National Evaluation Series

Test Framework

Biology (818)

December 2024

Multiple Choice

Subarea	Range of Objectives	Approximate Percentage of Test Score
I. Molecules: Structures and Processes	0001–0002	14%
II. Organisms: Structures and Processes	0003–0005	22%
III. Ecosystems: Interactions, Energy, and Dynamics	0006–0008	22%
IV. Heredity and Biological Evolution	0009–0011	22%
Total	0001–0011	**80%**

Open Response

Subarea	Range of Objectives	Approximate Percentage of Test Score
V. Integration of Knowledge and Understanding		
Key Scientific Concepts	0012	10%
Application of Science and Engineering Practices	0013	10%
Total	0012–0013	**20%**

MOLECULES: STRUCTURES AND PROCESSES

0001: Apply knowledge of the chemical components of living systems and basic principles of biochemistry.

- Demonstrate knowledge of the significance of the physical and chemical properties of water for living organisms.
- Demonstrate knowledge of the common elements present in living organisms (e.g., hydrogen, oxygen, carbon, nitrogen, sulfur, phosphorus) and the major compounds that they form.
- Apply knowledge of chemical bonding, pH, and enzyme structure and function to explain life processes (e.g., cellular respiration, dehydration synthesis, hydrolysis).
- Analyze the structures and functions of monomers (e.g., amino acids, mono- and disaccharides, nucleotides, fatty acids) and organic macromolecules, including proteins, carbohydrates, nucleic acids, and lipids.
- Apply knowledge of the use of science and engineering practices in exploring and understanding content related to biochemistry, such as developing and using models, planning and safely conducting investigations, applying mathematical concepts, and communicating and evaluating data and conclusions.

0002: Apply knowledge of the processes that generate cellular energy.

- Apply knowledge of the structure, function, and production of ATP and the role of ATP in essential life functions (e.g., anaerobic and aerobic respiration, photosynthesis, transport).
- Apply knowledge of the transfer and transformation of energy and the cycling of matter associated with photosynthesis and cellular respiration.
- Demonstrate knowledge of the inputs and outputs of aerobic and anaerobic cellular respiration and photosynthesis and how these processes result in the formation of new compounds and a net transfer of energy.
- Apply knowledge of the use of science and engineering practices in exploring and understanding content related to physiological processes of cells, such as developing and using models, planning and safely conducting investigations, applying mathematical concepts, and communicating and evaluating data and conclusions.

ORGANISMS: STRUCTURES AND PROCESSES

0003: Apply knowledge of cell structure and function and of the cell cycle.

- Apply knowledge of modern cell theory and the characteristics of all living things, and compare the characteristics of viruses to cells (e.g., bacteria).
- Apply knowledge of the structures, functions, and interrelationships among cell organelles and other cell components to homeostatic maintenance.
- Apply knowledge of the structure of the cell membrane and how cells exchange materials with their environment through passive and active transport, recycling of materials, and homeostasis.
- Apply knowledge of the relationship between a cell's structure and its function (e.g., how structural differences contribute to specialization of cell roles in multicellular organisms), and compare structure and function in different types of cells (e.g., plant vs. animal, prokaryotic vs. eukaryotic, neuron vs. blood cell).
- Demonstrate knowledge of the major events of the cell cycle, including DNA replication, mitosis, and cytokinesis; and relate these events to the processes of growth, maintenance, and repair in multicellular organisms.
- Apply knowledge of factors that affect cell growth, division, and differentiation and the role of cell differentiation in the development of multicellular organisms.
- Apply knowledge of the use of science and engineering practices in exploring and understanding content related to cells, such as developing and using models, planning and safely conducting investigations, applying mathematical concepts, and communicating and evaluating data and conclusions.

0004: Apply knowledge of the structures, structural organization, and life processes of unicellular and multicellular organisms (i.e., archaea, bacteria, protists, fungi, plants, and animals).

- Apply knowledge of the hierarchical organization of cells, tissues, organs and organ systems to the maintenance of homeostasis in organisms (e.g., how leaf structure corresponds to its function in photosynthesis).
- Demonstrate knowledge of the life cycles, growth, and reproductive strategies of organisms.
- Demonstrate knowledge of the processes by which nutrients, water, and energy are obtained, stored, conserved, and distributed within organisms to maintain homeostasis.
- Demonstrate knowledge of the mechanisms of cellular communication (e.g., endocrine, quorum sensing, synaptic, pheromonal).
- Apply knowledge of the use of science and engineering practices in exploring and understanding content related to unicellular and multicellular organisms, such as developing and using models, planning and safely conducting investigations, applying mathematical concepts, and communicating and evaluating data and conclusions.

0005: Apply knowledge of human anatomy and physiology.

- Apply knowledge of macronutrients and the structures and functions of the human digestive system.
- Apply knowledge of the structures and functions of the human circulatory and immune systems.
- Apply knowledge of the structures and functions of the human respiratory and excretory systems.
- Apply knowledge of the structures and functions of the human nervous, reproductive, and endocrine systems.
- Apply knowledge of the structures and functions of the human muscular and skeletal systems.
- Apply knowledge of body systems' processes and feedback loops that maintain homeostasis (e.g., hormone regulation, secretion, absorption, cell reproduction).
- Apply knowledge of the use of science and engineering practices in exploring and understanding content related to human anatomy and physiology, such as developing and using models, planning and safely conducting investigations, applying mathematical concepts, and communicating and evaluating data and conclusions.

ECOSYSTEMS: INTERACTIONS, ENERGY, AND DYNAMICS

0006: Analyze interactions and dynamics of populations, communities, ecosystems, and biomes.

- Demonstrate knowledge of ecological concepts (e.g., niche, population, community, ecosystem, biome), types of biomes, and the characteristic flora and fauna of various biomes.
- Analyze factors that affect the population size of species in an ecosystem (e.g., growth rates, carrying capacity, competition).
- Apply knowledge of patterns of interdependence and interrelationships among species in a community (e.g., competition, predation, symbiosis) and identify adaptations of predators and prey.
- Apply knowledge of how abiotic factors (e.g., limiting factors, seasonal variability, natural disasters) and biotic factors (e.g., genetic diversity, competition, disease) affect characteristics of populations and ecosystems (e.g., biodiversity, carrying capacity).
- Demonstrate knowledge of resilience, stability, and change in ecosystems (e.g., change in biodiversity, changes in species behavior, ecological succession) in response to variation in biotic and abiotic factors (e.g., loss of a keystone species).
- Apply knowledge of the use of science and engineering practices in exploring and understanding content related to populations, communities, ecosystems, and biomes, such as developing and using models, planning and safely conducting investigations, applying mathematical concepts, and communicating and evaluating data and conclusions.

0007: Apply knowledge of the cycling of materials and the transfer of energy through an ecosystem.

- Apply knowledge of the transfer of energy from one trophic level to another in an ecosystem.
- Analyze roles of organisms (e.g., producers, consumers, decomposers) within food webs in ecosystems and the effects resulting from a disruption of a food web.
- Apply knowledge of food webs and energy transfer to analyze and compare limiting factors in different ecosystems.
- Apply knowledge of the cycling of carbon, oxygen, nitrogen, and water through the biosphere, atmosphere, hydrosphere, and geosphere and the roles of photosynthesis and respiration in the cycling of carbon and oxygen.
- Apply knowledge of the use of science and engineering practices in exploring and understanding content related to the cycling of materials and the transfer of energy, such as developing and using models, planning and safely conducting investigations, applying mathematical concepts, and communicating and evaluating data and conclusions.

0008: Analyze the effects of human activities on ecosystems and the environment.

- Apply knowledge of renewable resources (e.g., wind, solar) and nonrenewable resources (e.g., natural gas, coal) to the importance of conserving natural resources and mitigating the effects of climate change.
- Demonstrate knowledge of the concept of sustainability and its applications to human activities (e.g., agriculture, forestry management, fisheries management, recycling).
- Apply knowledge of the types and sources of environmental pollution and of the biological, physical, or chemical processes that produce pollutants to the effects of pollution on natural populations, communities, and ecosystems.
- Apply knowledge of the importance of biodiversity and of the ecological consequences of human activities that lead to a loss in biodiversity (e.g., habitat fragmentation, introduction of invasive species, overharvesting, pollution, climate change).
- Demonstrate knowledge of the evidence for, causes of, and consequences of climate change and associated sea level rise.
- Evaluate potential solutions for preventing, mitigating, and reversing human-caused damage to ecological and environmental systems.
- Apply knowledge of the use of science and engineering practices in exploring and understanding content related to the effects of human activities, such as developing and using models, planning and safely conducting investigations, applying mathematical concepts, and communicating and evaluating data and conclusions.

HEREDITY AND BIOLOGICAL EVOLUTION

0009: Apply knowledge of the molecular basis of genetics.

- Demonstrate knowledge of the structure of DNA, genes, and chromosomes and of the process of DNA replication.
- Apply knowledge of the process of protein synthesis, including transcription, translation, and the structure and function of mRNA and tRNA.
- Demonstrate knowledge of how gene expression is influenced by environmental factors (e.g., ultraviolet radiation exposure and cancer, pH and flower color).
- Apply knowledge of the types and causes of different types of mutations.
- Apply knowledge of basic methods of genetic engineering (e.g., transformation, cloning) in various areas, including medicine and agriculture.
- Demonstrate knowledge of the applications of biotechnology (e.g., PCR, gel electrophoresis, DNA fingerprinting) in society.
- Apply knowledge of the use of science and engineering practices in exploring and understanding content related to the molecular basis of genetics, such as developing and using models, planning and safely conducting investigations, applying mathematical concepts, and communicating and evaluating data and conclusions.

0010: Apply knowledge of the principles of genetics to understand the inheritance and variation of traits.

- Apply knowledge of the stages of meiosis to increasing genetic variability and transmitting genetic information.
- Apply knowledge of the processes of mitosis and meiosis to compare the advantages and disadvantages of asexual and sexual reproduction.
- Demonstrate knowledge of the structure and function of chromosomes in the cell and how the behavior of chromosomes during meiosis (e.g., independent assortment, segregation, crossing over, linkage) results in genetic variation.
- Analyze inheritance patterns using various representations, including Punnett squares (i.e., monohybrid and dihybrid crosses) and pedigree charts.
- Apply principles of probability to analyze possible genotype and phenotype combinations in offspring (e.g., dominant–recessive, codominance, incomplete dominance, sex linked, polygenic).
- Apply knowledge of the use of science and engineering practices in exploring and understanding content related to the inheritance and variation of traits, such as developing and using models, planning and safely conducting investigations, applying mathematical concepts, and communicating and evaluating data and conclusions.

0011: Apply knowledge of the theories and mechanisms of evolution to understand biological change and the diversity of life.

- Demonstrate knowledge of historical and current evolutionary thought and of the multiple lines of evidence (e.g., endosymbiosis, genetics, amino acid sequences, fossil record, comparative anatomy) that support biological evolution.
- Apply knowledge of the theory of natural selection to adaptation (e.g., antibiotic resistance), speciation, and extinction.
- Apply knowledge of the sources of variation in a population (e.g., recombination, mutation) to variation in a genetic pool.
- Apply knowledge of population genetics and factors that can affect allelic frequencies in a population over time (e.g., genetic drift, selection) and interpret problems related to the Hardy-Weinberg equilibrium.
- Analyze how factors (e.g., environmental change, reproductive isolation) affect the rate and extent to which genetic change, speciation, and extinction occur.
- Demonstrate knowledge of key features of viruses to explain their ability to develop adaptations in a wide variety of environments (e.g., high rates of reproduction and mutation).
- Apply knowledge of common ancestry to interpret cladograms and binomial nomenclature.
- Apply knowledge of the use of science and engineering practices in exploring and understanding content related to biological change and the diversity of life, such as developing and using models, planning and safely conducting investigations, applying mathematical concepts, and communicating and evaluating data and conclusions.

INTEGRATION OF KNOWLEDGE AND UNDERSTANDING

0012: Prepare an organized, developed analysis of a key topic in biology related to Molecules: Structures and Processes or Heredity and Biological Evolution.

- Describe the key scientific concepts that relate to a given topic.
- Use a representative graph, formula, and/or diagram with proper labels to model the presented topic.
- Discuss how a specific science and engineering practice (e.g., developing and using models, constructing explanations, designing solutions) could be used to help a diverse group of students understand phenomena related to the given topic.

0013: Prepare an organized, developed analysis of a key topic in biology related to Organisms: Structures and Processes or Ecosystems: Interaction, Energy, and Dynamics that emphasizes the application of science and engineering practices in a classroom setting.

- Form a testable scientific claim that addresses a given topic.
- Plan a scientific investigation, including safety considerations, to test the proposed claim, including identifying variables and controls.
- Describe a possible result provided by collected data and provide reasoning about how the collected data provide evidence that supports or refutes the tested claim.
- Discuss how a specific science and engineering practice (e.g., developing and using models, planning and carrying out investigations) could be used to help students make sense of phenomena related to the given topic.