# Missouri Educator Gateway Assessments

## FIELD 075: BIOLOGY
## TEST FRAMEWORK

**June 2019**

# DRAFT

| | Content Domain | Range of Competencies | Approximate Percentage of Test Score |
|---|---|---|---|
| I. | From Molecules to Organisms: Structure and Processes | 0001–0003 | 20.5% |
| II. | Ecosystems: Interactions, Energy, and Dynamics | 0004–0006 | 17% |
| III. | Heredity: Inheritance and Variation of Traits | 0007–0008 | 12.5% |
| IV. | Biological Evolution: Unity and Diversity | 0009–0010 | 12.5% |
| V. | Chemistry | 0011 | 12.5% |
| VI. | Physics | 0012 | 12.5% |
| VII. | Earth Science | 0013 | 12.5% |

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## TEST FRAMEWORK
## FIELD 075: BIOLOGY

### FROM MOLECULES TO ORGANISMS: STRUCTURE AND PROCESSES

**0001 Analyze the chemistry of living systems.**

For example:

1.1 Demonstrate knowledge of the physical and chemical properties of water and carbon and the biological significance of these properties.

1.2 Analyze biological phenomena at the cellular level in terms of the basic principles of thermodynamics (e.g., in relation to ATP, cellular respiration, photosynthesis) and the properties of chemical reactions and covalent, ionic, and hydrogen bonds.

1.3 Analyze the structure and function of macromolecules (e.g., carbohydrates, lipids, nucleic acids, proteins) and their monomers, including metabolic pathways involving their synthesis and breakdown.

1.4 Analyze the structure and function of enzymes and their role in regulating metabolism.

1.5 Apply knowledge of scientific principles, crosscutting concepts, and engineering practices to the chemistry of living systems (e.g., looking at the number and size of molecules in living organisms, examining atomic model of carbon) and make connections between science, engineering, and daily life (e.g., determining what living organisms are made of, exploring the commercial use of enzymes).

**0002 Analyze cell structure, function, bioenergetics, and cellular homeostasis.**

For example:

2.1 Analyze the structure and function of membranes, organelles, and other cellular components in prokaryotic and eukaryotic cells and the mechanisms by which cells maintain homeostasis (e.g., observing changes to cells in hypertonic and hypotonic solutions, examining diffusion and osmosis).

2.2 Analyze the process of photosynthesis and cellular respiration.

2.3 Demonstrate knowledge of binary fission, mitosis, the stages of the cell cycle, and factors affecting the growth and division of cells.

2.4 Analyze the specializations of cells and differentiate cell types.

2.5 Demonstrate knowledge of the differentiation of cells during embryonic development, including factors affecting cell differentiation.

2.6 Apply knowledge of scientific principles, crosscutting concepts, and engineering practices to cell structure, function, bioenergetics, and cellular homeostasis (e.g., examining the role of the chloroplast and mitochondria, building a model of mitosis) and make connections between science, engineering, and daily life (e.g., relating differences in observed onion and muscle cells to their cellular function, understanding stem cell research).

**0003 Demonstrate knowledge of the structures and functions of organisms, including their life cycles.**

For example:

3.1 Demonstrate knowledge of the characteristics of viruses, prokaryotes, protists, and fungi, including their reproduction and life cycles.

3.2 Demonstrate knowledge of the organization of multicellular organisms into varying levels of complexity (e.g., cells, tissues, organs, organ systems).

3.3 Apply knowledge of the characteristics of the major groups of plants, including their reproduction and life cycles.

3.4 Apply knowledge of the characteristics of the major groups of animals, including their reproduction and life cycles.

3.5 Demonstrate knowledge of the general structure, organization, and function of human organ systems; and the causes and characteristics of ailments and diseases (e.g., the common cold, diabetes, cancer).

3.6 Apply knowledge of scientific principles, crosscutting concepts, and engineering practices to the structures and functions of organisms and their life cycles (e.g., interpreting dissections, developing a model of interacting body systems) and make connections between science, engineering, and daily life (e.g., investigating why viruses do not respond well to antibiotics, finding patterns in disease spread).

## ECOSYSTEMS: INTERACTIONS, ENERGY, AND DYNAMICS

### 0004 Analyze obtaining, storing, and using energy and matter to maintain homeostasis.

For example:

4.1 Analyze how prokaryotes, protists, and fungi obtain, store, and use energy, nutrients, and water to maintain homeostasis.

4.2 Analyze how plants obtain, store, and use energy, nutrients, and water to maintain homeostasis.

4.3 Analyze how animals obtain, store, and use energy, nutrients, and water to maintain homeostasis.

4.4 Analyze the homeostatic relationships of human organ systems.

4.5 Apply knowledge of scientific principles, crosscutting concepts, and engineering practices to obtaining, storing, and using energy and matter (e.g., discussing how body systems interact to maintain homeostasis, observing how plants respond to their environment) and make connections between science, engineering, and daily life (e.g., examining digestion rates of different substances; exploring the sources of carbon, which enable plant growth).

### 0005 Analyze populations and communities.

For example:

5.1 Analyze how biotic and abiotic factors affect carrying capacity and biodiversity of an ecosystem and how these factors limit or regulate population size, including the difference between density-independent and density-dependent factors.

5.2 Analyze the behavior of organisms (e.g., protection of young, communication, pollination, reproductive behavior).

5.3 Analyze demographic characteristics, life history patterns, population growth curves, and survivorship curves for populations occurring in different habitats and under different conditions.

5.4 Analyze the composition of biological communities, the types of relationships that exist between organisms in communities, the concept of ecological niche, and factors that produce change in communities.

5.5 Apply knowledge of scientific principles, crosscutting concepts, and engineering practices to populations and communities (e.g., determining the activity and function of a squirrel in seed dispersal and consumption, exploring animal mimicry and how it can evolve) and make connections between science, engineering, and daily life (e.g., examining a rain forest ecosystem as an ethnobotanist working for a pharmaceutical company, applying concepts of population density and distribution to city planning).

**0006 Demonstrate knowledge of ecosystems and biomes.**

For example:

6.1 Analyze energy flow and biogeochemical cycling in ecosystems.

6.2 Demonstrate knowledge of different types of biomes, their climates, geographical distribution, and physical characteristics, and their typical flora and fauna.

6.3 Analyze the trophic roles of organisms in different ecosystems.

6.4 Demonstrate knowledge of the ways in which environmental changes affect ecosystem dynamics.

6.5 Demonstrate knowledge of the effects of human activities on populations, communities, and ecosystems and the implications of these effects for humans and other organisms.

6.6 Demonstrate knowledge of solutions to problems created by human activities, including how these solutions mitigate the impact on the environment and positively influence the environment.

6.7 Apply knowledge of scientific principles, crosscutting concepts, and engineering practices to ecosystems and biomes (e.g., applying concepts of energy and nutrient flow in constructing a food web, experimentally determining what environmental factors favor bacterial decomposers) and make connections between science, engineering, and daily life (e.g., relating acid rain to changes in the germination and growth of seeds, growing algae to remove nutrients from polluted water).

## HEREDITY: INHERITANCE AND VARIATION OF TRAITS

### 0007 Analyze molecular genetics.

For example:

7.1 Analyze the structure, function, and synthesis of nucleic acids; gene structure and function, including factors controlling gene expression; and the processes involved in protein synthesis.

7.2 Analyze the types and causes of chromosomal and gene mutations, the consequences of these genetic changes, and the genetic basis of common disorders and diseases.

7.3 Demonstrate knowledge of basic methods and applications of genetic engineering (e.g., restriction enzymes, DNA sequencing, recombinant DNA).

7.4 Apply knowledge of scientific principles, crosscutting concepts, and engineering practices to molecular genetics (e.g., analyzing a sequence of DNA and then translating it to RNA, identifying how errors occur through the passage of DNA through the cellular generations and track the formation of mutations) and make connections between science, engineering, and daily life (e.g., using paper plasmids to model transformation, using DNA profiling to identify the culprit at a mock crime scene).

### 0008 Analyze patterns and processes of inheritance.

For example:

8.1 Compare and contrast asexual and sexual reproduction and the effects on variation in the offspring.

8.2 Analyze meiosis and fertilization and their roles in sexual life cycles.

8.3 Demonstrate knowledge of the basic structure and function of chromosomes in inheritance.

8.4 Analyze patterns of inheritance and the relationship between genotypic and phenotypic frequencies.

8.5 Analyze patterns of inheritance and solve genetics problems related to them (e.g., pedigree charts, complex inheritance).

8.6 Apply knowledge of scientific principles, crosscutting concepts, and engineering practices to patterns and processes of inheritance (e.g., using models of chromosomes with specific alleles and performing crosses, discussing the advantages and disadvantages of asexual and sexual reproduction) and make connections between science, engineering, and daily life (e.g., examining changes in alleles over time, designing a species to have a specific ecosystem function using the rules of inheritance).

## BIOLOGICAL EVOLUTION: UNITY AND DIVERSITY

### 0009 Demonstrate knowledge of biological evolution.

For example:

9.1 Demonstrate knowledge of evolution as a unifying principle in biology.

9.2 Demonstrate knowledge of the primary mechanisms of evolution (e.g., natural selection, mutation, genetic drift, gene flow, sexual selection) and how they interact to produce genetic change in populations.

9.3 Apply knowledge of the mechanisms of natural selection (e.g., variation, excess offspring, differential reproduction, adaptation, fitness) and artificial selection.

9.4 Demonstrate knowledge of population genetics (e.g., Hardy-Weinberg equilibrium) and the sources and significance of variation in populations.

9.5 Demonstrate knowledge of the relationship between natural selection and adaptation, the types of natural selection (e.g., stabilizing, directional, disruptive), and how natural selection leads to changes in the frequency of specific traits over time.

9.6 Analyze the mechanisms of speciation (e.g., geographic isolation, pre- and post-zygotic isolating mechanisms, founder effect).

9.7 Apply knowledge of scientific principles, crosscutting concepts, and engineering practices to biological evolution (e.g., evolving a digital organism, examining functioning of the coevolution in organisms over time) and make connections between science, engineering, and daily life (e.g., simulating island biogeography, examining the fitness of evolved and engineered organisms in a particular environment).

**0010 Demonstrate knowledge of common ancestry and diversity.**

For example:

10.1 Apply knowledge of the multiple lines of empirical evidence for biological evolution (e.g., fossil record, anatomy, genetic similarities and differences, embryology).

10.2 Demonstrate knowledge of the principles of biological classification, phylogenetic trees and their cladistic basis, and evolutionary relationships of major groups of organisms.

10.3 Demonstrate knowledge of current scientific theories on the origin of life, biologically significant events in Earth's history, and the fossil record.

10.4 Analyze patterns that occur during evolutionary history (e.g., extinctions, adaptive radiations, emergence of evolutionary novelties, vestigial structures).

10.5 Apply knowledge of scientific principles, crosscutting concepts, and engineering practices to common ancestry and diversity (e.g., hypothesizing the evolutionary relationships of certain animals based on traits, graphing the geological timeline with major events in biological history annotated) and make connections between science, engineering, and daily life (e.g., analyzing a model of an insect based on genetic information provided, looking at changes in tooth characteristics in the fossil record to examine evolutionary adaptations and link these adaptations with habitat change).

## CHEMISTRY

### 0011 Apply knowledge of chemistry concepts.

For example:

11.1 Apply knowledge of predominant historical models of the atom; the experimental techniques used to refine and revise those models; and the properties of elements, including development of the periodic table and basic periodic trends in the elements.

11.2 Distinguish between various forms of matter (i.e., pure substances and mixtures).

11.3 Analyze the various types of chemical bonds (i.e., covalent, ionic, and metallic), predict what types of bonds specific elements will form, and apply general rules of nomenclature.

11.4 Analyze energy transfer during chemical reactions and identify exothermic and endothermic reactions.

11.5 Analyze and identify types of reactions in terms of conservation of mass, energy, and charge; and balance common chemical equations.

11.6 Apply the mole concept and solve basic stoichiometry problems.

11.7 Demonstrate knowledge of solutions, suspensions, and colloids; analyze the acid/base nature of solutions; and predict the extent of dissociation.

## PHYSICS

### 0012 Apply knowledge of physics concepts.

For example:

12.1 Apply concepts of mechanical forces and interactions to describe the motion of an object (e.g., position, velocity, and acceleration; Newton's laws; momentum and collisions; the universal law of gravitation).

12.2 Apply concepts of electric and electromagnetic forces in a variety of situations (e.g., Coulomb's law, Ohm's law, circuits, electromagnets).

12.3 Apply knowledge of energy and the conservation of energy, including kinetic energy, potential energy, and thermal energy, and conversions among them (e.g., evaluate real-world devices that convert energy from one form to another).

12.4 Apply knowledge of relationships between frequency, wavelength, and speed of a wave; wave reflection, refraction, and superposition; principles of optics; and applications of waves in technologies for information transfer.

## EARTH SCIENCE

### 0013 Apply knowledge of Earth science concepts.

For example:

13.1 Demonstrate knowledge of the origin of the universe and the characteristics and life cycles of stars, galaxies, and other objects in the universe.

13.2 Apply knowledge of the characteristics and motions of objects within the solar system and the interactions of the Earth-moon-sun system.

13.3 Demonstrate knowledge of the geologic timescale and dating methods; the structure of Earth's interior and methods used to study it; the evidence for, and causes of, plate tectonics; the rock cycle; and the processes of weathering, erosion, and deposition.

13.4 Apply knowledge of the properties of water, movement of water through the hydrologic cycle, and characteristics of different water reservoirs.

13.5 Demonstrate knowledge of factors of the composition, evolution, and structure of the atmosphere; the processes of energy transfer in the atmosphere; factors that affect weather, climate, and climate change; and the use of weather models, maps, and weather-related technology.

13.6 Demonstrate knowledge of factors that influence the movement of matter through geochemical cycles; types, characteristics, distribution, and management of renewable and nonrenewable resources; and the advantages and disadvantages of different sources of energy.

13.7 Demonstrate knowledge of natural hazards and catastrophic events and their impacts on human populations, the effects of human activities on each of Earth's systems, and strategies for mitigating these effects.