

# Massachusetts Tests for Educator Licensure® (MTEL®)

## FIELD 13: BIOLOGY TEST OBJECTIVES

Subarea	Multiple-Choice	Range of Objectives	Approximate Test Weighting
I.	Nature of Science	01–04	10%
II.	Chemistry of Life and Cell Biology	05–07	14%
III.	Characteristics of Organisms	08–10	14%
IV.	Human Anatomy and Physiology	11–15	14%
V.	Genetics, Evolution, and Biodiversity	16–19	14%
VI.	Populations, Ecosystems, and the Environment	20–22	<u>14%</u>
			<b>80%</b>
	<b>Open-Response</b>		
VII.	Integration of Knowledge and Understanding	23	<b>20%</b>

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**Effective September 1, 2009**

**Massachusetts Tests for Educator Licensure® (MTEL®)**  
**Test Objectives**  
**Field 13: Biology**

**SUBAREAS:**

NATURE OF SCIENCE  
CHEMISTRY OF LIFE AND CELL BIOLOGY  
CHARACTERISTICS OF ORGANISMS  
HUMAN ANATOMY AND PHYSIOLOGY  
GENETICS, EVOLUTION, AND BIODIVERSITY  
POPULATIONS, ECOSYSTEMS, AND THE ENVIRONMENT  
INTEGRATION OF KNOWLEDGE AND UNDERSTANDING

**NATURE OF SCIENCE [10%]**

**0001 Understand the dynamic nature of scientific inquiry and scientific processes.**

For example:

- Demonstrate knowledge of the principles of scientific inquiry and the dynamic nature of science.
- Demonstrate the ability to formulate scientific questions and testable hypotheses.
- Evaluate the validity of an experimental design for collecting data and testing a hypothesis.
- Identify sources of bias and strategies for avoiding bias in scientific investigations.

**0002 Understand the processes of gathering, organizing, analyzing, and reporting scientific data.**

For example:

- Demonstrate knowledge of appropriate methods and procedures for collecting data in biological investigations.
- Demonstrate knowledge of various methods of representing, organizing, and reporting experimental results (e.g., tables, graphs).
- Apply mathematical concepts to measurement and the analysis and interpretation of data (e.g., accuracy, significant figures, scientific notation, unit conversion, descriptive statistics).
- Demonstrate the ability to draw conclusions from, identify sources of error in, and make predictions from empirical data.

## **Field 13: Biology Test Objectives**

### **0003 Understand scientific instruments, materials, and safety practices.**

For example:

- Select appropriate instruments and procedures to collect, measure, and represent data in biological investigations.
- Recognize proper practices and requirements related to the use and care of living and preserved organisms.
- Demonstrate knowledge of the safe and proper use of laboratory equipment and materials.
- Recognize proper methods for storing, identifying, dispensing, and disposing of chemicals and biological materials.
- Demonstrate knowledge of the appropriate protocols for maintaining safety and responding to emergencies in laboratory and field situations.

### **0004 Understand the historical and contemporary relationships among science, technology, and society.**

For example:

- Demonstrate knowledge of scientific theories and the events and experiments that contributed to their development.
- Recognize the integration and interdependence among scientific disciplines and between science and technology, including aspects of chemistry, physics, and earth science related to biology.
- Identify the benefits, risks, and ethical concerns associated with biological research and developing technologies.
- Recognize how societal conditions support or inhibit scientific research and technological advances.
- Demonstrate knowledge of engineering and biotechnology.
- Analyze scientific claims in the media.

## Field 13: Biology Test Objectives

### CHEMISTRY OF LIFE AND CELL BIOLOGY [14%]

#### **0005 Understand the chemical components of living systems and basic principles of biochemistry.**

For example:

- Analyze the significance of the physical and chemical properties of water for living organisms.
- Identify characteristics of acids, bases, salts, and buffers.
- Identify the most common elements in living organisms.
- Identify types of chemical bonds (e.g., hydrogen, covalent, ionic).
- Analyze the structures and functions of lipids, carbohydrates, proteins, and nucleic acids.
- Analyze the role of enzymes in biochemical processes and factors (e.g., temperature, pH) that affect the activity of enzymes.

#### **0006 Understand cell structure and function.**

For example:

- Identify components of the modern cell theory and describe their implications.
- Demonstrate knowledge of the structures, functions, and interrelationships between cell organelles and other cell components.
- Analyze specializations of cells and the relationship between a cell's structure and its function.
- Compare different types of cells (e.g., plant and animal, prokaryotic and eukaryotic).
- Characterize viruses and differentiate them from cells.

## Field 13: Biology Test Objectives

### 0007 Understand the physiological processes of cells.

For example:

- Analyze the process of cellular respiration and differentiate between aerobic and anaerobic respiration.
- Analyze the process of photosynthesis.
- Analyze the role of ATP in metabolism, including cellular respiration and photosynthesis.
- Analyze the processes by which cells exchange materials with the environment and maintain homeostasis (e.g., diffusion, active transport, endocytosis).
- Analyze binary fission and the cell cycle.
- Analyze factors that affect cell growth, division, and differentiation and the role of cell differentiation in development.

### CHARACTERISTICS OF ORGANISMS [14%]

### 0008 Understand the structures, structural organization, and life processes of plants.

For example:

- Analyze the life cycles and reproductive strategies of representative plants (e.g., green algae, mosses, seedless vascular plants, seed plants).
- Identify the types of cells, tissues, organs, and organ systems of plants.
- Analyze the processes by which plants obtain, store, and distribute nutrients and energy.
- Analyze the processes by which plants obtain, transport, and conserve water.
- Analyze the growth of plants and their control systems (e.g., hormones, tropisms, circadian rhythms).

## **Field 13: Biology Test Objectives**

### **0009 Understand the structures, structural organization, and life processes of archaea, bacteria, protists, fungi, and invertebrates.**

For example:

- Analyze the reproductive strategies, behaviors, and life cycles of representative groups of archaea, bacteria, protists (e.g., amoebas, flagellates, red algae), fungi (e.g., molds, mushrooms, sac fungi), and invertebrates (e.g., annelids, echinoderms, arthropods).
- Identify the structural organization of representative archaea, bacteria, protists, fungi, and invertebrates.
- Analyze the processes by which archaea, bacteria, protists, fungi, and invertebrates obtain, store, and distribute nutrients and energy.
- Analyze the strategies and processes that enable archaea, bacteria, protists, fungi, and invertebrates to grow and maintain homeostasis.

### **0010 Understand the structures, structural organization, and life processes of vertebrates.**

For example:

- Analyze the reproductive strategies, behaviors, and life cycles of vertebrates.
- Identify the types of cells, tissues, organs, organ systems, and body plans (e.g., symmetry, cephalization) of vertebrates.
- Analyze the processes by which vertebrates obtain, store, and distribute nutrients and energy.
- Analyze the processes used by vertebrates to exchange respiratory gases with the environment.
- Analyze the processes used by vertebrates to maintain homeostasis (e.g., water balance, waste level, temperature).
- Analyze nervous systems, sensory mechanisms, and means of locomotion in vertebrates.

## Field 13: Biology Test Objectives

### HUMAN ANATOMY AND PHYSIOLOGY [14%]

#### 0011 Understand the structures and functions of the human digestive system and the principles of nutrition.

For example:

- Identify the structures and components of the digestive system, including accessory organs (e.g., salivary glands, pancreas, liver).
- Analyze the process of digestion.
- Identify the roles of water, vitamins, minerals, proteins, carbohydrates, and lipids in nutrition.
- Analyze how the digestive system maintains homeostasis in the body.
- Identify common disorders and diseases of the digestive system.

#### 0012 Understand the structures and functions of the human circulatory and immune systems.

For example:

- Identify the structures of the circulatory system and the heart and relate them to their functions.
- Analyze the pattern of blood flow in the body.
- Identify the components and functions of blood and lymph.
- Identify the structures and components of the immune system.
- Analyze the immune response.
- Analyze how the circulatory and immune systems maintain homeostasis.
- Identify common disorders and diseases of the circulatory and immune systems.

#### 0013 Understand the structures and functions of the human respiratory and excretory systems.

For example:

- Identify the structures and components of the respiratory and excretory systems and relate them to their functions.
- Analyze the exchange of gases and other materials between blood and other tissues, and the process of countercurrent exchange in the kidney.
- Analyze how the respiratory and excretory systems maintain homeostasis.
- Identify common disorders and diseases of the respiratory and excretory systems.

## **Field 13: Biology Test Objectives**

### **0014 Understand the structures and functions of the human nervous, endocrine, and reproductive systems.**

For example:

- Differentiate between the structures and functions of the central and peripheral nervous systems.
- Analyze the transmission of nerve impulses within and between neurons.
- Identify the structures and components of the male and female reproductive systems and relate them to their functions.
- Relate structures of the endocrine system, specific hormones, and their functions, and analyze the roles of hormones in the development and functioning of the reproductive systems.
- Analyze how feedback mechanisms of the nervous and endocrine systems maintain homeostasis.
- Identify common disorders and diseases of the nervous, endocrine, and reproductive systems.

### **0015 Understand the structures and functions of the human skeletal, muscular, and integumentary systems.**

For example:

- Identify the types, structures, and functions of bone, muscle, and connective tissues.
- Identify the types of joints and their functions.
- Analyze the process of muscle contraction.
- Relate the structure of skin to its function.
- Identify common diseases and disorders of the skeletal, muscular, and integumentary systems.

## **Field 13: Biology Test Objectives**

### **GENETICS, EVOLUTION, AND BIODIVERSITY [14%]**

#### **0016 Understand the principles of heredity.**

For example:

- Identify and distinguish among observed inheritance patterns (e.g., autosomal, sex-linked, polygenic, nonnuclear).
- Analyze the structure and behavior of chromosomes (e.g., crossing over, linkage) and relate these to patterns of inheritance (e.g., independent assortment, segregation).
- Identify the consequences of abnormal chromosomal behavior (e.g., aneuploidy, human diseases and syndromes).
- Identify the stages of meiosis and analyze the role of meiosis in the transmission of genetic information.
- Solve genetic problems by application of genetic principles, including Punnett squares and pedigrees.

#### **0017 Understand the molecular basis of genetics.**

For example:

- Analyze the structure of DNA and the process of DNA replication.
- Analyze the process of protein synthesis, including the different types of RNA and their functions in transcription and translation.
- Analyze the control of genomic expression in prokaryotes and eukaryotes.
- Differentiate among different types of mutations and their possible consequences, and identify environmental factors that may affect genetic material.
- Identify basic methods used in genetic engineering and areas in which these methods have had an impact.

## Field 13: Biology Test Objectives

### **0018 Understand the theories and mechanisms of evolution.**

For example:

- Identify evidence (e.g., fossil record, comparative anatomy, molecular biology) that species change over time.
- Demonstrate knowledge of historical and current theories of evolution (e.g., Darwinian, Lamarckian, punctuated equilibrium).
- Analyze the process of natural selection and its relationship to adaptation and biological fitness.
- Identify the importance of variation in populations and sources of variation (e.g., recombination, mutation) on which selection can act.
- Demonstrate knowledge of population genetics and factors that may affect allele frequencies in a population (e.g., selection, genetic drift).
- Identify and analyze processes (e.g., isolation) that affect the rate and extent to which genetic differentiation and speciation occur.

### **0019 Understand biodiversity and classification.**

For example:

- Identify distinguishing characteristics of taxonomic groups at the domain and kingdom levels.
- Compare procedures and criteria used to classify organisms (e.g., biological species concept, cladistics, phenetics).
- Identify the characteristics of biological classification (e.g., hierarchy of taxonomic levels, importance of heritable characteristics, relationship of classification to evolutionary history).
- Recognize evolutionary relationships among species and taxonomic groups, including hominids.

## **Field 13: Biology Test Objectives**

### **POPULATIONS, ECOSYSTEMS, AND THE ENVIRONMENT [14%]**

#### **0020 Understand populations, communities, ecosystems, and biomes.**

For example:

- Analyze factors that affect population size (e.g., growth rates, carrying capacity, migration).
- Identify patterns of interdependence and interrelationships among species in a community (e.g., competition, predation, parasitism, mutualism).
- Analyze abiotic and biotic factors that affect ecosystems.
- Identify types of biomes and their characteristic flora and fauna.
- Analyze the process of biological succession.

#### **0021 Understand the cycling of materials and the transfer of energy through an ecosystem.**

For example:

- Analyze trophic levels, energy relationships, and the roles of organisms (e.g., producers, consumers, decomposers) within food webs.
- Analyze the characteristics and processes of biogeochemical cycles (e.g., water, carbon, oxygen, nitrogen, phosphorus).
- Analyze the concept of limiting factors and its effects on different ecosystems.

#### **0022 Understand the effects of human activities on the environment.**

For example:

- Identify renewable resources and demonstrate knowledge of strategies for managing or conserving them.
- Identify types and sources of environmental pollution; the biological, physical, or chemical processes that produce pollutants; and the effects of pollution on natural populations, communities, and ecosystems.
- Analyze the consequences of human activities (e.g., loss of biodiversity, introduction of invasive species, global climate change), as well as proposed solutions.

**Field 13: Biology  
Test Objectives**

**INTEGRATION OF KNOWLEDGE AND UNDERSTANDING [20%]**

*In addition to answering multiple-choice items, candidates will prepare written responses to questions addressing content summarized in the objective below.*

**0023 Prepare an organized, developed analysis on a topic related to one or more of the following subareas: Nature of Science; Chemistry of Life and Cell Biology; Characteristics of Organisms; Human Anatomy and Physiology; Genetics, Evolution, and Biodiversity; and Populations, Ecosystems, and the Environment.**

(Refer to objectives 0001 through 0022 and associated descriptive statements.)