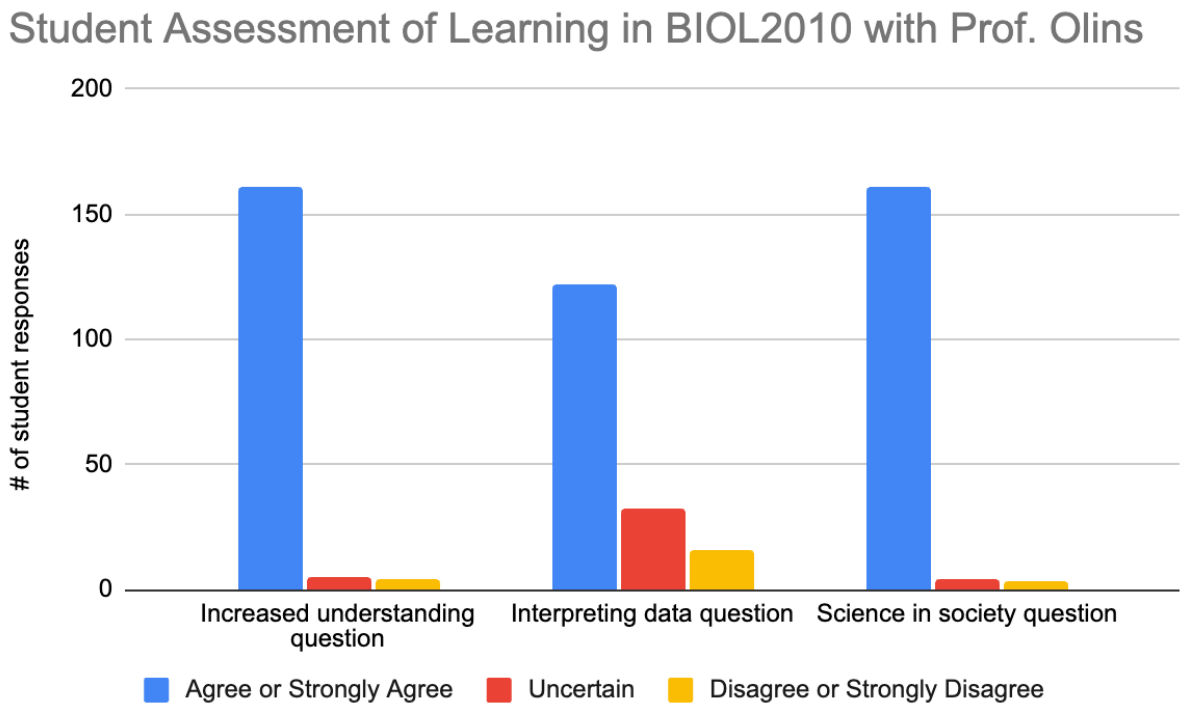



FIgure 1. Summary of student responses to likert-scale course evaluation questions listed above. Agree and strongly agree responses have been pooled, and are shown in blue (first bar for each question). Uncertain responses are shown in red (middle bar). Disagree and strongly disagree responses are pooled and shown in orange (third bar for each question).

In addition to these questions from the student evaluations, students were also asked to reflect at the end of the semester on how the climate change content in the course had influenced their confidence in discussing this particular topic outside of class. For the second year in a row, 95% of students stated that their learning in the course had increased their comfort level discussing climate change outside of class either “quite a lot” or “somewhat”.

Attempts: 198 out of 198

To what extent do you think that your learning in this course this semester has increased your comfort level discussing climate change?

| | | | |
|---|---|---|---|
| quite a lot | 117 respondents | 59 % | |
| somewhat | 72 respondents | 36 % | |
| just a bit | 8 respondents | 4 % | |
| not at all | 1 respondent | 1 % | |

Figure 2. Summary of student responses from an in-class activity reflecting on the extent to which the course had increased their comfort discussing climate change.

**Assessment of students' ability to assess scientific data through figures**.

Figure 3 shows overall student responses to a question from the final exam tasking students with graph interpretation. While 66% of students earned full credit on this question (which was revised slightly since last year's report). The vast majority of students selected the three correct statements. The 13% of students who selected the first statement are an indication that there is still some work to be done to ensure that all students in this course are proficient in their ability to read and interpret a graph. This is in line with the student perceptions about data interpretation described above.

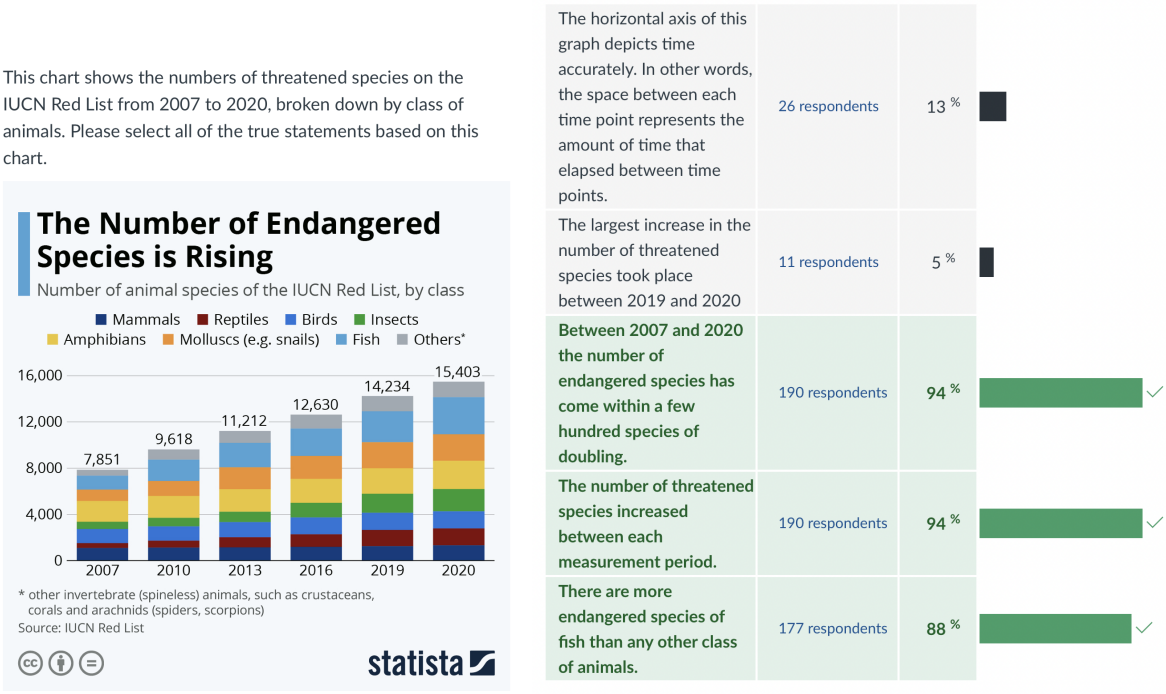



Figure 3. Summary of student responses to a graph interpretation question from the course final exam.

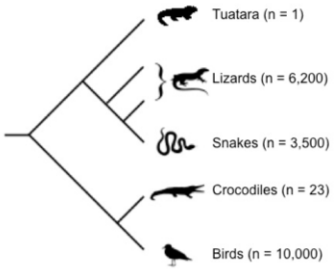
## Assessment of Core Learning in Ecology and Evolution with Prof. Jeffery Dacosta - Spring 2023

**Assessment of students' ability to assess scientific data through figures**.

The following two questions on my final exam present a figure representing a phylogeny (question 1) or a sub-type of natural selection (question 2) and ask students to interpret the data presented with respect to a topic covered in class. Correct answers are in bold, and the percentage of students marking each answer is given in parentheses. In each case, students were exposed to similar figures during the semester, but not the same ones given in these questions. For example, stabilizing selection (question 2) was presented with survival or fitness

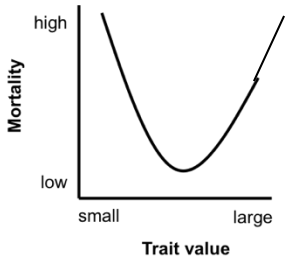
on the y-axis, which inverts the pattern in the figure. The high percentage of correct answers is thus a reflection that students are able to interpret figures and transfer previous knowledge to a familiar, but different, situation.

*Question 1*. This phylogeny shows the relationships among five lineages and the estimated number of extant species within each lineage. Which lineage should receive conservation priority based on the phylogenetic diversity metric?




1. **Tuatara (84.4%)**
2. lizards
3. snakes
4. crocodiles
5. birds

*Question 2*. Based on the data shown in this figure, what type of natural selection do you expect for this trait?




1. directional
2. **stabilizing (87.9%)**
3. diversifying
4. kin
5. frequency dependent

**Assessment of students' ability to synthesize a recurring topic.**

Global climate change is a wide-ranging topic in ecology and evolution, and one of the most important challenges of the 21st century. As such, the topic is introduced at the beginning of the semester and recurs often within different subjects. At the end of the semester, students are asked to write a reflection essay with the following prompt:

> *Current climate change and its impacts on the biosphere and human society will be one of the most prominent subjects of the next century. Climate change has become highly politicized, however, which obscures and undermines our scientific understanding of the topic. Suppose that a person in your life thinks that climate change is happening but "is not a big deal." Drawing on your experience in this class, choose and describe THREE specific themes/subjects/concepts that you would use to demonstrate to this person that climate change is important at a local and/or global level.*

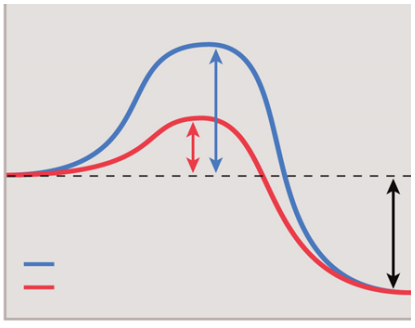
For this report, 10 essays were randomly drawn and the specific course topics that were reviewed were analyzed. Some of the more prominent subjects were used in several essays, which demonstrates that central themes in the course made a lasting impression. For example, multiple students discussed extreme weather (6/10), greenhouse gasses and fossil fuels (5/10), and biodiversity/habitat loss (4/10). On the other hand, no two students used the same three

subjects in their essays and a total of 12 subjects were used. This variety demonstrates individual thinking and the ability to synthesize across a wide swarth of topics.

| | Random Proposal | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Topic** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **Sum** |
| Extreme weather | | | x | | x | x | | x | x | x | 6 |
| Greenhouse gases, fossil fuels | x | x | x | | | | x | | | x | 5 |
| Biodiversity/habitat loss | x | | | x | | | x | | x | | 4 |
| Ecosystem services | | | | x | | x | | x | | | 3 |
| Phenology changes | | | | x | | x | | | | x | 3 |
| Environmental justice | | x | | | x | | | | | | 2 |
| Ocean acidification | | | | | | | x | | x | | 2 |
| Decreased net primary productivity | | | | | x | | | | | | 1 |
| Ecological feedback loops | | x | | | | | | | | | 1 |
| Human health | | | | | | | | x | | | 1 |
| Range shifts | | | x | | | | | | | | 1 |
| Winter weather in NE | x | | | | | | | | | | 1 |

## Assessment of Core Learning in Molecules and Cells with Prof. Doug Warner - Spring 2023

These two questions from the Final Exam evaluated the ability of the students to interpret the results of a scientific experiment and understanding how biological systems work:



62) Consider the above Figure, what type of reaction is this?

A. Endergonic
B. Exergonic
C. Null reaction
D. Z scheme

E. Non-spontaneous reaction

63) Still considering that figure ----Which arrow shows the net change in free energy of this reaction?

A. Leftmost
B. The middle Arrow
C. Rightmost
D. None of the Above

In both cases 95% of the students were correct in their answer, a similar question was introduced in a previous midterm in which ~70% of the students were correct. These questions are representative of other questions asked at multiple times throughout the semester that show evidence of students deepening their understanding of the biological sciences.

4) **Who interprets the evidence? What is the process?** (Who in the department is responsible for interpreting the data and making recommendations for curriculum or assignment changes if appropriate?)

Department Core Representative and faculty teaching in the core.

5) **What changes have been made as a result of using the data/evidence?** (Have there been any recent changes to your curriculum or program? Why were they made?)

In previous years, this assessment focused on non-majors courses. The shift to our introductory courses occurred the year before last. We are still determining the most appropriate and meaningful ways to assess core learning objectives in these courses. As such, no changes have been made yet as a direct result of these analyses. However, our focus for this coming year is going to be on the interpretation of scientific findings and attempting to better understand what skills our students have and need to develop in this area.

6) **What evidence do you have that the changes have resulted in improved learning outcomes?**

See previous response. We anticipate that an increased emphasis on applied data analysis, and discussions highlighting the relevance of these skills, will lead to higher overall agreement with statement 2 above (After taking this course, I am more confident in my ability to interpret the results of scientific experiments) in subsequent rounds of assessment.

7**) Date of the most recent program review.** (Your latest comprehensive departmental self-study and external review.)

2019-2024 (still in progress). Previously completed in 2007.