Michigan

TEST FOR TEACHER CERTIFICATION

STUDY GUIDE

17 Biology

MI-SG-FLD017-03

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PART 1: General Information About the MTTC Program and Test Preparation

The first section of the study guide is available in a separate PDF file. Click the link below to view or print this section.

General Information About the MTTC Program and Test Preparation

PART 2: Test Objectives and Sample Test Questions

INTRODUCTION

This section includes a list of the test objectives, immediately followed by sample test questions and an answer key for the field covered by this study guide.

Test Objectives

As noted, the test objectives are broad, conceptual statements that reflect the knowledge, skills, and understanding an entry-level teacher needs in order to teach effectively in a Michigan classroom. Each field's list of test objectives represents the **only** source of information about what a specific test will cover and, therefore, should be studied carefully.

The test objectives are organized into groups known as "subareas." These subareas define the major content areas of the test. You will find a list of subareas at the beginning of the test objective list. The percentages shown in the list of subareas indicate the approximate weighting of the subareas on the test.

Sample Multiple-Choice Test Questions

The sample multiple-choice test questions included in this section are designed to give the test-taker an introduction to the nature of the test questions included on the MTTC test for each field. The sample test questions represent the various types of test questions you may expect to see on an actual test; however, they are **not** designed to provide diagnostic information to help you identify specific areas of individual strengths and weaknesses or predict your performance on the test as a whole. Use the answer key that follows the sample test questions to check your answers.

To help you identify which test objective is being assessed, the objective statement to which the question corresponds is listed in the answer key. When you are finished with the sample test questions, you may wish to go back and review the entire list of test objectives and descriptive statements once again.

TEST OBJECTIVES

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.

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.

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.

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).

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.

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.

SAMPLE MULTIPLE-CHOICE TEST QUESTIONS

Use the information below to answer the two questions that follow.

For an experiment, students collect a bucket of water from a local marsh. The students fill five flasks with 500 mL of water from the bucket. One flask is sealed and set aside. Each of the other flasks is rapidly heated to 60ºC using a Bunsen burner. Each flask is kept at this temperature for 1, 2, 5, or 10 minutes and then sealed and quickly cooled to 30ºC using a tub filled with ice. The five flasks are allowed to stand at room temperature for five days. Students then examine a sample from each flask under a microscope and record the number of living organisms that are present. Using this information, the students calculate the total number of organisms in each flask.

1. It would be most important for students to follow which of the following safety practices during this experiment?

   A. Place filled flasks in a secure location away from class activities.

   B. Wear latex gloves when collecting the water from the marsh.

   C. Use pipettes to fill the flasks rather than pouring water from the bucket.

   D. Wear safety glasses when heating and cooling the flasks.

2. The dependent variable in this experiment is:

   A. the maximum temperature to which each flask was heated.

   B. the number of living organisms present in each flask.

   C. the length of time each flask was heated.

   D. the length of time the flasks stood at room temperature.

3. Rosalind Franklin, a British chemist, is best known for her work as an x-ray crystallographer. Her work is important to our understanding of:

   A. the double-helical structure of DNA.

   B. the shapes of the active sites of important enzymes.

   C. the structures and function of genes.

   D. regulation of the *Lac* operon.

4. Certain classes of antibiotics specifically interfere with bacterial ribosomes. This interference would effectively halt which of the following cellular processes?

   A. transcription

   B. photosynthesis

   C. DNA replication

   D. translation

5. Water's high specific heat has which of the following important implications for living organisms?

   A. It prevents the freezing of the cytosol of cells.

   B. It supplies the energy needed to drive metabolic processes.

   C. It maintains elevated body temperatures.

   D. It moderates environmental temperature fluctuations.

6. Which of the following best describes the process of cell differentiation?

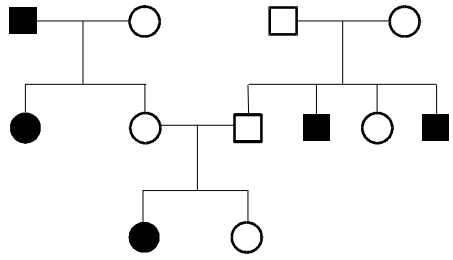
   A. Specialized proteins found in the fertilized egg are segregated to different types of differentiated cells.

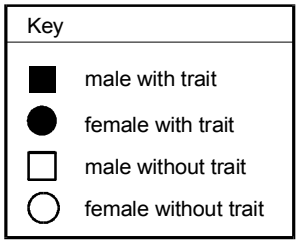
   B. Changes in enzymes in cells result in alterations of the metabolic rates.

   C. Cells on the surface of the blastula move inward and form specialized sheets of cells that make up the three embryonic germ layers.

   D. Changes in gene expression result in the synthesis of specific proteins found in specialized cells.

7. Use the information below to answer the question that follows.





The diagram above shows a pedigree of a family for a particular trait. Based on the pedigree, the trait is best characterized as:

A. sex-linked dominant.

B. autosomal dominant.

C. sex-linked recessive.

D. autosomal recessive.

8. A single nucleotide insertion or deletion that occurs in a prokaryotic gene will most likely have which of the following effects?

A. It will shift the reading frame and likely result in a nonfunctional polypeptide.

B. It will prematurely halt transcription at that point.

C. It will result in the substitution of a different amino acid for the normal one only at that location.

D. It will have minimal effects on the resulting polypeptide due to redundancy of the genetic code.

9. In modern genetic research and engineering, restriction enzymes are used to:

A. cut DNA strands at specific nucleotide sequences.

B. prevent foreign DNA from contaminating experimental samples.

C. make multiple copies of DNA molecules.

D. purify DNA from other cellular components and molecules.

10. Atmospheric oxygen began accumulating about 2.7 billion years ago with the appearance of photosynthetic cyanobacteria. The accumulation of atmospheric oxygen was gradual from about 2.7 to 2.2 billion years ago, then shot up rapidly to more than 10% of current levels. This rapid rise in atmospheric oxygen was most likely due to:

    A. the evolution of eukaryotic algae containing chloroplasts.

    B. the development of an ozone layer that allowed the evolution of plants.

    C. the saturation of the oceans with gaseous oxygen.

    D. the rapid multiplication of cyanobacteria in shallow seas.

11. Crocodiles and lizards share many more morphological similarities than either group shares with birds. However, phylogenetic trees based on genetic and other evidence show that crocodiles are more closely related to birds than they are to lizards. Which of the following is the most likely explanation for this apparent contradiction?

    A. Since diverging from a common ancestor, the lineage leading to birds has experienced more evolutionary change than that of crocodiles.

    B. Crocodiles and lizards have evolved similar morphological traits independently.

    C. Differences between crocodiles and birds are due to changes in a small number of genes that control the timing of growth and development.

    D. The lineage leading to birds appeared much later in time than that of crocodiles and lizards.

12. Compared to the endoskeleton of vertebrates, the exoskeleton of arthropods has which of the following disadvantages?

    A. The exoskeleton contains chitin, which is weaker for its weight than bone.

    B. Muscles must be attached to the interior of the exoskeleton, which reduces their mechanical advantage.

    C. The exoskeleton must be shed as the organism grows, which leaves the organism unprotected for a time.

    D. The exoskeleton is relatively rigid, which restricts the movement capabilities of the organism.

13. Which of the following best explains how plants store surplus glucose for future use?

    A. Glucose is stored directly in the intercellular spaces of specialized organs of the roots and stems.

    B. Glucose is converted into starch, which is stored as granules within plastids.

    C. Glucose is converted into glycogen, which is stored in dense clusters within the cell mitochondria.

    D. Glucose is converted into cellulose, which is stored within the cell walls of the cells of the stem and leaves.

14. Which of the following best summarizes how the nervous system senses the need to increase the rate and depth of breathing when a person begins to exercise vigorously?

    A. Sensors in the medulla, carotid arteries, and aorta respond to decreased pH of the blood, which results from increased CO_2 levels.

    B. Sensors in the arteries respond to increased blood pressure, which is brought about by increased heart rate associated with exercise.

    C. Sensors in the muscles respond to increased lactic acid, which is produced as a by-product of fermentation.

    D. Sensors in the cerebral cortex respond to decreased O_2 levels in the blood, which is brought about by increased oxygen use in muscles.

Use the information below to answer the two questions that follow.

Smallpox was one of the world's most dreaded plagues until l977, when it was declared eradicated through the efforts of the World Health Organization. Smallpox is an acute disease characterized by high fever and the appearance of lesions, especially on the face, that often leave deep scars. An effective smallpox vaccine was first employed in 1796 by Edward Jenner, a surgeon who had noticed that persons who had been infected by cowpox seldom became infected with smallpox. Jenner used material from a cowpox lesion on the finger of a young dairymaid to inoculate an eight-year-old boy. Eight weeks later he inoculated him with material obtained from a smallpox lesion. When the boy remained healthy, Jenner concluded that the cowpox inoculation had protected him against smallpox infection.

15. Vaccines act to protect individuals against smallpox and many other diseases by:

    A. inhibiting the action of enzymes used by the pathogen in performing its metabolic processes.

    B. sensitizing the immune system by stimulating production of antibodies that recognize antigens present on the pathogen.

    C. mimicking the toxins produced by a pathogen in order to provoke a systemic inflammation response.

    D. increasing the production of macrophages that circulate in the blood stream and destroy pathogens by phagocytosis.

16. Which of the following aspects of eighteenth-century medicine is best demonstrated by Jenner's experiment?

    A. Specialized disciplines within the field of medicine had not yet appeared.

    B. Scientific methods involving the formation and testing of medical hypotheses had not yet been developed.

    C. The existence of infectious agents such as bacteria and viruses had not yet been demonstrated.

    D. Standardized ethical and legal guidelines for medical experiments had not yet been widely adapted.

17. In which of the following cases is the size of a population limited by a density-independent factor?

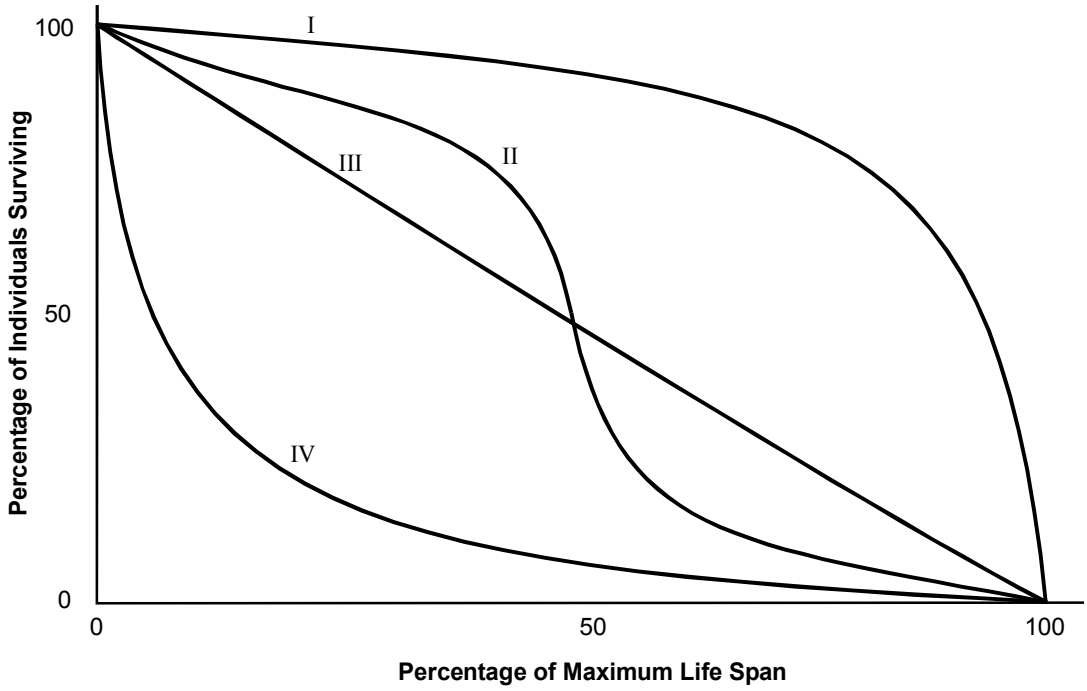
    A. More predators move into an area as the number of mice in the area increases.

    B. A late spring windstorm destroys many nests containing the eggs or new hatchlings of a bird species.

    C. Young pine seedlings have difficulty growing in the shade cast by the canopy of the mature pines.

    D. Each female squirrel in a population has fewer young following a winter of intense competition for food.

18. Use the graph below to answer the question that follows.



Which of the survivorship curves displayed on the graph above is characteristic of humans in modern industrialized countries?

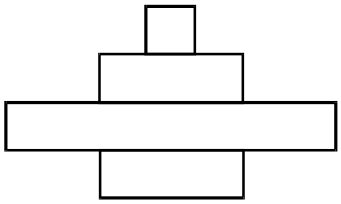
A. I

B. II

C. III

D. IV

19. Use the information below to answer the question that follows.



The diagram above shows a biomass pyramid for a type of ecosystem. Based on the shape of its biomass pyramid, this ecosystem is most likely to have which of the following characteristics?

A. The producers reproduce, grow, and are consumed very rapidly.

B. Energy transfer between trophic levels is highly efficient.

C. A single producer can sustain many primary consumers.

D. Decomposers feed directly on the ecosystem's producers.

20. It will take the longest time for the hydrologic cycle to replace water that has been used in which of the following ways?

A. A city withdraws water from a reservoir to supply homes and businesses.

B. A cloud-seeding airplane causes rain to fall over an agricultural area.

C. Farmers pump water from an underground aquifer to irrigate their fields.

D. Village residents catch rainwater in basins and use it for washing.

ANSWER KEY FOR THE SAMPLE MULTIPLE-CHOICE TEST QUESTIONS

Item Number	Correct Response	Objective
1.	**D**	Apply knowledge of methods and materials used in scientific investigations.
2.	**B**	Understand the principles and procedures for conducting scientific research.
3.	**A**	Understand the nature and history of scientific thought and inquiry.
4.	**D**	Understand cell theory and cellular structure and function.
5.	**D**	Understand the basic chemical components and reactions of cells.
6.	**D**	Understand the processes of cell division, growth, and differentiation.
7.	**D**	Understand the concepts and principles of Mendelian genetics.
8.	**A**	Understand the concepts and principles of molecular genetics.
9.	**A**	Understand the techniques and applications of modern genetics.
10.	**A**	Understand characteristics of ancient life and related evidence.
11.	**A**	Understand the characteristics of living organisms and how organisms are classified.
12.	**C**	Understand the structures, organization, and functions of systems in organisms.
13.	**B**	Analyze processes used by organisms to obtain, store, and use matter and energy and to maintain homeostasis.
14.	**A**	Understand human anatomy and physiology.
15.	**B**	Understand characteristics of human diseases and immunology.
16.	**D**	Understand the relationship of biology to contemporary, historical, technological, and societal issues.
17.	**B**	Understand the characteristics of populations and communities.
18.	**A**	Understand factors that influence human population growth and diversity.
19.	**A**	Analyze the transfer of energy in ecosystems.
20.	**C**	Understand resource use and management by humans.