

MICHIGAN TEST FOR TEACHER CERTIFICATION (MTTC)

TEST OBJECTIVES FIELD 017: BIOLOGY

Subarea	Approximate Percentage of Questions on Test
Foundations of Scientific Inquiry	19%
Cellular Function	15%
Heredity and Evolutionary Changes	22%
Organization of Living Things	22%
Ecological Systems	22%

FOUNDATIONS OF SCIENTIFIC INQUIRY

Understand the principles and procedures for conducting scientific research.

Includes developing valid experimental designs for collecting data and testing hypotheses; recognizing the role of control groups in experiments; understanding procedures for collecting and interpreting data to minimize bias; identifying procedures used in setting up and conducting scientific investigations in the field and in the laboratory; recognizing variables being held constant, being manipulated (i.e., independent variables), and responding (i.e., dependent variables); identifying the most effective method for presenting data for a given purpose (e.g., graph, table, map); evaluating simple descriptive statistics; interpreting data presented in different formats; evaluating the validity of conclusions; and assessing the reliability of sources of information.

Apply knowledge of methods and materials used in scientific investigations.

Includes identifying procedures and sources of information (e.g., MSDS sheets, chemical hygiene plans) for the safe use and storage of materials related to scientific investigations (e.g., chemicals, biohazards, equipment); understanding the practices and requirements related to the handling and ethical use of living organisms; and applying procedures for selecting and using measurement devices (e.g., rulers, balance scales, thermometers).

Understand the nature and history of scientific thought and inquiry.

Includes being aware of the reliance of scientific inquiry on empirical data, verifiable evidence, and logical reasoning; recognizing the limits of science; evaluating the effect of researcher bias on scientific investigations and the interpretation of data; demonstrating an awareness of the contributions made in biology by individuals of diverse backgrounds; and analyzing the dynamic nature of scientific knowledge, including ways in which scientific knowledge is acquired, modified, and disseminated.

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TEST OBJECTIVES FIELD 017: BIOLOGY

Understand the relationship of biology to contemporary, historical, technological, and societal issues.

Includes demonstrating an awareness of the differences between science and technology; analyzing historical, political, and social factors affecting developments in biology, including current societal issues related to developments in biology and technology; recognizing ethical issues related to biological research (e.g., cloning, genetic engineering); and evaluating the credibility of scientific claims made in various forums (e.g., the popular media, professional journals, advertising).

Understand interrelationships among the life, physical, and earth/space sciences and among science, mathematics, and technology.

Includes recognizing major unifying themes and concepts in the various scientific disciplines (e.g., classification, cause and effect, conservation of energy, entropy); and understanding the interdisciplinary connections among science, mathematics, and technology and their applications in real-world contexts.

CELLULAR FUNCTION

Understand cell theory and cellular structure and function.

Includes recognizing the basic tenets of cell theory; comparing prokaryotic (i.e., archaea, eubacteria) and eukaryotic cells; recognizing the structures, functions, and interactions of cellular components common to all cells (e.g., membranes, metabolism, genetic information) and those that are unique to some cells (e.g., nucleus, lysosomes, chloroplasts); and relating the structures of specialized cells to their functions (e.g., red blood cells, guard cells, neurons).

Understand the basic chemical components and reactions of cells.

Includes identifying the basic chemical structures of carbohydrates, lipids, proteins, and nucleic acids, the interactions among these compounds, their roles in cells, and their roles in living systems; demonstrating knowledge of the reactions by which biological macromolecules are metabolized; recognizing the physical and chemical properties of water and its role in living organisms; and analyzing the structure and function of enzymes and factors that affect enzyme function.

Analyze the physiological processes of cells.

Includes applying knowledge of the biochemical pathways used to synthesize and break down macromolecules, including photosynthesis and respiration; comparing the transformations of energy and the flow of matter during photosynthesis and respiration; and analyzing the roles of active and passive transport processes in cellular homeostasis.

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Understand the processes of cell division, growth, and differentiation.

Includes identifying the stages of the cell cycle and the characteristics of each stage; recognizing the processes, outcomes, and roles of mitosis and meiosis in organisms; evaluating the roles of cell growth and division in the growth of multicellular organisms; recognizing characteristics of the process of cell differentiation and its role in development; and analyzing factors that affect cell division, growth, and differentiation.

HEREDITY AND EVOLUTIONARY CHANGES

Understand the concepts and principles of Mendelian genetics.

Includes evaluating evidence that certain characteristics are inherited; analyzing the significance of Mendel's experiments and their role in formulating the basic principles of heredity (e.g., segregation, independent assortment); relating the behavior of chromosomes during meiosis and fertilization to inheritance patterns; recognizing the relationship between genotype and phenotype; applying knowledge of dominance, recessiveness, incomplete dominance, and sex linkage to solve problems involving genetic crosses; and analyzing the effects of crossing-over on genotypes and phenotypes.

Understand the concepts and principles of molecular genetics.

Includes identifying the structures and functions of DNA and RNA in organisms; relating the structure of DNA and RNA to the processes of replication, transcription, and translation; analyzing steps in the process of protein synthesis; recognizing current models of gene structure and function and how gene expression is regulated in various organisms; identifying characteristics of the genetic code; analyzing types of mutations and their consequences; and identifying the role of nonnuclear inheritance (e.g., mitochondrial DNA) in phenotypic expression.

Understand the techniques and applications of modern genetics.

Includes recognizing techniques used in the isolation, manipulation, and expression of genetic material (e.g., electrophoresis, DNA fingerprinting, recombinant DNA technology); and relating the applications of genetic engineering to medicine (e.g., gene therapy) and agriculture (e.g., transgenic crops).

Understand concepts and principles of population genetics.

Includes recognizing the concept of a gene pool; demonstrating knowledge of the concept of Hardy-Weinberg equilibrium; applying the Hardy-Weinberg equation to solve problems involving genotypic and phenotypic frequencies in populations; identifying factors that contribute to changing allele frequencies in a population; analyzing how new traits become established in populations; and recognizing populations as the units of evolution.

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Understand processes of evolutionary change.

Includes recognizing the key points of Darwin's theory of evolution; identifying sources of population variation on which natural selection can act (e.g., mutations, genetic drift); analyzing the role of natural selection in leading to genotypic and phenotypic changes in a population over time; recognizing adaptations as products of selection of naturally occurring variations in populations; analyzing factors that contribute to speciation (e.g., geographic isolation, reproductive isolation); and evaluating observations in various areas of biology in terms of evolutionary theory (e.g., embryology, biochemistry, molecular genetics).

Understand characteristics of ancient life and related evidence.

Includes identifying theories regarding the origins and evolution of life; evaluating evidence from various areas of biology (e.g., paleontology, molecular genetics) regarding the origins of life and evolutionary relationships among major groups of organisms; evaluating the strengths and limitations of the fossil record; and recognizing characteristics of major extinction events in earth's history and evidence of their causes.

ORGANIZATION OF LIVING THINGS

Understand the characteristics of living organisms and how organisms are classified.

Includes identifying the characteristics of life and requirements needed to sustain life; comparing living organisms and nonliving things; analyzing criteria used to classify organisms (e.g., morphology, genetic similarities, evolutionary relationships); recognizing the hierarchical structure of the taxonomic system; interpreting phylogenetic trees of related species; and classifying organisms based on given characteristics.

Understand the life cycles of organisms, including reproduction, growth, and development.

Includes recognizing the characteristics of sexual and asexual reproduction; comparing the relative advantages and disadvantages of sexual and asexual reproduction; analyzing the reproductive strategies of various organisms; recognizing characteristics of developing embryos of plants and animals and the processes related to development (e.g., cleavage, gastrulation); and demonstrating knowledge of the life cycles of familiar organisms (e.g., bacteria, flowering plants, amphibians, insects).

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Understand the structures, organization, and functions of systems in organisms.

Includes recognizing levels of organization in multicellular organisms and the relationships among the levels (i.e., cells, tissues, organs, systems); comparing the organization and structures of diverse life forms, from single-celled to complex multicellular organisms; analyzing anatomical structures and physiological processes of body systems in various organisms (e.g., plants, invertebrates, vertebrates); relating the function of a body part or system to its structure or organization; and evaluating the adaptive significance of given structures or physiological processes.

Analyze processes used by organisms to obtain, store, and use matter and energy and to maintain homeostasis.

Includes understanding the need for organisms to obtain energy and cycle matter and comparing the processes by which different organisms do so; identifying structures and processes used by organisms to store food and energy; analyzing systems and processes involved in the distribution of nutrients to all parts of an organism; recognizing the sources of energy used by various organisms (e.g., archaebacteria, plants, animals); and analyzing anatomical structures, physiological responses, and behaviors that are involved in maintaining homeostasis.

Understand human anatomy and physiology.

Includes identifying structures and functions of the various body systems; recognizing the interrelationships of the different systems; analyzing physiological processes (e.g., digestion, circulation, excretion) and their role in maintaining homeostasis; and demonstrating knowledge of human reproduction, growth, and development.

Understand characteristics of human diseases and immunology.

Includes recognizing characteristics of common human diseases, including their causes, prevention, diagnosis, and treatment; evaluating the effects of behaviors (e.g., smoking, exercising regularly) on short- and long-term health; and demonstrating knowledge of the human immune system and the characteristics of immune responses.

ECOLOGICAL SYSTEMS

Understand the characteristics of populations and communities.

Includes identifying the basic requirements of organisms (e.g., nutrients, space); demonstrating knowledge of the concept of an ecological niche; evaluating conditions that affect population size and growth rate (e.g., birth rate, limiting factors); analyzing the interrelationships among organisms in a community (e.g., predator/prey, symbiosis); and recognizing patterns and processes of ecological succession.

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Understand factors that influence human population growth and diversity.

Includes recognizing characteristics and consequences of human population growth; relating historical patterns of human population growth to changing patterns of resource use and availability; and recognizing factors that contribute to human diversity (e.g., adaptations to different environments).

Analyze the transfer of energy in ecosystems.

Includes identifying the ultimate source of energy for various types of ecosystems; analyzing the flow of energy through the trophic levels of an ecosystem; demonstrating knowledge of factors that affect ecosystem productivity and the efficiency with which energy is transferred from one level to the next; and comparing energy, numbers, and biomass pyramids for different types of ecosystems.

Understand biogeochemical cycles.

Includes recognizing characteristics and processes of biogeochemical cycles (e.g., water, carbon, nitrogen); demonstrating knowledge of the roles of decomposers, producers, and consumers in the cycling of nutrients; and evaluating factors that affect the release and cycling of nutrients.

Analyze the effects of natural phenomena and human activities on ecosystems.

Includes identifying the effects of natural phenomena on ecosystems (e.g., volcanic eruptions, floods); identifying types, sources, and effects of pollution; analyzing the consequences of human activities, such as habitat destruction, introduction of exotic species, and burning of fossil fuels, on the environment and species diversity; and evaluating the effectiveness of methods and technologies designed to reduce or mitigate environmental damage.

Understand resource use and management by humans.

Includes identifying types of resources used by humans (e.g., mineral, plant, fossil fuels); recognizing the role of technology in obtaining and managing resources; analyzing issues related to the availability, distribution, and use of resources; and recognizing strategies used to manage various types of resources.