

## **An Overview of Changes in the Revised Biology TAG Courses I and II**

### **Background:**

The primary goals for this revision effort include:

1. Defining the Student Learning Outcomes (SLOs) in terms of what students who successfully complete the courses should be able to do;
2. Aligning the list of student learning outcomes with the set of core concepts and competencies identified as foundational for undergraduate Biology education by the National Science Foundation and the American Association for the Advancement of Science as published in the “Vision and Change in Undergraduate Biology Education” document (<http://visionandchange.org/files/2013/11/aaas-VISchange-web1113.pdf>); and
3. Focusing and validating each course submission using specific measurable student learning outcomes, rather than course or instructor goals for the courses.

It is important to emphasize that these changes were intended to have several effects that will be outlined below; it is not expected that these changes will necessarily result in courses that had been approved under the former criteria (OSC003 and OSC004) to fall out of compliance with the match criteria under the revised criteria (OSC003 and OSC004).

Rather, it is expected that the changes in the wording of the Student Learning Outcomes (SLOs) will make it easier for educators, students, assessment bodies (including the TAG panelists and accreditors), as well as other interested individuals to understand what a student who has completed the course should be able to do. Under the former criteria, about half of the student learning outcomes across the two courses were expressed in terms of goals, rather than specific **measurable** outcomes. By specifying measurable student learning outcomes, the expected level of achievement, depth of knowledge, and the expected level of fluency in the discipline for students who have successfully completed the courses can be made explicit. Students who can demonstrate that they have satisfactorily met the outcome of an SLO will, by definition, have met the goal of the previously used criteria at a specific level of competency.

It is expected that by aligning the Student Learning Outcomes (SLOs) with foundational core concepts and competencies of undergraduate biology education, educators, students, assessment bodies, and other interested individuals will better understand how specific SLOs in the courses provide pathways leading to student proficiency in both essential knowledge and basic scientific practices in the discipline.

### **Core Concepts and Competencies**

#### **Core Concepts**

Core concepts are “organizing themes [that] describe lines of inquiry in modern biology” and also “provide a set of overarching principles that are important throughout the living world, and their use in teaching biology lends meaning to the multitude of facts that the student encounters in any undergraduate biology course”<sup>1</sup>. As noted, core concepts organize the individual topics and areas of biological study into a larger framework, and this framework of core concepts can help students see the connections between the topics, and by extension the SLOs. In our revision, we found that some topics link to more than one core concept, but all topics aligned to at least one of the core concepts.

#### **Core Competencies**

Core competencies are relevant skills that are used in the practice of biology and in its relationship and applications in society. Six competencies are described in the “Vision and Change in Undergraduate Biology Education”:

1. “Vision and Change in Undergraduate Biology Education” (<http://visionandchange.org/files/2013/11/aaas-VISchange-web1113.pdf>)

- 1) The ability to apply the process of science,
- 2) The ability to use quantitative reasoning,
- 3) The ability to use modeling and simulation,
- 4) The ability to communicate and collaborate (with other disciplines),
- 5) The ability to understand the relationship between science and society, and
- 6) The ability to tap into the interdisciplinary nature of science.

These six fall into two broad areas: perspectives in biology and practices in biology. Competencies are gained by students in the context of learning about and exploring the core concepts, which is why proficiency in the SLOs that fall under the core competencies is expected to be demonstrated within the relevant concepts (e.g., although some practices are universal, the process of data collection may vary, depending on the particular area of inquiry).

### **Specific Revised Changes**

#### *1. Revised Verbiage Changes*

We examined all of the former TAG criteria to ensure that they were written in terms of measurable student outcomes. About half of the SLOs needed minor wording changes to ensure that they described measurable student outcomes. For example, “Understand the stages of meiosis, their significance, and how meiosis relates to sexual life cycles.” was revised to read: “Explain the stages of meiosis, their significance, and how meiosis relates to sexual life cycles.”

#### *2. Cell Structure and Function*

Basic cell structure and function are typically taught in Biology I courses, although it is reviewed in many Biology II courses. Current TAG criteria do not reflect this. Therefore, the following changes were made in OSC003 Biology I and OSC 004 Biology II:

- a. The former SLO in Biology II was rewritten as 3 separate, more focused SLOs.
- b. The three separate SLOs were added to Biology I.
- c. Two of the three SLOs were retained in Biology II as well, with an option for these two to be taught in either or both courses.
- d. The former SLO in Biology I was rewritten as a more focused, measurable structure/function SLO and a separate SLO for reproduction of cells.

<b>Cell-Focused SLO in Former Biology I (OSC003)</b>	<b>Cell-Focused SLOs in Revised Biology I (OSC003)</b>
<ul style="list-style-type: none"> <li>• Understand the structure, function and reproduction of cells, including viruses and microorganisms.</li> </ul>	<ul style="list-style-type: none"> <li>• Recognize cells as the basic unit of life in all living organisms; compare and contrast the differences between prokaryotic and eukaryotic cells. (From Revised OSC004 Biology II)</li> <li>• Compare plant and animal cell structure and function, including their respective organelles and other components. (From Revised OSC004 Biology II)</li> </ul>

	<ul style="list-style-type: none"> <li>• Describe the structure and functional role of the cell and its constituent parts.</li> <li>• Describe current models of cell membrane structure and function. (From Revised OSC004 Biology II)</li> <li>• Describe the reproduction of cells, including viruses and microorganisms.</li> </ul>
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<b>Cell-Focused SLO in Former Biology II (OSC004)</b>	<b>Cell-Focused SLOs in Revised Biology II (OSC004)</b>
<ul style="list-style-type: none"> <li>• Develop a basic understanding of plant and animal cell structure and function including</li> </ul>	<ul style="list-style-type: none"> <li>• Recognize cells as the basic unit of life in all living organisms; compare and contrast the differences between prokaryotic and eukaryotic cells.</li> <li>• Compare plant and animal cell structure and function, including their respective organelles and other components.</li> </ul>

### 3. *Evolution (Associated with Biology II Content Only)*

The endosymbiotic theory of eukaryotic cell origins is central to understanding the evolution of eukaryotic cells and the phylogenic relationships between prokaryotes and more complex cells. In addition, over the past 15 years, the use of genomic methods has revolutionized phylogenetic analysis. The revisions made in evolution include:

- a. Two new SLOs were added to Biology II (OSC004) under the Evolution Core Concept.
- b. The term phyla was dropped and replaced by clade in the SLO dealing with phylogenic comparisons (found under Structure and Function Core Concept)

<b>Evolution SLOs in Revised Biology II (OSC004)</b>
<ul style="list-style-type: none"> <li>• Describe the evidence that endosymbiotic events resulted in the evolution of eukaryotic cells from prokaryotic ancestors.</li> <li>• Explain how genomic comparisons allow phylogenetic relationships to be determined.</li> <li>• Explain differences in structure and function among the major invertebrate and vertebrate <u>clades</u> in terms of nutrition, life history, and evolutionary relationships.</li> </ul>

### 4. *Regulatory Mechanisms*

The SLO dealing with regulatory mechanisms at level of the whole organism was moved from Biology I (OSC003) to Biology II (OSC004). Biology II typically is where whole animal regulatory mechanisms and diversity of life are taught.

### Regulatory Mechanisms SLOs in Revised Biology II (OSC004)

- Explain how regulatory mechanisms at the level of the whole organism ensure balance in living systems that interact continuously with their environments; compare regulatory mechanisms within and across species.

#### 4. *New Core Competencies*

The SLOs associated with three specific areas of the former criteria (Historical development and perspectives in biology; How to design, conduct, and report research in biology; Applications of biology and biotechnology in society, business, industry, and health fields) fit under the two new core competencies. The remaining revised SLOs were placed under the core content area that they most closely aligned with. However, the TAG Revision Panel also noted when there were strong secondary alignments.

#### 5. *Ecology*

Ecology was added to the description of the revised Biology II (OSC004) and removed from the description of the revised Biology I (OSC003).

#### 6. *Textbook Reference*

The requirement for an appropriate textbook or the equivalent was added to both courses:

Lecture to include a standard modern general biology text designed for a full-year sequence of introductory biology for science majors or the equivalent at the same level of rigor.

#### 7. *70% Standards for the TAG Approval*

Under the former criteria, only 70% of the SLOs needed to be met for approval as a course that matches the TAG. Theoretically two approved courses could each meet 70% of the outcomes and yet still have just under 50% of the outcomes in common, which raised grave concerns about students who transfer being prepared for the subsequent course(s) at the next institution.

Under the revised guidelines, although 70% of *all* SLOs must be met, certain outcomes are now considered essential/required and *must* be met. Some of the revised essential outcomes are common to both Biology I (OSC003) and Biology II (OSC004) and may be covered in either Biology I or II or in both, but must be met in at least one of the courses.

At least one SLO from each core concept and each core competency must be met, even if the essential outcomes under that concept are taught in only one of the two courses. For instance, if the SLO #1 and 2 under Evolution are taught only in Biology I, at least one of the SLOs 3, 4, and 5 must be met in Biology II.