

**Massachusetts Tests for Educator Licensure™**  
**Test Objectives**  
**Field 13: Biology**

**SUBAREAS:**

SCIENTIFIC INQUIRY  
CELLS AND CELL THEORY  
CHARACTERISTICS OF ORGANISMS  
HUMAN BIOLOGY  
PRINCIPLES OF HEREDITY AND THE EVOLUTION OF LIFE  
MATTER AND ENERGY IN ECOSYSTEMS

**SCIENTIFIC INQUIRY**

**0001 Apply procedures for gathering, organizing, interpreting, evaluating, and communicating data.**

For example: identifying appropriate questions to ask in a given biological science context; systematically observing phenomena; gathering information from a variety of sources; selecting and using measurement devices; using, manipulating, and interpreting metric units; organizing data gathered through observation and experimentation; communicating and interpreting data presented in a variety of formats (e.g., graphs, flow charts, tables, step-by-step directions, reports); making predictions and drawing conclusions based on data; and evaluating, reporting, and applying simple descriptive statistics.

**0002 Apply principles and procedures of research and experimental design.**

For example: selecting an appropriate biological problem to be solved through planned experimentation; identifying procedures and considerations in setting up and conducting experiments; applying sampling techniques; using control and experimental groups to test hypotheses; and recognizing variables being held constant, variables being manipulated, and variables responding.

**0003 Apply procedures related to the proper use of tools, equipment, and materials (including chemicals and living organisms) commonly used in biology, and practices for maintaining safety during biological investigations.**

For example: proper practices and techniques related to the safe use and storage of tools, equipment, and materials; proper practices and requirements related to the use and care of living organisms; and procedures for preventing accidents in biology classrooms and laboratories.

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

**0004 Understand historical and social aspects of biological study and contributions made to biology by various people.**

For example: the historical development and significance of key biological ideas from different periods and cultures; the cultural and social contexts of biology; and the historical development of important biological breakthroughs.

**0005 Understand the interrelationships between biology, society, technology, and other sciences and disciplines.**

For example: the effects of biological science and technology on society; the application of biology in personal decision making; the implications of biological discoveries for technological advances; the use of technology in biology; the use of mathematics and chemistry to describe and analyze biological phenomena; and themes and concepts (e.g., energy, systems, constancy) that link biology to other sciences and disciplines.

**0006 Analyze the nature of scientific thought and inquiry.**

For example: science as the study of natural phenomena; the reliance of scientific investigation on empirical data, verifiable evidence, reasoning, and logical arguments; the importance of avoiding researcher bias in scientific investigations; and the evaluation of scientific claims and arguments.

**0007 Understand processes for decision making related to biological problems and issues.**

For example: identifying sources of information that aid in decision making; analyzing pros and cons of an issue; evaluating the validity of conclusions; and recognizing issues (e.g., ethical) that influence decisions related to biology.

### **CELLS AND CELL THEORY**

**0008 Understand cell structure and function and the cell theory.**

For example: the structures, functions, and interrelationships between cell organelles and other cell components; specializations of cells and the relationship between a cell's structure and its function; comparison of different types of cells (e.g., plant and animal cells, prokaryotic and eukaryotic cells); and the basic tenets and implications of cell theory.

**0009 Understand the chemical components of living systems and basic principles of biochemistry.**

For example: the physical and chemical characteristics of water and its role in living organisms; the chemical characteristics of carbon, acids, bases, salts, and buffers and their roles in living organisms; and structures, functions, and composition of lipids, carbohydrates, proteins, amino acids, and nucleic acids.

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

### **0010 Analyze physiological processes of cells.**

For example: the processes of protein synthesis, photosynthesis, and respiration (anaerobic and aerobic) and the role of enzymes in regulating these processes; and the processes by which cells obtain nutrients and maintain homeostasis (e.g., diffusion, facilitated diffusion, osmosis, active transport, exocytosis, endocytosis).

### **0011 Analyze cell growth, division, and differentiation.**

For example: the cell cycle; the processes of mitosis and meiosis; cell structures involved in mitosis and meiosis; the consequences of normal and abnormal mitotic and meiotic divisions; the role of mitosis and meiosis in living organisms; factors that affect cell growth, division, and differentiation; and the role of cell differentiation in development.

## **CHARACTERISTICS OF ORGANISMS**

### **0012 Understand principles of taxonomy and classification in biology.**

For example: the characteristics of biological classification (e.g., hierarchy of taxonomic levels, importance of heritable characteristics in classifying organisms, relationship of taxonomic classification to evolutionary history); the biological species concept; organization and characteristics of the five-kingdom system; procedures and criteria used to classify organisms; taxonomic relationships among organisms (including both living and extinct organisms); and classification of organisms on the basis of given characteristics.

### **0013 Analyze reproduction, development, and life cycles of living organisms.**

For example: characteristics of sexual and asexual reproduction; advantages and disadvantages of sexual and asexual reproduction; reproductive strategies of common organisms; characteristics of developing embryos of plants and animals; processes related to developing embryos (e.g., cleavage, gastrulation); and life cycles of common organisms.

### **0014 Analyze the processes used by living organisms to obtain, store, and use energy.**

For example: comparisons of processes used by organisms from the five kingdoms to obtain energy; structures used to store food; structures and processes involved in the distribution of food to all parts of an organism; and ways in which organisms use food.

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### **0015 Analyze the anatomy and physiology of living organisms.**

For example: anatomical structures and physiological processes that allow organisms from the five kingdoms to carry out specific life functions (e.g., maintaining homeostasis, respiration, photosynthesis); levels of biological organization (i.e., tissues, organs, organ systems) in multicellular organisms; functions of and relationships among given tissues, organs, and organ systems; and adaptations of structures and processes.

## **HUMAN BIOLOGY**

### **0016 Understand the structures and functions of the human skeletal, muscular, and integumentary systems.**

For example: types, structures, and functions of bone, muscle, and connective tissues; the importance of muscle and bone arrangement in joint movement; the physiology of muscle contraction; the relationship between the structure of the skin and its functions; common diseases and disorders of the skeletal, muscular, and integumentary systems; and the homeostatic roles of the skeletal, muscular, and integumentary systems within the body.

### **0017 Understand the structures and functions of the human circulatory and immune systems.**

For example: structures and processes of the circulatory and immune systems; factors that affect heart function and cardiac output; the relationship between the pattern of circulation and transport of materials in the blood; characteristics and regulation of immune responses; components and functions of blood and lymph; common diseases and disorders of the circulatory and immune systems (e.g., AIDS); and the homeostatic roles of the circulatory and immune systems within the body.

### **0018 Understand the structures and functions of the human respiratory and excretory systems.**

For example: structures and processes of the respiratory and excretory systems; the relationship between surface area and volume in the functioning of the respiratory and excretory systems; the exchange of materials and gases between the blood and other tissues; the principle of countercurrent exchange and its role in kidney function; common diseases and disorders of the respiratory and excretory systems; and the homeostatic roles of the respiratory and excretory systems within the body.

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**0019 Understand the principles of human nutrition and structures and functions of the human digestive system.**

For example: the roles in the body of basic nutrients found in foods (e.g., water, vitamins, proteins, carbohydrates, lipids); structures and processes of the digestive system, including accessory organs (e.g., salivary glands, pancreas, liver); processes by which nutrients are transported from the intestinal lumen to other parts of the body; common diseases and disorders of the digestive system; and the homeostatic role of the digestive system within the body.

**0020 Understand the structures and functions of the human nervous and endocrine systems.**

For example: differences in the structures and functions of the central and peripheral nervous systems; processes involved in the transmission of nerve impulses within and between neurons; structures of the endocrine system and the functions of specific hormones; comparisons of nervous and hormonal signals; the role of feedback mechanisms in nervous system and endocrine system functioning; common diseases and disorders of the nervous and endocrine systems; and the homeostatic roles of the nervous and endocrine systems within the body.

**0021 Understand the structures and functions of the human reproductive systems and the processes of embryonic development.**

For example: structures and functions of the male and female reproductive systems; the role of hormones in the development and function of the reproductive systems; the processes of gametogenesis and fertilization; processes and stages of embryonic development and factors that may influence development (e.g., drugs, alcohol, radioactivity); common diseases and disorders of the human reproductive systems; and the homeostatic role of the reproductive system within the body.

## Field 13: Biology Test Objectives

### PRINCIPLES OF HEREDITY AND THE EVOLUTION OF LIFE

#### **0022 Understand the principles of Mendelian and non-Mendelian genetics.**

For example: evidence that certain characteristics are inherited; basic principles of heredity (e.g., independent assortment); the relationship of Mendelian genetics to the structure and behavior of chromosomes; crossing-over and its effect on genotype and phenotype; sex-linked characteristics; incomplete dominance and co-dominance; polygenic inheritance; non-nuclear inheritance; and application of genetic principles to solve problems involving genetic crosses.

#### **0023 Understand the synthesis of DNA, RNA, and protein.**

For example: processes of replication, transcription, and translation; the relationship of molecular structure to these processes; and the genetic code (including analysis of problems involving codons and anticodons).

#### **0024 Understand genes, chromosomes, and changes in genetic material.**

For example: modern theories regarding gene structure and function; the relationship between genes and chromosomes; types of mutations and their consequences; the influence of environment on heredity; basic methods used in genetic engineering; and applications of genetic engineering/recombinant DNA technology (including positive effects and potential risks).

#### **0025 Analyze the process of natural selection.**

For example: the concept of variation in populations (including genetic and phenotypic variation); the concept of selection pressure; the influence of selection pressure on species adaptations; the concept of biological fitness; and the role of selection pressure on the survival of organisms and species and on the evolution of species.

#### **0026 Analyze the theory of evolution.**

For example: evidence that species change over time; research methods used to investigate evolutionary history; evolutionary relationships among familiar species and taxonomic groups, including hominids; and modern and historic theories of evolution.

## Field 13: Biology Test Objectives

### MATTER AND ENERGY IN ECOSYSTEMS

#### **0027 Understand populations and communities.**

For example: basic requirements of organisms (e.g., food, habitat, shelter); factors that affect population size (e.g., carrying capacity, competition, predation); common patterns of interdependence and interrelationships among species in a community (including the roles of producers, consumers, and decomposers); the concept of niche; and energy relationships within food chains and food webs.

#### **0028 Understand types and characteristics of ecosystems and biomes and factors affecting their change over time.**

For example: common patterns of interdependence and interrelationships among species in an ecosystem; biotic and abiotic factors that affect ecosystems; types and characteristics of biomes; typical flora and fauna of biomes; and the process of ecological succession.

#### **0029 Analyze the cycling of materials through an ecosystem.**

For example: characteristics and processes of biogeochemical cycles (e.g., water, carbon-oxygen, nitrogen, phosphorus); roles of organisms in biogeochemical cycles; the concept of limiting factors; and implications of biogeochemical cycles for living things.

#### **0030 Understand human ecology and the physical and societal effects of human activities on the environment.**

For example: characteristics and consequences of human population growth; food production and the world food supply; issues related to the availability, distribution, and use of water, space, and energy; types, sources, and effects of pollution (e.g., depletion of the ozone layer); chemical and physical mechanisms (e.g., burning of fossil fuels) by which pollutants (e.g., acid precipitation) are created; consequences of habitat destruction; and methods of pollution control, resource conservation (e.g., recycling), land reclamation, and environmental preservation.