

Biology: Content Knowledge (0235)

Test at a Glance

Test Name	Biology: Content Knowledge		
Test Code	0235		
Time	2 hours		
Number of Questions	150		
Format	Multiple-choice		
	Content Categories	Approximate Number of Questions	Approximate Percentage of Questions
	I. Basic Principles of Science II. Molecular and Cellular Biology III. Classical Genetics and Evolution IV. Diversity of Life, Plants, and Animals V. Ecology VI. Science, Technology, and Society	12 38 23 45 22 10	8% 25% 15% 30% 15% 7%

About This Test

The Biology: Content Knowledge test is designed to assess whether an examinee has the knowledge and competencies necessary for a beginning teacher of biology in a secondary school. The development of the test questions and the construction of the test reflect the National Science Education Standards and recognize that there are conceptual and procedural schemes that unify the various scientific disciplines. The 150 multiple-choice questions address examinees' knowledge of the biological sciences, the basic principles of science, and the issues and applications concerning science, technology, and society. Questions are derived from topics typically covered in an introductory college-level biology course. Within these content areas, the test questions require a variety of abilities and knowledge, including definition of terms, comprehension of critical concepts, and application and analysis, to address and solve problems.

This test may contain some questions that will not count toward your score.

Topics Covered

Representative descriptions of topics covered in each category are provided below.

I. Basic Principles of Science (History and Natural Science)

- Nature of scientific knowledge, inquiry, and historical perspectives:
 - scientific methods
 - processes involved in scientific inquiry
 - process skills, facts, concepts, models, commonly shared scientific ideals, history, and philosophy
 - contributions made by major historical figures and landmark events in the field of biology
- Mathematics, measurement, and data manipulation:
 - measurement and notation systems
 - data collection, manipulation, interpretation, and presentation, including tables, graphs, charts, and error analysis
- Laboratory procedures and safety:
 - safe preparation, storage, use, and disposal of laboratory and field materials
 - selection and use of appropriate laboratory equipment
 - legal responsibilities of the teacher, and safety and emergency procedures for the science classroom and laboratories

II. Molecular and Cellular Biology

- Chemical basis of life:
 - basic chemical structures
 - atoms, molecules, and chemical bonds
 - buffers
 - pH
 - biologically important molecules
 - thermodynamics and free energy
 - cellular bioenergetics
 - photosynthesis
 - respiration
 - enzymes
- Cell structure and function:
 - membranes, organelles, and subcellular components of prokaryotic and eukaryotic cells
 - cell cycle and cytokinesis
 - mitosis and meiosis
- Molecular basis of heredity:
 - structure and function of nucleic acids
 - DNA replication
 - protein synthesis
 - gene regulation
 - mutation and transposable elements
 - viruses
 - molecular basis of genetic diseases, e.g., cancer, sickle-cell anemia, hemophilia
 - recombinant DNA and genetic engineering
 - genome mapping of humans and other organisms

III. Classical Genetics and Evolution

- Classical genetics: Mendelian and non-Mendelian inheritance, probability, linkage, human genetic disorders, interaction between heredity and the environment
- Evolution: evidence, mechanisms, population genetics, speciation, phylogeny, origin of life, species extinction

IV. Diversity of Life, Plants, and Animals

- Diversity of life: classification schemes, characteristics and representatives of organisms
- Plants:
 - evolution, including adaptation to land and major divisions
 - anatomy, including roots, stems, leaves, and reproductive structures
 - physiology, including C3 and C4 photosynthesis, hormones, photoperiods, water and nutrient uptake, and translocation
 - reproduction, including alternation of generations, fertilization and zygote formation, dispersal, germination, growth and differentiation, and vegetative propagation
- Animals:
 - evolution, including phylogeny and classification, and major phyla
 - life functions and associated structures, including digestion, circulation, respiration, excretion, nervous control, contractile systems and movement, support, integument, immunity, and the endocrine system
 - reproduction and development, including gametogenesis, fertilization, parthenogenesis, embryogenesis, growth and differentiation, metamorphosis, and aging
 - behavior, including taxes, instincts, learned behaviors, and communication

V. Ecology

- Populations: intraspecific competition, density factors, population growth, dispersion patterns, life-history patterns, social behavior
- Communities: niche, interspecific relationships, species diversity, succession
- Ecosystems: terrestrial ecosystems, aquatic ecosystems, biomes, energy flow, biogeochemical cycles, stability and disturbances, human impact, interrelationships among ecosystems

VI. Science, Technology, and Society

- Impact of science and technology on the environment and human affairs
- Human and nature-induced hazards
- Issues and applications: production, storage, use, management, and disposal of consumer products and energy, and management of natural resources
- Social, political, ethical, and economic issues in biology
- Societal issues with health and medical advances

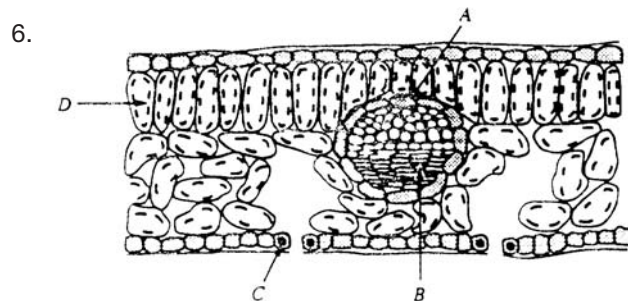
Sample Test Questions

The sample questions that follow illustrate the kinds of questions in the test. They are not, however, representative of the entire scope of the test in either content or difficulty. Answers with explanations follow the questions.

Directions: Each of the questions or incomplete statements below is followed by four suggested answers or completions. Select the one that is best in each case.

- The movement of water upward in xylem vessels of trees is most directly related to which of the following?
 - Wall pressure
 - Turgor pressure
 - Transpiration
 - Cytoplasmic streaming
- Which of the following is a true statement about the flow of energy in an ecosystem?
 - Smaller organisms need less energy per gram of body weight than do larger organisms.
 - Energy transfer between organisms normally involves conservation of heat energy.
 - Energy flow between trophic levels is inefficient.
 - Chemical energy is converted into radiant energy, which is then converted to chemical energy at the next trophic level.
- The diversity of the finches on the Galápagos Islands is an example of which of the following?
 - Adaptive radiation
 - Seasonal isolation
 - Mechanical isolation
 - Selective hybrid elimination

- Two parents who do not exhibit phenylketonuria (PKU) have a son with PKU. Which of the following conclusions can be drawn from this situation?
 - The allele for PKU is located on the Y chromosome.
 - PKU is a dominant trait.
 - PKU is a recessive trait.
 - A mutation occurred in the sperm of the son.
- All of the following represent primary consumers feeding on first-trophic-level organisms EXCEPT
 - paramecia feeding on green algae
 - mice feeding on dead grass
 - deer feeding on branches of trees
 - slugs feeding on mushrooms



The diagram above represents a cross section of a leaf. Which region serves primarily to regulate the stomatal opening?

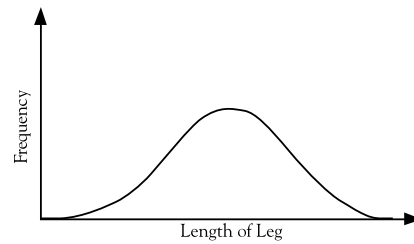
- A
- B
- C
- D

7. Which of the following best describes the pathway of a protein from its manufacture to its release from the cell?

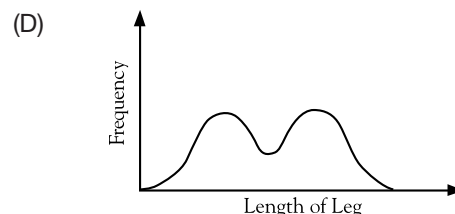
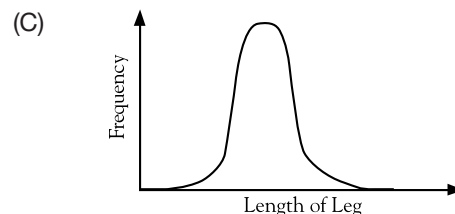
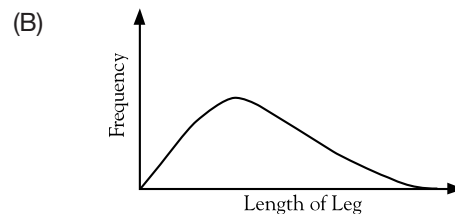
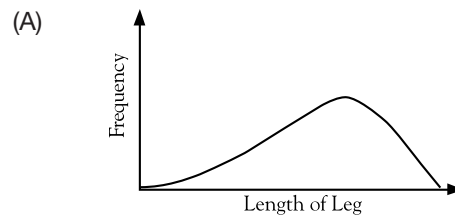
- (A) Endoplasmic reticulum → Golgi complex → secretory vesicle
- (B) Secretory vesicle → endoplasmic reticulum → Golgi complex
- (C) Secretory vesicle → Golgi complex → endoplasmic reticulum
- (D) Golgi complex → endoplasmic reticulum → secretory vesicle

8. All of the following are likely to increase after large areas of tropical rain forests are cut down EXCEPT the

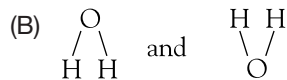
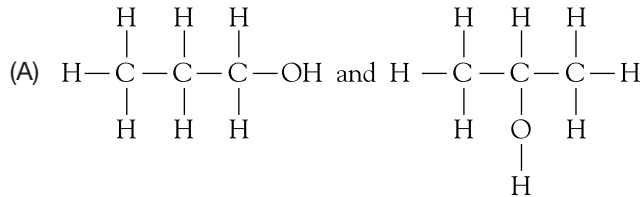
- (A) species diversity of the areas
- (B) erosion by rivers flowing through the areas
- (C) rate of nutrient loss from the areas
- (D) average surface temperature of the soil in the areas



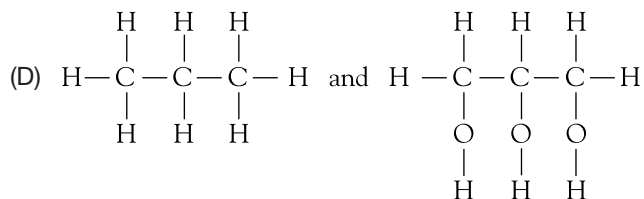
9. The graph above depicts the frequency of expression of the range of leg lengths in a population of grazing animals. In this species, leg length is directly related to speed, which is a heritable characteristic. These grazers are being preyed on by a newly introduced species of swift-running predators. Which of the following graphs represents the range of expression most likely to result from this selection pressure over a long period of time?



10. Which of the following are isomers?



(C) NaCl and KCl



11. If a DNA template has the base sequence 5' -TAG- 3', the corresponding base sequence on an mRNA transcript would be

- (A) 5' -ATC- 3'
- (B) 5' -CTA- 3'
- (C) 5' -AUC- 3'
- (D) 5' -CUA- 3'

12. Which of the following structures is present in the roots of vascular plants but NOT in stems?

- (A) Cambium
- (B) Pericycle
- (C) Xylem
- (D) Cortex

13. A certain autosomal recessive trait is expressed in 1 percent of a population. Assuming that the population is in Hardy-Weinberg equilibrium, what percent of the population are carriers but do not express the trait?

- (A) 10%
- (B) 18%
- (C) 27%
- (D) 50%

14. Which of the following cellular processes normally produces ATP from glucose in the absence of oxygen?

- (A) Krebs cycle
- (B) Glycolysis
- (C) Chemiosmosis
- (D) Calvin cycle

15. Which of the following mechanisms can best account for the higher concentrations of mineral nutrients in the root cells of vascular plants than in the surrounding soil environment?

- (A) Osmosis
- (B) Diffusion
- (C) Facilitated diffusion
- (D) Active transport

16. A person touches a hot object and immediately moves her finger away from it. Which of the following structures is the first to receive an impulse triggered by the stimulus?

- (A) Synapse
- (B) Ventral root ganglion
- (C) Motor neuron
- (D) Sensory neuron

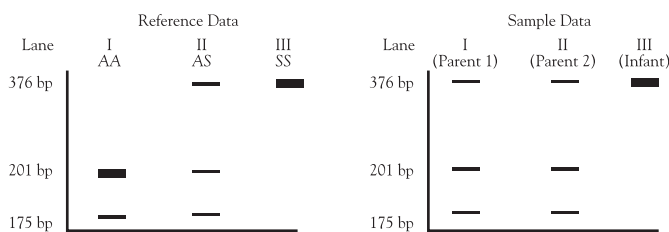
17. Males of a certain species of small mammal have been observed to have either fluffy tails or furless tails. Those with the fluffy tails have been observed to attract significantly more mates than those with furless tails. The phenomenon described is an example of

- (A) disruptive dimorphism
- (B) disruptive selection
- (C) sexual dimorphism
- (D) sexual selection

Directions for Questions 18–19: The group of questions below concerns an experimental situation. First study the description of the situation; then choose the one best answer to each question and fill in completely the space on the answer sheet.

Sickle cell anemia is a genetic disorder. Specialized techniques for DNA analysis are used to detect carriers of the sickle cell anemia allele and infants that are homozygous for the trait. The DNA is cut into fragments that are separated according to size by use of gel electrophoresis. Radiolabeled probes can then be used to identify both the normal gene sequence and the mutant (sickle cell) gene.

The reference data shown below indicate that the DNA in lane I is from a noncarrier (AA), the DNA in lane II is from a carrier (AS), and the DNA in lane III is from an individual having sickle cell anemia (SS). The sample data are from two parents (lanes I and II) and their infant (lane III).



18. Which of the following is correct concerning the sickle cell trait in Parent 1 (lane I)?
- (A) Parent 1 is a carrier (AS).
 - (B) Parent 1 is a noncarrier (AA).
 - (C) Parent 1 has sickle cell anemia (SS).
 - (D) The occurrence of the sickle cell trait cannot be determined from the data.

19. Which of the following can be concluded from the sample data?
- (A) The infant is homozygous for the sickle cell allele (SS).
 - (B) The infant is a carrier of the sickle cell allele (AS).
 - (C) The infant is a noncarrier of the sickle cell allele (AA).
 - (D) The occurrence of the sickle cell trait cannot be determined for the infant.

Directions for Questions 20–21: The group of questions below consists of four lettered headings followed by a list of phrases or sentences. For each sentence, select the one heading that is most closely related to it. One heading may be used once, more than once, or not at all.

- (A) Nephrons
 - (B) Flame cells
 - (C) Malpighian tubules
 - (D) Skin gills
20. Function in both arachnids and insects
21. Have cilia to guide waste products to excretory pores

Answers

1. The correct answer is C. The upward movement of water is caused by a “pull” generated by water loss in the leaves (transpiration) and facilitated by the cohesive properties of water in capillaries.
2. The correct answer is C. Biologists estimate that 90 percent of the energy is lost between levels of an energy pyramid. Thus, it is true that energy is transferred between trophic levels inefficiently.
3. The correct answer is A. The Galapagos finches are a classical example of adaptive radiation of a single species that arrived from the continent and diversified following dispersion to several islands and subsequent speciation.
4. The correct answer is C. PKU must be a recessive trait because the parents did not exhibit the disorder, yet must have been carriers for the disorder.
5. The correct answer is D. The first trophic level consists of producers. Neither slugs nor mushrooms are producers. In choices A, B, and C, the producers are green algae, dead grass, and tree branches, and the primary consumers are paramecia, mice, and deer.
6. The correct answer is C. These are the guard cells that regulate the stomatal opening.
7. The correct answer is A. Proteins pass from the ribosomes into the lumen of the endoplasmic reticulum. They are then sent to the Golgi complex, where they are modified and packaged into vesicles, which transport them to the outside of the cell.
8. Choice A is the exception. The continuing loss of the incredibly diverse habitats found in tropical rain forests will cause a decrease in species diversity, not an increase. Thus, A is the correct answer.
9. The correct answer is A. Selection pressure would favor longer legs in the prey animals, and choice A depicts a population with a large number of individuals with longer legs.
10. The correct answer is A. Structural isomers are compounds that have the same empirical formula but whose atoms are arranged in a different way. Both compounds in choice A are alcohols with the formula C_3H_8O , but the position of the OH group is different in each.
11. The correct answer is D. RNA and DNA hybridize with base pairing between A-U and C-G nucleotides. The strands will also be antiparallel in the resulting double-stranded molecule. That is, one strand aligns with 5'–3' polarity, and the other strand aligns with 3'–5' polarity.
12. The correct answer is B. In plant roots, the vascular tissue is located in the center of the root and is surrounded by a layer of endoderm cells. The pericycle is a layer of cells on the inner side of the endoderm in plant roots. Root branching is initiated in the pericycle.
13. The correct answer is B. The Hardy-Weinberg equation states $p^2 + 2pq + q^2 = 1$, where p = the frequency of the dominant allele of a gene and q = the frequency of the recessive allele of a gene. If a recessive trait is expressed in 1% of the population ($q^2 = 0.01$), the frequency of the allele in the population is 0.1 (square root of 0.01). If the frequency of the recessive allele = 0.1, then the frequency of the dominant allele must be 0.9 (i.e., $1.0 - 0.1 = 0.9$). Therefore, $2pq = (2)(0.1)(0.9) = 0.18$.
14. The correct answer is B. In the absence of oxygen, glycolysis can still occur, and it produces a net yield of 2 ATP per molecule of glucose. Neither oxidative phosphorylation nor the Krebs cycle function in the absence of oxygen. The Calvin cycle normally uses ATP, and lactose fermentation does not produce ATP.
15. The correct answer is D. Energy is required to move minerals up their concentration gradient. In both osmosis and diffusion, substances move down a gradient. Guttation occurs when hydrostatic pressure builds up in roots (typically at night when transpiration rates are low) and forces water up through the xylem.
16. The correct answer is D. This question describes a motor reflex loop between a thermosensory neuron and a motor neuron. Most reflex loops involve an impulse being initiated in a sensory neuron and then passing either directly from a sensory neuron to a motor neuron or from the sensory neuron to an interneuron and then from the interneuron to a motor neuron.
17. The correct answer is D. Mate selection based on a physical feature defines sexual selection.
18. The correct answer is A. By comparing the data from Parent 1 to the reference data, it is clear that Parent 1 is a carrier (AS).
19. The correct answer is A. The infant is homozygous for the sickle cell allele. This can be seen by comparing lane III of the reference data with lane III of the sample data.
20. The correct answer is C. Malpighian tubules are found in arthropods.
21. The correct answer is B. Flame cells contain cilia.



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