

# Using an Essential Question to Guide Inquiry in a College Biology Class

SP17 BIOL 100: Concepts of Biology  
“What does it mean to SURVIVE?”

Molly Wolk, M.S.  
BSWP Science Fellow 2016-17  
mollywolk@cwidaho.cc

## THE COURSE

Concepts of Biology at the College of Western Idaho (CWI) is a 4-credit course and, “This is an introductory course for non-science majors. The course will provide an introduction to the principles and processes that apply to living systems, including a broad range of current biological issues. It meets for an equivalent of five contact hours per week with a minimum of two contact hours devoted to laboratory/investigative activities. Additional fee required for lab. COREQ: BIOL 100L. (This CWI course meets Idaho State Board GEM competency requirements in GEM 4 - Scientific Ways of Knowing.)”

## 1. STANDARDS

### **General Education Competency Area**

This course fulfills the Idaho State General Education competency area of Scientific Ways of Knowing by meeting the following competencies:

- Apply foundational knowledge and models of a natural or physical science to analyze and/or predict phenomena. *(Fulfilled by learning outcomes A-F)*
- Understand the scientific method and apply scientific reasoning to critically evaluate arguments. *(Fulfilled by learning outcome A)*
- Interpret and communicate scientific information via written, spoken, and/or visual representations. *(Fulfilled by all learning outcomes)*
- Describe the relevance of specific scientific principles to the human experience. *(Fulfilled by all learning outcomes.)*

### **CWI Academic Affairs Objectives:**

This course meets the following Academic Affairs Objectives:

- ✓ **Learn to Learn.** Students learn that as important as content knowledge is, shaping one’s future requires the development of skill in discerning, applying, analyzing, synthesizing and evaluating knowledge in diverse contexts. The educational experience at CWI prepares students for a world in which they are likely to change occupations and face unpredictable life events. We strive to develop courses and learning experiences that give students the tools to confidently thrive in a complex, information-saturated, diverse, and dynamic world.
- ✓ **Make Connections.** Students learn success in today’s interconnected world requires deliberate engagement and comfort with multiple perspectives, cultures, and contexts. In navigating difference and diversity in the natural and social worlds, students connect ideas, forms of knowledge, and practices to create a richer understanding of themselves as personally and socially responsible citizens.
- ✓ **Solve Problems.** Students identify problems, analyze and implement solutions, and interpret and reflect on outcomes to develop skills to individually and collaboratively face challenges and create opportunities.

## 2. CULMINATING OUTCOMES

### **BIOL 100-006 Course Objectives and Outcomes Assessments**

Students who satisfactorily complete this course should be able to meet the following objectives in the following ways:

Student Learning Outcomes	Expanded Description of Student Outcomes	Method of Assessment
Students will be able to demonstrate an understanding of and be able to apply the scientific method to a variety of circumstances and to interpret data ethically.	<ol style="list-style-type: none"> <li>Students will be able to name the steps that make up the scientific method and describe their function.</li> <li>Students will be able to analyze results and develop an evidence-based conclusion.</li> <li>Students will be able to discuss the implications of ethics on scientific data.</li> <li>Students will be able assess their own ethical values and identify the origin of their values and compare/contrast these to scientific ethics.</li> <li>Students will be able to discuss the scientific ethics that govern data publication and the ramifications of ethical violations (both personal and to the community)</li> <li>Students will be able describe the relevance of the scientific method to the human experience of problem solving.</li> </ol>	<p>“C” or better on:</p> <ul style="list-style-type: none"> <li>Exam 1</li> <li>Signature Assignment</li> </ul>
Students will be able to define evolution and demonstrate an understanding of the process and theory of evolution.	<ol style="list-style-type: none"> <li>Students will be able define and explain the core concepts associated with the theory of evolution</li> <li>Students will be able to discuss examples of evolution.</li> <li>Students will be able describe the impact of evolution the human experience and understanding our place on earth.</li> </ol>	<p>“C” or better on:</p> <ul style="list-style-type: none"> <li>Exam 4</li> </ul>
Students will be able to demonstrate an understanding of the relationship between structure and function and use this understanding to solve problems and describe relationships.	<ol style="list-style-type: none"> <li>Students will be able to provide examples of how structure informs the function.</li> <li>Students will be able analyze how the change in a structure may impact the function.</li> <li>Students will be to apply these concepts to solve biological problems.</li> <li>Students will be able to apply concepts from the theory of evolution to discuss the relationship between structure and function.</li> <li>Students will be able describe the relationship between various biological structures and their function to the human experience.</li> </ol>	<p>“C” or better on:</p> <ul style="list-style-type: none"> <li>Exam 3</li> <li>Final Exam</li> <li>Signature Assignment</li> </ul>
Students will be able to discuss and provide examples of information flow within biological systems.	<ol style="list-style-type: none"> <li>Students will be able to discuss the properties of DNA, RNA and proteins.</li> <li>Students will be able to explain the process of DNA replication, transcription and translation.</li> <li>Students will be able to discuss the principles of heredity including Mendel’s laws and their implications.</li> <li>Students will be to apply these concepts to solve biological problems.</li> <li>Students will be able to apply concepts from the theory of evolution to discuss how biological information is modified and passed from generation to generation.</li> <li>Students will be able describe how information flow shapes the human experience.</li> </ol>	<p>“C” or better on:</p> <ul style="list-style-type: none"> <li>Exam 2</li> <li>Exam 3</li> </ul>
Students will be able to demonstrate an understanding of energy and matter transformations and be able to discuss how	<ol style="list-style-type: none"> <li>Students will be able to define various types of energy and matter.</li> <li>Students will be able to describe the carbon</li> </ol>	<p>“C” or better on:</p> <ul style="list-style-type: none"> <li>Exam 2</li> <li>Final Exam</li> </ul>

these processes impact the global community.	<p>cycle and the various biological processes that impact the carbon cycle.</p> <ol style="list-style-type: none"> <li>Students will be to apply these concepts to solve biological problems.</li> <li>Students will be able describe how energy and matter transformations shape the human experience.</li> </ol>	
Students will be able to provide examples of biological systems and explain how they function both with the system and within the world around it.	<ol style="list-style-type: none"> <li>Students will be able to identify biological systems.</li> <li>Students will be able to describe the function and importance of biological systems and their relationship to the human experience.</li> <li>Students will be able to explain the concept of emergent properties.</li> <li>Students will be to apply these concepts to solve biological problems.</li> <li>Students will be able to apply concepts from the theory of evolution to discuss the formation and continued changes of biological systems.</li> </ol>	<p>“C” or better on:</p> <ul style="list-style-type: none"> <li>Final Exam</li> <li>Signature Assignment</li> <li>Homework</li> </ul>
Students will develop a comfort with discussing/presenting scientific information.	<ol style="list-style-type: none"> <li>Students will be able to discuss formally and informally concepts presented in this course.</li> </ol>	<p>“C” or better on:</p> <ul style="list-style-type: none"> <li>Final Exam</li> <li>Signature Assignment</li> </ul>

### 3a. ESSENTIAL QUESTION

- What does it mean to survive?

#### Guiding Principles:

- Fitness (survive and reproduce)
- “Food and sex”

### 3b. CHAPTER-SPECIFIC SUBQUESTIONS

Over the course of a 16-week semester, meeting twice per week for 75 minutes, students explored each of 14 different chapters as outlined in Johnson’s (2017) *Essentials of the Living World* (5<sup>th</sup> ed.). Both preceding and following each chapter students are invited to respond to one of several subquestions that guide a deeper understanding of the chapter. These subquestions support the overarching Essential Question for the course and are provided below.

- Ch. 2: What does it mean to survive in terms of atoms, molecules, bonds, properties of water and pH?
- Ch. 3: What does it mean to survive in terms of macromolecules (monomers & polymers), carbohydrates, nucleic acids, proteins and lipids?
- Ch. 4: What does it mean to survive in terms of cells (two types of cells, cellular components and cell transport)?
- Ch. 6 & 7: What does it mean to survive in terms of photosynthesis and cellular respiration?
  - Option A: Use the chemical formula for photosynthesis to explain why WE needs plants, but plants don’t need US.
  - Option B: Explain the difference between aerobic and anaerobic respiration as well as the pluses and minuses of each.
- Ch. 10: What does it mean to survive in terms of heredity?
  - Option A: What do pea plants have to do with human inheritance patterns?
  - Option B: What role do mutations play in human heredity?

## 4. SEQUENCE OF INQUIRY-BASED LEARNING

For each chapter:

- Lecture prior
  - Frontload with probing questions
  - Address misconceptions
  - **ARTIFACT: Chapter 10 – Whole-class interactive questionnaire with topics from chapter**
  
- Lecture day
  - Open socrative.com and project on screen at front of room
  - Invite students in to socrative “room” by displaying “room number”
  - Students log in to socrative.com on their devices
  - Display EQ and two subquestions via socrative.com
  - Students read both subquestions and answer one of them on their device
  - Student responses are shown live (and anonymous) on screen at front of room
  - **ARTIFACT: socrative.com student responses**

## 5. FORMATIVE ASSESSMENT

- Partner thinking in class
- Probing questions and discussion in class
- McGraw-Hill Connect LearnSmart (adaptive frontloading)
- McGraw-Hill Connect Homework

## 6. SUMMATIVE ASSESSMENT

- Exam covering Natural Selection, Taxonomy, and the Kingdoms of Life
  - 44 multiple choice
  - 2 of 4 short essays
    - **Discuss evolution, highlighting its driving mechanism – natural selection. Use the four evidences for evolution in your answer. Supporting drawings are welcome! Your answer should include the following components:**
      - Explain natural selection
        - WHAT it is
        - HOW it drives evolution
        - WHY it matters in Biology
      - Apply the 1<sup>st</sup> evidence for evolution
      - Apply the 2<sup>nd</sup> evidence for evolution
      - Apply the 3<sup>rd</sup> evidence for evolution
      - Apply the 4<sup>th</sup> evidence for evolution
  
    - **Explain how Paul Andersen’s “Five Fingers of Evolution” (2012) disrupts the Hardy-Weinberg Equilibrium. Again, drawings are more than welcome! Your answer should include the following components:**
      - Define the Hardy-Weinberg Equilibrium
      - List each of the “Five Fingers of Evolution”
      - Explain each of the “Five Fingers of Evolution”
      - Use the “Five Fingers of Evolution” to reveal a disruption in the Hardy-Weinberg Equilibrium
        - How does this relate to a species’ fitness?
  
    - **What does it mean to have a hierarchical system of biological classification? Provide examples and use diagrams to support your answer. Your answer should include the following components:**
      - Explain our current system of classification

- Provide examples from the past of earlier systems of classification, think: Linnaeus' time!
- Detail a species from the most comprehensive taxon it belongs to all the way down to its specific epithet. Use diagrams!
- **Explain the highlights of each of the 3 eras and 1 period of the geologic timescale, making sure to draw attention to HOW and WHY species evolve over time. Your answer should include the following components:**
  - Explain the defining characteristics/prevalent species during the first period
  - Explain the defining characteristics/prevalent species during the first era
  - Explain the defining characteristics/prevalent species during the second era
  - Explain the defining characteristics/prevalent species during the third era
  - Based on what you studied about the geologic timescale, HOW do species evolve over time?
  - Based on what you studied about the geologic timescale, WHY do species evolve over time?
- Signature Assignment on a controversial Biological topic
  - APA paper
  - 4 pages of content
  - Connect topic to our course and the Nature of Science