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A plan to assess student learning in a University General Education Core Curriculum course: BIOL1543/1541L, Principles of Biology

WHAT UNIVERSITY GENERAL EDUCATION OUTCOMES GUIDE STUDENT LEARNING IN COURSES THAT CARRY NATURAL SCIENCES CREDIT?

A primary goal of these courses is to develop an appreciation of the basic principles that govern natural phenomena and the role of experiment and observation in revealing these principles. Students should acquire an understanding of the relationship between hypothesis, experiment, and theory, and develop the skills common to scientific inquiry, including the ability to frame hypotheses and defend conclusions based on the analysis of data. These courses are designed to prepare a student for informed citizenship by illustrating the importance of science and technology to the present and future quality of life and the ethical questions raised by scientific and technological advances.

Upon completion of eight hours of science courses, students will:

- NSLO1a - Understand how scientific inquiry is performed.
- NSLO2a - Understand the boundaries of scientific data.
- NSLO3a - Have a basic working knowledge of a few areas of science.
- NSLO4a - Be able to make better-informed decisions regarding potential government policies that involve science.
- NSLO5a - Have improved problem solving skills.
- NSLO6a - Be able to identify challenges created by society's increasing reliance upon technology.

HOW DOES THE DEPARTMENT OF BIOLOGICAL SCIENCES INTEND TO ASSESS STUDENT LEARNING OF THESE OUTCOMES IN BIOL1543/Biol1541L?

The assessment consists of a pre-test in each course at the start of the semester followed by a post-test near the end of the semester. Assessment exams included 42 questions composed and agreed upon by the faculty teaching BIOL1543. The questions for each exam were designed to be overarching and related to broad thematic components of each of the courses. Analysis of student performance will be based on overall performance on the exam, not on the individual questions. The same assessment exam will be used for multiple semesters so that performance over time can be compared.

HOW IS THE ASSESSMENT INSTRUMENT KEYED TO THE UNIVERSITY GENERAL EDUCATION CORE CURRICULUM LEARNING OUTCOMES FOR THE NATURAL SCIENCES?

Principles of Biology Assessment

1. Some students consume large amounts of coffee and so-called energy drinks to help them stay alert when studying. You notice that many who engage in this practice seem to do poorly on exams. Suppose you want to investigate the relationship between caffeine consumption and exam performance. Which of the following statements would be an appropriate hypothesis?

- A. Students who consume large amounts of caffeine while studying will have lower exam scores than those who consume less caffeine.
- B. One should avoid consuming too much caffeine while studying.
- C. Too much caffeine is harmful to your health.
- D. Many students consume large amounts of caffeine while studying.
- E. Caffeine increases alertness but also increases anxiety.

NSLO1a; NSLO2a; NSLO5a

Bloom's Level: 4. Analyze

Learning Outcome: Distinguish between a theory and a hypothesis.

Topic: Experimental Design

2. Which statement about living organisms is not correct?

- A. Living organisms create energy.
- B. Living organisms maintain homeostasis.
- C. Living organisms reproduce.
- D. Living organisms have adaptations.
- E. Living organisms grow and develop.

NSLO2a; NSLO3a

Bloom's Level: 2. Understand

Learning Outcome: Identify the basic characteristics of life.

Topic: Characteristics of Life

3. Water is a liquid at room temperature. This is due to

- A. ionic bonding of the atoms in the water molecule.
- B. covalent bonding in the water molecule.
- C. covalent bonding between water molecules.
- D. hydrogen bonding within the water molecule.
- E. hydrogen bonding between water molecules.

NSLO3a

Bloom's Level: 3. Apply

Learning Outcome: Evaluate which properties of water are important for biological life.

Topic: Properties of Water

4. Organic molecules

- A. always contain carbon.
- B. always contain hydrogen.
- C. always contain carbon and hydrogen.
- D. are found only in organisms, hence their name.
- E. are always food molecules.

NSLO3a

Bloom's Level: 1. Remember

Learning Outcome: Compare inorganic molecules to organic molecules.

Topic: Chemical Reactions

5. The cell theory states

- A. all organisms are composed of only one cell.
- B. organelles are the basic living unit of structure and function of organisms.
- C. all cells come only from other cells.
- D. all organisms are composed of only one cell AND organelles are the basic living unit of structure and function of organisms.
- E. all multicellular organisms are unicellular at some point in their life cycle.

NSLO2a; NSLO3a

Bloom's Level: 1. Remember

Learning Outcome: List the basic principles of the cell theory.

Topic: Cell Theory

6. Within eukaryotic cells, the ____ is surrounded by a double membrane and carries the coding that determines protein synthesis.

- A. smooth endoplasmic reticulum
- B. chloroplast
- C. nucleolus
- D. nucleus
- E. rough endoplasmic reticulum

NSLO3a; NSLO4a

Bloom's Level: 1. Remember

Learning Outcome: Recognize the structure and function of the organelles within eukaryotic cells.

Topic: Eukaryote Structure

7. According to the fluid-mosaic model of membrane structure,

- A. proteins make up the bulk of the membrane.
- B. only lipids are found in the membrane.
- C. cholesterol is the main constituent of the membrane.
- D. glycolipids form a mosaic pattern inside the cell.
- E. proteins float inside or within the phospholipid bilayer.

NSLO2a; NSLO3a; NSLO4a

Bloom's Level: 2. Understand

Learning Outcome: Describe the fluid-mosaic model of membrane structure.

Topic: Plasma Membrane

8. If 0.9% NaCl were isotonic to a cell, then

- A. 0.9% would also be hypotonic.
- B. 0.9% would also be hypertonic.
- C. 1.0% would be hypertonic.
- D. 1.0% would be hypotonic.
- E. 0.1% would be hypertonic.

NSLO2a; NSLO3a

Bloom's Level: 2. Understand

Learning Outcome: Predict the movement of molecules in diffusion and osmosis.

Topic: Passive Transport

9. Which is NOT a correct association?

- A. S stage-DNA synthesis
- B. M stage-mitosis and cytokinesis
- C. interphase-shortest stage of the cell cycle
- D. G₁ stage-cell grows in size and cell organelles increase in number
- E. G₂ stage-metabolic preparation for mitosis

NSLO2a; NSLO3a; NSLO4a

Bloom's Level: 1. Remember

Learning Outcome: Describe the stages of the cell cycle and what occurs in each stage.

Topic: Cell Cycle

10. If the total number of chromosomes in a cell is six, then after mitosis there will be

- A. six chromosomes in each daughter cell.
- B. three chromosomes in each daughter cell.
- C. 12 chromosomes in each daughter cell.
- D. two chromosomes in each daughter cell.
- E. three chromosomes in one daughter cell and six chromosomes in the other cell.

NSLO2a; NSLO3a; NSLO4a; NSLO5a

Bloom's Level: 3. Apply

Learning Outcome: Explain the role of mitosis and how it maintains the chromosome number of a cell.

Topic: Mitosis

11. Which of the following statements is true about enzymes?

- A. Their 3D shape can vary and still be active.
- B. Boiling temperatures do not affect their activity.
- C. They catalyze only one specific type of reaction.
- D. They can associate with a wide variety of substrates.
- E. They are unaffected by changes in pH.

NSLO2a; NSLO3a; NSLO4a

Bloom's Level: 2. Understand

Learning Outcome: Identify how environmental conditions influence the activity of an enzyme.

Topic: Enzymes

12. If you wished to increase enzyme activity, you would do all of the following except

- A. increase the temperature moderately.
- B. increase the concentration of the enzyme.
- C. increase the amount of substrate.
- D. change to optimum pH for the reaction.
- E. decrease the temperature.

NSLO2a; NSLO3a; NSLO4a

Bloom's Level: 2. Understand

Learning Outcome: Identify how environmental conditions influence the activity of an enzyme.

Topic: Enzymes

13. Which molecules are the products of aerobic respiration?

- A. glucose and carbon dioxide
- B. glucose and water
- C. glucose and oxygen
- D. lactate and carbon dioxide
- E. carbon dioxide and water

NSLO2a; NSLO3a; NSLO4a

Bloom's Level: 1. Remember

Learning Outcome: Describe the overall equation for cellular respiration.

Topic: Cellular Respiration

14. Why is cellular respiration organized into four phases?

- A. So that the energy within the glucose molecule can be released in a stepwise fashion.
- B. So that it can take place within different cells.
- C. So that most of the energy can be released as body heat.
- D. So that oxidation can occur without reduction.
- E. So that the body can make energy from different substrates.

NSLO2a; NSLO3a; NSLO5a

Bloom's Level: 3. Apply

Learning Outcome: Summarize the phases of cellular respiration and indicate where they occur in a cell.

Topic: Cellular Respiration

15. What are the products of photosynthesis?

- A. water and carbon dioxide
- B. water and oxygen
- C. carbohydrate and water
- D. oxygen and carbohydrate
- E. carbon dioxide and carbohydrate

NSLO2a; NSLO3a; NSLO4a

Bloom's Level: 1. Remember

Learning Outcome: Recognize the overall chemical equation for photosynthesis.

Topic: Photosynthesis

16. Why are plant leaves green?

- A. They absorb only green wavelengths of light.
- B. They absorb only yellow and blue wavelengths of light.
- C. They reflect nearly all wavelengths of light.
- D. They reflect green wavelengths of light.
- E. They reflect yellow and blue wavelengths of light.

NSLO3a

Bloom's Level: 2. Understand

Learning Outcome: Identify the photosynthetic pigments required to absorb the various wavelengths of light necessary for photosynthesis.

Topic: Photosynthesis

17. What are alleles?

- A. genes for different traits, such as hair color and eye color
- B. alternative forms of a gene for a single trait, such as blue eyes or brown eyes
- C. the locations of genes on a chromosome
- D. recessive forms of a kind of characteristic carried by genes
- E. dominant forms of a kind of characteristic carried by genes

NSLO3a; NSLO4a

Bloom's Level: 2. Understand

Learning Outcome: Define the term allele, and explain what it means for an allele to be dominant or recessive.

Topic: Mendelian Genetics

18. In humans, brown eyes (B) is a simple dominant trait over blue eyes (b). What is the genotype of a brown-eyed woman who has a blue-eyed child?

- A. bb.
- B. Bb.
- C. BB.
- D. BBB.
- E. BbBb.

NSLO2a; NSLO3a; NSLO4a; NSLO5a

Bloom's Level: 4. Analyze

Learning Outcome: Predict outcome ratios and probabilities for problems based on Mendelian patterns of inheritance.

Topic: Mendelian Genetics

19. The location of a gene on a chromosome is called

- A. a locus.
- B. homologous.
- C. a linkage map.
- D. a linkage group.
- E. an allele.

NSLO2a; NSLO3a; NSLO4a

Bloom's Level: 1. Remember

Learning Outcome: Describe what is meant by the term linkage group.

Topic: Mendelian Genetics

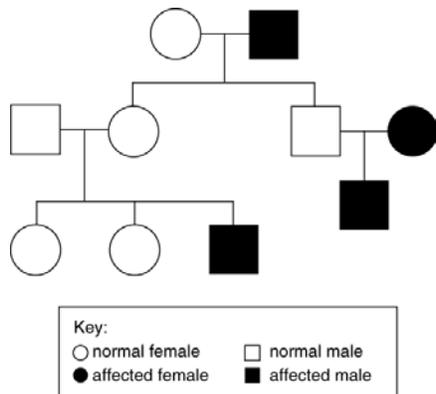


Figure 24.1

20. The trait diagrammed in Figure 24.1 is a(n)

- A. dominant X-linked trait.
- B. recessive X-linked trait.
- C. recessive Y-linked trait.
- D. autosomal dominant trait.
- E. dominant Y-linked trait.

NSLO2a; NSLO3a; NSLO4a; NSLO5a

Bloom's Level: 5. Evaluate

Learning Outcome: Explain X-linked genetic inheritance.

Topic: Pedigrees

21. Which of the following is NOT true about DNA?

- A. has a double helix
- B. bases held together by hydrogen bonds
- C. bases are complementary to each other
- D. has a deoxyribose sugar
- E. contains adenine, guanine, cytosine, and uracil

NSLO2a; NSLO3a; NSLO4a

Bloom's Level: 2. Understand

Learning Outcome: Describe the structure of a DNA molecule.

Topic: DNA Structure

22. In modern biochemical genetics, the flow of inherited information is from

- A. protein → RNA → DNA.
- B. DNA → RNA → protein.
- C. DNA → protein → RNA.
- D. RNA → DNA → protein.
- E. RNA → protein → DNA.

NSLO2a; NSLO3a; NSLO4a

Bloom's Level: 2. Understand

Learning Outcome: Summarize the sequence of events that occurs during gene expression.

Topic: Gene Regulation: Eukaryotes

23. The purpose of PCR is to create

- A. fragments of DNA that are different lengths.
- B. recombinant DNA.
- C. billions of copies of a segment of DNA.
- D. plasmids to be used as vectors in cloning.
- E. transgenic crop plants.

NSLO2a; NSLO3a; NSLO4a; NSLO5a; NSLO6a

Bloom's Level: 2. Understand

Learning Outcome: Discuss how the polymerase chain reaction works.

Topic: DNA Technology

24. The study of proteomics is more complex than the study of genomics because

- A. proteins are more complex than DNA.
- B. proteins are harder to sequence than DNA.
- C. there are 20 amino acids that comprise proteins and only 4 nucleotides that compose DNA.
- D. scientists understand less about amino acids than they do about nucleotides.
- E. each cell in an organism has exactly the same DNA but different cell types each produce different types of proteins.

NSLO2a; NSLO3a; NSLO4a; NSLO5a; NSLO6a

Bloom's Level: 3. Apply

Learning Outcome: Compare and contrast functional genomics and proteomics.

Topic: Proteomics

25. What is the term used to describe the accumulation of small changes in the gene pool of a species over time?

- A. genetic drift
- B. founder effect
- C. microevolution
- D. directional selection
- E. mutation rate

NSLO2a; NSLO3a; NSLO4a; NSLO6a

Bloom's Level: 1. Remember

Learning Outcome: List the five conditions necessary for the allele frequencies of a population to be in Hardy-Weinberg equilibrium.

Topic: Microevolution

26. Which of the following is true about natural selection?

- A. It acts on genotypes rather than phenotypes.
- B. It assures the survival of each fit individual.
- C. On average, it favors the survival of young with adaptive characteristics.
- D. It always selects for more complex forms.
- E. It always selects for forms that are a mutated variation.

NSLO2a; NSLO3a; NSLO4a; NSLO6a

Bloom's Level: 2. Understand

Learning Outcome: List the four requirements of evolution by natural selection.

Topic: Natural Selection

27. Which statement is NOT true about bacteria?

- A. They lack mitochondria.
- B. They lack a nucleus but contain DNA.
- C. They reproduce sexually.
- D. They occur in three basic shapes.
- E. They have a single circular chromosome.

NSLO2a; NSLO3a; NSLO4a

Bloom's Level: 2. Understand

Learning Outcome: Identify the major structural features of bacteria.

Topic: Prokaryote Structure

28. Which of these is the most accurate description of a virus?

- A. a noncellular living organism
- B. one of the smallest bacteria known
- C. a member of the kingdom Virusae
- D. a cell at the boundary between living and nonliving things
- E. chemical complexes of RNA or DNA protected by protein

NSLO2a; NSLO3a; NSLO4a; NSLO6a

Bloom's Level: 3. Apply

Learning Outcome: Identify the major structural features of viruses.

Topic: Viruses

29. Single-celled eukaryotes belong to the kingdom

- A. Prokaryotae.
- B. Protista.
- C. Archaea.
- D. Plantae.
- E. Animalia.

NSLO3a

Bloom's Level: 1. Remember

Learning Outcome: Describe the general characteristics of a protist.

Topic: Protists

30. ____ are mostly saprotrophic decomposers that assist in recycling of nutrients in ecosystems.

- A. Algae
- B. Viruses
- C. Fungi
- D. Protozoans
- E. Ciliates

NSLO2a; NSLO3a

Bloom's Level: 1. Remember

Learning Outcome: Describe the structural components of a fungal body.

Topic: Fungi

31. Which sequence is correct in the life cycle of alternation of generations?

- A. gametophyte → spores → sporophyte
- B. gametophyte → gametes → spores → sporophyte
- C. gametophyte → gametes → zygote → spores → sporophyte
- D. gametophyte → spores → gametes → zygote → sporophyte
- E. gametophyte → gametes → zygote → sporophyte → spores

NSLO3a

Bloom's Level: 2. Understand

Learning Outcome: Describe alternation of generations in plants.

Topic: Plants

32. The reproductive parts of an angiosperm are the

- A. petals and sepals.
- B. petals and stamen.
- C. sepals and stamen.
- D. sepals and carpel.
- E. carpel and stamen.

NSLO3a; NSLO4a

Bloom's Level: 1. Remember

Learning Outcome: Compare and contrast gymnosperms with angiosperms, explaining why angiosperms are more species-rich today.

Topic: Angiosperms

33. Which of the following is generally NOT a characteristic of all animals?

- A. They ingest food that is digested in a central cavity.
- B. Usually undergo sexual reproduction.
- C. They produce an embryo that undergoes development in stages.
- D. Animals range from unspecialized single-celled to specialized multicellular forms.
- E. The adult form is diploid.

NSLO3a; NSLO4a; NSLO6a

Bloom's Level: 2. Understand

Learning Outcome: List the general characteristics of animals.

Topic: Animals

34. The life cycle of animals

- A. demonstrates alternation of generations, where the zygote is haploid and the adult is diploid.
- B. does not demonstrate alternation of generations. Both the zygote and the adult are haploid.
- C. demonstrates alternation of generations, where the zygote is diploid and the adult is haploid.
- D. does not demonstrate alternation of generations because only the spores are haploid.
- E. does not demonstrate alternation of generations; gametes are haploid and the organism is diploid.

NSLO3a; NSLO4a; NSLO6a

Bloom's Level: 4. Analyze

Learning Outcome: List the general characteristics of animals.

Topic: Animals

35. Which of the following sequences correctly represents vertebrate evolution?

- A. jawless fish → lobe-finned fish → amphibians → reptiles → mammals
- B. jawless fish → amphibians → reptiles → lobe-finned fish → mammals
- C. mammals → lobe-finned fish → reptiles → jawless fish → amphibians
- D. lobe-finned fish → mammals → reptiles → jawless fish → amphibians
- E. lobe-finned fish → reptiles → mammals → jawless fish → amphibians

NSLO2a; NSLO3a; NSLO4a; NSLO5a; NSLO6a

Bloom's Level: 4. Analyze

Learning Outcome: Identify the four morphological characteristics unique to the chordates.

Topic: Chordates

36. The chief distinguishing characteristic of all mammals is the presence of

- A. constant internal temperature.
- B. four limbs.
- C. a four-chambered heart.
- D. hair and mammary glands.
- E. a placenta

NSLO2a; NSLO3a; NSLO4a; NSLO6a

Bloom's Level: 2. Understand

Learning Outcome: Identify the unique features that define the three living lineages of mammals.

Topic: Mammals

37. You are passing through one of the science buildings on a university campus when you see a researcher come out of his laboratory and go into another room. You hear and then see a newly hatched duckling come out of the lab and run to follow the researcher into the other room. The duck's behavior can best be described as

- A. a fixed action pattern.
- B. classical conditioning.
- C. imprinting.
- D. operant conditioning.
- E. altruistic.

NSLO3a; NSLO4a

Bloom's Level: 3. Apply

Learning Outcome: Compare three different types of learned behavior.

Topic: Behavioral Ecology

38. Pheromones are

- A. visual signals.
- B. auditory signals.
- C. chemical attractants.
- D. tactile responses.
- E. hormones.

NSLO3a

Bloom's Level: 1. Remember

Learning Outcome: Summarize the various ways in which animals communicate.

Topic: Animal Communication

39. An ecosystem contains

- A. only the biotic (living) components of the environment.
- B. only the abiotic (nonliving) components of the environment.
- C. only the energy flow components of an environment.
- D. both the living organisms and the abiotic components of the environment.
- E. only the food relationships found in an environment.

NSLO1a; NSLO2a; NSLO3a; NSLO4a; NSLO6a

Bloom's Level: 1. Remember

Learning Outcome: Identify what aspects of biology the study of ecology encompasses.

Topic: Ecosystem Ecology

40. The carrying capacity of the environment for a species is determined by

- A. the reproductive rate of the organism.
- B. the number of organisms of that species.
- C. the state and national wildlife laws pertaining to that species.
- D. a complex "balance of nature" that still has not been explained in terms that scientists can calculate.
- E. the limited productivity of the environment and the environmental resistance to the biotic potential of the organism.

NSLO1a; NSLO2a; NSLO3a; NSLO4a; NSLO6a

Bloom's Level: 2. Understand

Learning Outcome: Compare exponential and logistic population growth curves.

Topic: Population Growth Models

41. In the biosphere, which of the following is NOT constantly recycled?

- A. carbon
- B. nitrogen
- C. water
- D. energy
- E. phosphorus

NSLO2a; NSLO3a; NSLO4a; NSLO6a

Bloom's Level: 2. Understand

Learning Outcome: Interpret the energy flow and biogeochemical cycling within and among ecosystems.

Topic: Energy and Chemical Cycling

42. The two general categories of biogeochemical cycles are

- A. energy and matter.
- B. terrestrial and aquatic.
- C. gaseous and sedimentary.
- D. chemical and physical.
- E. organic and inorganic.

NSLO3a; NSLO4a; NSLO6a

Bloom's Level: 1. Remember

Learning Outcome: Define what is meant by a biogeochemical cycle.

Topic: Energy and Chemical Cycling

HOW WILL THE DEPARTMENT OF BIOLOGICAL SCIENCES USE THE DATA GENERATED BY THIS INSTRUMENT TO PLAN CURRICULAR AND PEDAGOGICAL CHANGES THAT MIGHT BE NECESSARY IN BIOL1543/BIOL1541L?

Analysis of student performance was based on overall performance on the exam, not on the individual questions. Faculty review the exam results annually, including responses on individual questions and will modify some questions for the assessment to better respond to the Natural Science Learning Outcomes. The faculty will discuss the results of the assessment process to identify problem areas in the course that can be addressed through implemented curricular modification including changes to course content or structure, and delivery mechanisms necessary to meet the needs of the target audience and fully address the Natural Science Learning Outcomes.