This test is now delivered as a computer-based test. See www.nystce.nesinc.com for current program information.
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INTRODUCTION

Purpose of This Preparation Guide

This preparation guide is designed to help familiarize candidates with the content and format of a test for the New York State Teacher Certification Examinations (NYSTCE®) program. Education faculty and administrators at teacher preparation institutions may also find the information in this guide useful as they discuss the test with candidates.

The knowledge and skills assessed by the test are acquired throughout the academic career of a candidate. A primary means of preparing for the test is the collegiate preparation of the candidate.

This preparation guide illustrates some of the types of questions that appear on a test; however, the set of sample questions provided in this preparation guide does not necessarily define the content or difficulty of an entire actual test. All test components (e.g., directions, question content and formats) may differ from those presented here. The NYSTCE program is subject to change at the sole discretion of the New York State Education Department.

Organization of This Preparation Guide

Contained in the beginning sections of this preparation guide are general information about the NYSTCE program and how the tests were developed, a description of the organization of test content, and strategies for taking the test.

Following these general information sections, specific information about the test described in this guide is presented. The test objectives appear on the pages following the test-specific overview. The objectives define the content of the test.

Next, information about the multiple-choice section of the test is presented, including sample test directions. Sample multiple-choice questions are also presented, with the correct responses indicated and explanations of why the responses are correct.

Following the sample multiple-choice questions, a description of the written assignment section of the test is provided, including sample directions. A sample written assignment is presented next, followed by a sample strong response to the assignment and an evaluation of that response.

For Further Information

If you have questions after reading this preparation guide, you may wish to consult the NYSTCE Registration Bulletin. You can view or print the registration bulletin online at www.nystce.nesinc.com.
GENERAL INFORMATION ABOUT THE NYSTCE

How Were the NYSTCE Tests Developed?

The New York State Teacher Certification Examinations are criterion referenced and objective based. A criterion-referenced test is designed to measure a candidate’s knowledge and skills in relation to an established standard rather than in relation to the performance of other candidates. The explicit purpose of these tests is to help identify for certification those candidates who have demonstrated the appropriate level of knowledge and skills that are important for performing the responsibilities of a teacher in New York State public schools.

Each test is designed to measure areas of knowledge called subareas. Within each subarea, statements of important knowledge and skills, called objectives, define the content of the test. The test objectives were developed for the New York State Teacher Certification Examinations in conjunction with committees of New York State educators.

Test questions matched to the objectives were developed using, in part, textbooks; New York State learning standards and curriculum guides; teacher education curricula; and certification standards. The test questions were developed in consultation with committees of New York State teachers, teacher educators, and other content and assessment specialists.

An individual’s performance on a test is evaluated against an established standard. The passing score for each test is established by the New York State Commissioner of Education based on the professional judgments and recommendations of New York State teachers. Examinees who do not pass a test may retake it at any of the subsequently scheduled test administrations.
Organization of Content

The content covered by each test is organized into subareas. These subareas define the major content domains of the test.

Subareas typically consist of several objectives. Objectives provide specific information about the knowledge and skills that are assessed by the test.

Each objective is elaborated on by focus statements. The focus statements provide examples of the range, type, and level of content that may appear on the tests.

Test questions are designed to measure specific test objectives. The number of objectives within a given subarea generally determines the number of questions that will address the content of that subarea on the test. In other words, the subareas that consist of more objectives will receive more emphasis on the test and contribute more to a candidate's test score than the subareas that consist of fewer objectives.

The following example, taken from the field of Social Studies, illustrates the relationship of test questions to subareas, objectives, and focus statements.
TEST-TAKING STRATEGIES

Be On Time.

Arrive at the test center on time so that you are rested and ready to begin the test when instructed to do so.

Follow Directions.

At the beginning of the test session and throughout the test, follow all directions carefully. This includes the oral directions that will be read by the test administrators and any written directions in the test booklet. The test booklet will contain general directions for the test as a whole and specific directions for individual test questions or groups of test questions. If you do not understand something about the directions, do not hesitate to raise your hand and ask your test administrator.

Pace Yourself.

The test schedule is designed to allow sufficient time for completion of the test. Each test session is four hours in length. The tests are designed to allow you to allocate your time within the session as you need. You can spend as much time on any section of the test as you need, and you can complete the sections of the test in any order you desire; however, you will be required to return your materials at the end of the four-hour session.

Since the allocation of your time during the test session is largely yours to determine, planning your own pace for taking the test is very important. Do not spend a lot of time with a test question that you cannot answer promptly; skip that question and move on. If you skip a question, be sure to skip the corresponding row of answer choices on your answer document. Mark the question in your test booklet so that you can return to it later, but be careful to appropriately record on the answer document the answers to the remaining questions.

You may find that you need less time than the four hours allotted in a test session, but you should be prepared to stay for the entire time period. Do not make any other commitments for this time period that may cause you to rush through the test.

Read Carefully.

Read the directions and the questions carefully. Read all response options. Remember that multiple-choice test questions call for the "best answer"; do not choose the first answer that seems reasonable. Read and evaluate all choices to find the best answer. Read the questions closely so that you understand what they ask. For example, it would be a waste of time to perform a long computation when the question calls for an approximation.

Read the test questions, but don’t read into them. The questions are designed to be straightforward, not tricky.
Mark Answers Carefully.

Your answers for all multiple-choice questions will be scored electronically; therefore, the answer you select must be clearly marked and the only answer marked. If you change your mind about an answer, erase the old answer completely. Do not make any stray marks on the answer document; these may be misinterpreted by the scoring machine.

IF YOU SKIP A MULTIPLE-CHOICE QUESTION, BE SURE TO SKIP THE CORRESPONDING ROW OF ANSWER CHOICES ON YOUR ANSWER DOCUMENT.

You may use any available space in the test booklet for notes, but your answers and your written response must be clearly marked on your answer document. ONLY ANSWERS AND WRITTEN RESPONSES THAT APPEAR ON YOUR ANSWER DOCUMENT WILL BE SCORED. Answers and written responses in your test booklet will not be scored.

Guessing

As you read through the response options, try to find the best answer. If you cannot quickly find the best answer, try to eliminate as many of the other options as possible. Then guess among the remaining answer choices. Your score on the test is based on the number of test questions that you have answered correctly. There is no penalty for incorrect answers; therefore, it is better to guess than not to respond at all.

Passages or Other Presented Materials

Some test questions are based on passages or other presented materials (e.g., graphs, charts). You may wish to employ some of the following strategies while you are completing these test questions.

One strategy is to read the passage or other presented material thoroughly and carefully and then answer each question, referring to the passage or presented material only as needed. Another strategy is to read the questions first, gaining an idea of what is sought in them, and then read the passage or presented material with the questions in mind. Yet another strategy is to review the passage or presented material to gain an overview of its content, and then answer each question by referring back to the passage or presented material for the specific answer. Any of these strategies may be appropriate for you. You should not answer the questions on the basis of your own opinions but rather on the basis of the information in the passage or presented material.

Check Accuracy.

Use any remaining time at the end of the test session to check the accuracy of your work. Go back to the test questions that gave you difficulty and verify your work on them. Check the answer document, too. Be sure that you have marked your answers accurately and have completely erased changed answers.
ABOUT THE BIOLOGY TEST

The purpose of the Biology Content Specialty Test (CST) is to assess knowledge and skills in the following seven subareas:

Subarea I. Foundations of Scientific Inquiry
Subarea II. Cell Biology and Biochemistry
Subarea III. Genetics and Evolution
Subarea IV. Biological Unity and Diversity and Life Processes
Subarea V. Human Biology
Subarea VI. Ecology
Subarea VII. Foundations of Scientific Inquiry: Constructed-Response Assignment

The test objectives presented on the following pages define the content that may be assessed by the Biology CST. Each test objective is followed by focus statements that provide examples of the range, type, and level of content that may appear on the test for questions measuring that objective.

The test contains approximately 90 multiple-choice test questions and one constructed-response (written) assignment. The figure below illustrates the approximate percentage of the test corresponding to each subarea.

![Percentage of Test Corresponding to Each Subarea]

The section that follows the test objectives presents sample test questions for you to review as part of your preparation for the test. To demonstrate how each objective may be assessed, a sample question is presented for each objective. The correct response and an explanation of why the response is correct follow each question. A sample written assignment is also presented, along with an example of a strong response to the assignment and an evaluation of that response.

The sample questions are designed to illustrate the nature of the test questions; they should not be used as a diagnostic tool to determine your individual strengths and weaknesses.
BIOLOGY TEST OBJECTIVES

Foundations of Scientific Inquiry
Cell Biology and Biochemistry
Genetics and Evolution
Biological Unity and Diversity and Life Processes
Human Biology
Ecology

Foundations of Scientific Inquiry: Constructed-Response Assignment

The New York State biology educator has the knowledge and skills necessary to teach effectively in New York State public schools. The biology teacher is a skilled problem solver who understands the historical development of ideas in science and the connections among science, mathematics, and technology. The biology teacher knows how to access, generate, process, and transfer information using appropriate technologies and can apply knowledge and thinking skills of mathematics, science, and technology to address problems and make informed decisions. Most importantly, the biology teacher understands the process of scientific inquiry and applies biological concepts, principles, and theories to pose questions, seek answers, and communicate explanations of natural phenomena.

SUBAREA I—FOUNDATIONS OF SCIENTIFIC INQUIRY

0001 Understand the relationships and common themes that connect mathematics, science, and technology.

For example:

- analyzing similarities among systems in mathematics, science, and technology (e.g., stability, equilibrium)
- applying concepts and theories from mathematics and other sciences to a biological system
- analyzing the use of biology and other sciences in the design of a technological solution to a given problem
- using the Internet, a variety of software (e.g., spreadsheets, graphing utilities, statistical packages, simulations), and technologies (e.g., graphing calculators, computers) to model and solve problems in mathematics, science, and technology
0002 Understand the historical and contemporary contexts of biological study and the applications of biology and biotechnology to society.

For example:

- recognizing the significance of key events in the history of biological study (e.g., development of the microscope, understanding the structure of DNA, use of animals in research, genomic research)
- recognizing the contributions of diverse cultures and individuals to biological study
- evaluating the impact of social factors on biological study (e.g., restrictions on the development of human cloning techniques, demand for genetically modified agricultural crops, bioethics)
- interpreting the implications for society of recent developments in biology and biotechnology (e.g., medical technology, genetic engineering, wastewater treatment, food safety)

0003 Understand the process of scientific inquiry and the role of observation, experimentation, and communication in explaining natural phenomena.

For example:

- analyzing processes by which new scientific knowledge and hypotheses are generated
- analyzing ethical issues related to the process of scientific research and reporting
- evaluating the appropriateness of a specified experimental design to test a hypothesis
- demonstrating an ability to design a hypothesis-testing inquiry experiment

0004 Understand the processes of gathering, organizing, reporting, and interpreting scientific data, and apply this understanding in the context of biological investigations.

For example:

- evaluating the appropriateness of a given method or procedure for collecting data for a specified purpose
- selecting an appropriate and effective graphic representation (e.g., graph, table, diagram) for organizing, reporting, and analyzing given experimental data
- demonstrating the ability to appropriately set up and label graphs with dependent and independent variables
- applying procedures and criteria for reporting experimental protocols and data (e.g., use of statistical tests)
- analyzing relationships between factors (e.g., linear, exponential) as indicated by experimental data
0005 Understand and apply principles and procedures of measurement used in the biological sciences.

For example:

- demonstrating an ability to use the metric system
- evaluating the appropriateness and limitations of units of measurement, measuring devices, or methods of measurement for given situations
- applying methods of measuring microscopic organisms and structures
- analyzing likely sources of error in measurement and the consequences of such error on subsequent calculations and conclusions

0006 Understand the use of equipment, materials, chemicals, and living organisms in biological studies and the application of procedures for their proper, safe, and legal use.

For example:

- demonstrating knowledge of the appropriate use of given laboratory materials, instruments, and equipment (e.g., indicators, microscopes, centrifuges, spectrophotometers, chromatography equipment)
- applying proper methods for storing, identifying, dispensing, and disposing of chemicals and biological materials
- identifying sources of and interpreting information (e.g., material safety data sheets) regarding the proper, safe, and legal use of equipment, materials, and chemicals
- interpreting guidelines and regulations for the proper and humane procurement and treatment of living organisms in biological studies
- recognizing possible alternatives to dissection
- applying proper procedures for promoting laboratory safety (e.g., the use of safety goggles, universal health precautions) and responding to accidents and injuries in the biology laboratory

SUBAREA II—CELL BIOLOGY AND BIOCHEMISTRY

0007 Understand cell structure and function, the dynamic nature of cells, and the uniqueness of different types of cells.

For example:

- comparing and contrasting the cellular structures and functions of archaea, prokaryotes, and eukaryotes
- analyzing the primary functions, processes, products, and interactions of various cellular structures (e.g., lysosomes, microtubules, cell membrane)
- analyzing the importance of active and passive transport processes in maintaining homeostasis in cells and the relationships between these processes and the cellular membranes
Understand chemistry and biochemistry to analyze the role of biologically important elements and compounds in living organisms.

For example:

• comparing and contrasting hydrogen, ionic, and covalent bonds and the conditions under which these bonds form and break apart
• relating the structure and function of carbohydrates, lipids, proteins (e.g., level of structure), nucleic acids, and inorganic compounds to cellular activities
• analyzing the properties of water and the significance of these properties to living organisms
• demonstrating an understanding of pH chemistry in biological systems
• analyzing the structure and function of enzymes and factors that affect the rate of enzyme action

Understand the raw materials, products, and significance of photosynthesis and cellular respiration and the relationships of these processes to cell structure and function.

For example:

• recognizing the significance of photosynthesis and respiration to living organisms
• identifying the overall chemical equations for the processes of respiration and photosynthesis
• demonstrating an understanding of ATP production through chemiosmosis in both photosynthesis and respiration
• analyzing factors that affect photosynthesis and respiration
• comparing aerobic and anaerobic respiration
• evaluating the significance of chloroplast structure in photosynthesis and mitochondrion structure in respiration

Understand the structure and function of DNA and RNA.

For example:

• demonstrating an understanding of the mechanism of DNA replication, potential errors, and implications of these errors
• analyzing the roles of DNA and ribosomal, messenger, and transfer RNA in protein synthesis
• analyzing the implications of mutations in DNA molecules for protein structure and function (e.g., sickle-cell anemia, cystic fibrosis)
• analyzing the control of gene expression in cells (e.g., lac operon in E. coli)
0011 Understand the procedures involved in the isolation, manipulation, and expression of genetic material and the application of genetic engineering in basic and applied research.

For example:

• analyzing the role and applications of genetic engineering in the basic discoveries of molecular genetics (e.g., in medicine, agriculture)
• demonstrating an understanding of genetic engineering techniques (e.g., restriction enzymes, PCR, gel electrophoresis)
• analyzing the role of genetic engineering in the development of microbial cultures capable of producing valuable products (e.g., human insulin, growth hormone)
• recognizing the role of gene cloning in deriving nucleotide and amino acid sequences and the role of cloned genes as probes in determining the structure of more complex DNA molecules
• recognizing how genetic engineers design new biological products unavailable from natural sources and alter gene products by site-directed mutagenesis (e.g., transgenic plants and animals)
• recognizing the ethical, legal, and social implications of genetic engineering

0012 Understand the cell cycle, the stages and end products of meiosis and mitosis, and the role of cell division in unicellular and multicellular organisms.

For example:

• describing general events in the cell cycle and analyzing the significance of these events
• interpreting the results of experiments relating to the eukaryotic cell cycle (e.g., cloning, polyploidy, tissue cultures, pharming)
• comparing chromosomal changes during the stages of meiosis and mitosis
• analyzing the significance of meiosis and fertilization in relation to the genetic diversity and evolution of multicellular organisms
• recognizing the relationship between an unrestricted cell cycle and cancer
• demonstrating an understanding of the process of cell differentiation, including the role of stem cells
SUBAREA III—GENETICS AND EVOLUTION

0013 Understand concepts, principles, and applications of classical and molecular genetics.

For example:

- demonstrating an understanding of basic principles of heredity (e.g., dominance, codominance, incomplete dominance, segregation, independent assortment)
- analyzing techniques used to determine the presence of human genetic diseases (e.g., PKU, cystic fibrosis)
- analyzing genetic inheritance problems involving genotypic and phenotypic frequencies
- interpreting pedigree charts
- recognizing the role of nonnuclear inheritance (e.g., mitochondrial DNA) in phenotypic expression

0014 Understand the principles of population genetics and the interaction between heredity and the environment, and apply this knowledge to problems involving populations.

For example:

- evaluating conditions that affect allele frequency in a gene pool
- analyzing the relationship between an organism's phenotype for a particular trait and its selective advantage in a given environment (e.g., the human sickle-cell trait and malaria)

0015 Understand hypotheses about the origins of life, evidence supporting evolution, and evolution as a unifying theme in biology.

For example:

- evaluating evidence supporting various hypotheses about the origins of life
- analyzing the progression from simpler to more complex life forms (e.g., unicellular to colonial to multicellular) by various processes (e.g., endosymbiosis)
- assessing the significance of geological and fossil records in determining evolutionary histories and relationships of given organisms
- evaluating observations made in various areas of biology (e.g., embryology, biochemistry, anatomy) in terms of evolution
0016 Understand the mechanisms of evolution.
For example:
• recognizing sources of variation in a population
• analyzing relationships between changes in allele frequencies and evolution
• analyzing the implications of natural selection versus the inheritance of acquired traits in given situations
• comparing alternative mechanisms of evolution (e.g., gradualism, punctuated equilibrium)
• analyzing factors that lead to speciation (e.g., geographic and reproductive isolation, genetic drift)

0017 Understand the principles of taxonomy and the relationship between taxonomy and the history of evolution.
For example:
• analyzing criteria used to classify organisms (e.g., morphology, biochemical comparisons)
• interpreting a given phylogenetic tree or cladogram of related species
• demonstrating the ability to design and use taxonomic keys (e.g., dichotomous keys)
• relating changes in the structure and organization of the classification system to developments in biological thought (e.g., evolution, modern genetics)

SUBAREA IV—BIOLOGICAL UNITY AND DIVERSITY AND LIFE PROCESSES

0018 Understand the unity and diversity of life, including common structures and functions.
For example:
• analyzing characteristics of living organisms (e.g., differences between living organisms and nonliving things)
• recognizing levels of organization (e.g., cells, tissues, organs)
• comparing and analyzing the basic life functions carried out by living organisms (e.g., obtaining nutrients, excretion, reproduction)
• recognizing the role of physiological processes (e.g., active transport) that contribute to homeostasis and dynamic equilibrium
• recognizing the relationship of structure and function in all living things
0019 Understand the general characteristics, functions, and adaptations of prions, viruses, bacteria, protoctists (protists), and fungi.

For example:

• comparing the structure and processes of prions and viruses to cells
• comparing archaebacteria and eubacteria
• analyzing the processes of chromosome and plasmid replication and gene transfer in bacteria
• comparing the structure and function of protoctists (protists)
• recognizing the significance of prions, viruses, retroviruses, bacteria, protoctists (protists), and fungi in terms of their beneficial uses or deleterious effects

0020 Understand the general characteristics, life functions, and adaptations of plants.

For example:

• comparing structures and their functions in nonvascular and vascular plants (e.g., mosses, ferns, conifers)
• analyzing reproduction and development in the different divisions of plants
• analyzing the structures and forces involved in transport in plants
• evaluating the evolutionary and adaptive significance of plant structures (e.g., modified leaves, colorful flowers)

0021 Understand the general characteristics, life functions, and adaptations of animals.

For example:

• identifying general characteristics of the embryonic development of invertebrates and vertebrates
• comparing and contrasting the life cycles of invertebrates and vertebrates
• demonstrating an understanding of physiological processes (e.g., excretion, respiration, aging) of animals and their significance
• recognizing the relationship between structure and function in given animal species
• analyzing the adaptive and evolutionary significance of animal behaviors and structures
SUBAREA V—HUMAN BIOLOGY

0022 Understand the structures and functions of the human skeletal, muscular, and integumentary systems; common malfunctions of these systems; and their homeostatic relationships within the body.

For example:
- comparing the structures, locations, and functions of the three types of muscles
- demonstrating an understanding of the mechanism of skeletal muscle contraction
- demonstrating an understanding of the movements of body joints in terms of muscle and bone arrangement and action
- relating the structure of the skin to its functions
- demonstrating an understanding of possible causes, effects, prevention, and treatment of malfunctions of the skeletal, muscular, and integumentary systems (e.g., arthritis, skin cancer, scoliosis, osteoporosis)

0023 Understand the structures and functions of the human respiratory and excretory systems, common malfunctions of these systems, and their homeostatic relationships within the body.

For example:
- demonstrating an understanding of the relationship between surface area and volume and the role of that relationship in the function of the respiratory and excretory systems
- analyzing the mechanism of breathing and the process of gas exchange between the lungs and blood and between blood and tissues
- analyzing the role of the kidneys in osmoregulation and waste removal from the blood and the factors that influence nephron function
- demonstrating an understanding of possible causes, effects, prevention, and treatment of malfunctions of the respiratory and excretory systems (e.g., emphysema, nephritis)
0024 Understand the structures and functions of the human circulatory and immune systems, common malfunctions of these systems, and their homeostatic relationships within the body.

For example:

- demonstrating an understanding of the structure, function, and regulation of the heart and the factors that influence cardiac output
- analyzing changes in the circulatory system (e.g., vessel structure and function) and their influence on blood composition and blood flow (e.g., blood cell diversity)
- demonstrating an understanding of the possible causes, effects, prevention, and treatment of malfunctions of the circulatory system (e.g., hypertension)
- demonstrating an understanding of the structure, function, and regulation of the immune system (e.g., cell-mediated and humoral responses)
- demonstrating an understanding of the possible causes, effects, prevention, and treatment of malfunctions of the immune system (e.g., autoimmune diseases, transplant rejection)

0025 Understand human nutrition and the structures and functions of the human digestive system and accessory organs, common malfunctions of the digestive system, and its homeostatic relationships within the body.

For example:

- demonstrating an understanding of the roles in the body of the basic nutrients found in foods (e.g., carbohydrates, vitamins, water)
- demonstrating an understanding of the processes of mechanical and chemical digestion in the digestive system, including contributions of accessory organs
- recognizing the process by which nutrients are transported from inside the small intestine to other parts of the body
- demonstrating an understanding of the possible causes, effects, prevention, and treatment of common malfunctions of the digestive system (e.g., ulcers, appendicitis, eating disorders)
0026 Understand the structures and functions of the human nervous and endocrine systems, common malfunctions of these systems, and their homeostatic relationships within the body.

For example:

• demonstrating an understanding of the structures and functions of the central and peripheral nervous systems
• demonstrating an understanding of the location and function of the major endocrine glands and the function of their associated hormones
• demonstrating an understanding of the transmission of nerve impulses within and between neurons and the influence of drugs and other chemicals on that transmission
• evaluating the role of feedback mechanisms in homeostasis (e.g., role of hormones, neurotransmitters)
• demonstrating an understanding of the possible causes, effects, prevention, and treatment of malfunctions of the nervous and endocrine systems (e.g., diabetes, brain disorders)

0027 Understand the structures and functions of the human reproductive systems, the processes of embryonic development, common malfunctions of the reproductive systems, and their homeostatic relationships within the body.

For example:

• recognizing the role of hormones in controlling the development and functions of the male and female reproductive systems
• demonstrating an understanding of gametogenesis, fertilization, and birth control
• demonstrating an understanding of embryonic and fetal development and the potential effects of drugs, alcohol, and nutrition on this process
• demonstrating an understanding of the possible causes, effects, prevention, and treatment of malfunctions of the reproductive systems (e.g., infertility, birth defects)

SUBAREA VI—ECOLOGY

0028 Understand the characteristics of populations and communities and use this knowledge to interpret population growth and interactions of organisms within an ecosystem.

For example:

• demonstrating an understanding of factors that affect population size and growth rate (e.g., carrying capacity, limiting factors)
• determining and interpreting population growth curves
• analyzing relationships among organisms in a community (e.g., competition, predation, symbiosis)
• evaluating the effects of population density on the environment
0029 Understand the development and structure of ecosystems and the characteristics of major biomes.

For example:

• demonstrating an understanding of the flow of energy through the trophic levels of an ecosystem
• comparing the strengths and limitations of various pyramid models (e.g., biomass, numbers, energy)
• recognizing the importance of the process of ecological succession and the role of biotic and abiotic factors in this process
• identifying the characteristics and geographic distribution of major biomes
• recognizing the effect of biome degradation and destruction on biosphere stability (e.g., climate changes, deforestation, reduction of species diversity)

0030 Understand the connections within and among the biogeochemical cycles and analyze their implications for living things.

For example:

• recognizing the importance of the processes involved in material cycles (e.g., water, carbon, nitrogen, phosphorus)
• demonstrating an understanding of the role of decomposers in nutrient cycling in ecosystems
• analyzing the role of respiration and photosynthesis in biogeochemical cycling
• evaluating the effects of limiting factors on ecosystem productivity (e.g., light intensity, gas concentrations, mineral availability)

0031 Understand concepts of human ecology and the impact of human decisions and activities on the physical and living environment.

For example:

• recognizing the importance and implications of various factors (e.g., nutrition, public health, geography, climate) for human population dynamics
• predicting the impact of the human use of natural resources (e.g., forests, rivers) on the stability of ecosystems
• analyzing types of resource misuse (e.g., deforestation, pollution, strip mining) and their long- and short-term effects
• recognizing the importance of maintaining biological diversity (e.g., pharmacological products, stability of ecosystems)
• evaluating methods and technologies that reduce or mitigate environmental degradation
• demonstrating an understanding of the concept of stewardship and ways in which it is applied to the environment
SUBAREA VII—FOUNDATIONS OF SCIENTIFIC INQUIRY: CONSTRUCTED-RESPONSE ASSIGNMENT

The content to be addressed by the constructed-response assignment is described in Subarea I, Objectives 01–06.
MUTIPLE-CHOICE SECTION

This preparation guide provides sample multiple-choice questions and a sample written assignment for the test. The multiple-choice questions illustrate the objectives of the test—one sample question for each objective.

Three pieces of information are presented for each test question:

1. the number of the test objective that the sample question illustrates,
2. a sample test question,
3. an indication of the correct response and an explanation of why it is the best available response.

Keep in mind when reviewing the questions and response options that there is one best answer to each question. Remember, too, that each explanation offers one of perhaps many perspectives on why a given response is correct or incorrect in the context of the question; there may be other explanations as well.

On the following page are sample test directions similar to those that candidates see when they take the test.
SAMPLE TEST DIRECTIONS FOR MULTIPLE-CHOICE QUESTIONS

DIRECTIONS

This test booklet contains a multiple-choice section and a section with a single written assignment. You may complete the sections of the test in the order you choose.

Each question in the first section of this booklet is a multiple-choice question with four answer choices. Read each question CAREFULLY and choose the ONE best answer. Record your answer on the answer document in the space that corresponds to the question number. Completely fill in the space that has the same letter as the answer you have chosen. Use only a No. 2 lead pencil.

Sample Question:

1. What is the capital of New York?
   A. Buffalo
   B. New York City
   C. Albany
   D. Rochester

The correct answer to this question is C. You would indicate that on the answer document as follows:

1.   A   B   ●   D

You should answer all questions. Even if you are unsure of an answer, it is better to guess than not to answer a question at all. You may use the margins of the test booklet for scratch paper, but you will be scored only on the responses on your answer document.

The directions for the written assignment appear later in this test booklet.

FOR TEST SECURITY REASONS, YOU MAY NOT TAKE NOTES OR REMOVE ANY OF THE TEST MATERIALS FROM THE ROOM.

The words "End of Test" indicate that you have completed the test. You may go back and review your answers, but be sure that you have answered all questions before raising your hand for dismissal. Your test materials must be returned to a test administrator when you finish the test.

If you have any questions, please ask them now before beginning the test.

STOP

DO NOT GO ON UNTIL YOU ARE TOLD TO DO SO.
Objective 0001
Understand the relationships and common themes that connect mathematics, science, and technology.

1. Which of the following is one limitation of using mathematical models to analyze complex natural systems?

A. Mathematical models are unable to describe accurately some complex natural systems due to unknown variables that influence natural phenomena.

B. Mathematical models use abstract symbols that cannot be applied to the concrete elements that make up natural systems.

C. Mathematical models are used by investigators, but different investigators may use alternative models to study the same system.

D. Mathematical models are useful for describing systems that are static and unchanging, but they cannot incorporate factors that produce change in a system over time.

Correct Response: A. Mathematical models attempt to describe the relationships in natural systems by assigning numbers or equations to known variables. Since a natural system often has parameters that are incompletely understood or have not yet been identified, a mathematical model cannot accurately account for these variables.
Objective 0002
Understand the historical and contemporary contexts of biological study and the applications of biology and biotechnology to society.

2. Which of the following describes the main purpose of the Human Genome Project?

A. to deepen public awareness of the genetic basis of human disease and efforts to treat such diseases

B. to map the nucleotide sequence of the DNA of each human chromosome

C. to develop DNA isolation and labeling techniques to be used in gene analysis

D. to identify every genetically transmitted disease and the gene or genes responsible for each

Correct Response: B. The primary goal of the Human Genome Project is to determine the sequence of the entire human genome. The information gained from this project may ultimately be applied to many other purposes, such as developing techniques for identifying or treating genetic diseases.
Objective 0003
Understand the process of scientific inquiry and the role of observation, experimentation, and communication in explaining natural phenomena.

3. A researcher notices frequent occurrences of harmful mutations in sturgeon, *Acipenser oxyrhynchus*, in a river where manufacturing wastes are regularly being dumped. To begin investigating whether the mutations are caused by the pollution in the river, the researcher should design an experiment wherein:

A. both mutated and healthy sturgeon from the river are moved to clean water conditions, and mutation frequencies in subsequent generations are measured and compared to river populations.

B. healthy sturgeon are introduced to the river's water conditions, and frequencies of mutations in their offspring are compared to a clean water control group.

C. population levels of the species in the regularly polluted section of the river are monitored for several years and compared to populations several miles downstream from the dump site.

D. other species present in the same habitat are systematically examined for genetic mutations, and the types and frequencies of mutations are recorded.

Correct Response: B. The researcher should begin the investigation by first trying to confirm that the high rate of mutations in the sturgeon are due to something in the water rather than due to a genetic abnormality within this particular population of sturgeon. The best way to do this would be to take a known healthy population of sturgeon and divide it into two groups, putting half of the sturgeon into the river water and the other half into water with no pollutants. If the group put in the river begins to develop harmful mutations and the clean water group does not (assuming all other conditions are kept identical), then it would provide strong evidence that the water conditions are indeed causing the mutations.
Objective 0004
Understand the processes of gathering, organizing, reporting, and interpreting scientific data, and apply this understanding in the context of biological investigations.

4. A botanist conducted a study to examine how soil temperature affects the length of time it takes different varieties of carrot seeds to germinate. The amount of light and humidity levels were the same for all seeds. To report the results in a graph, which of the following variables should be placed on the horizontal and vertical axes, respectively?

A. variety of carrot—soil temperature
B. soil temperature—length of time to germination
C. amount of light and humidity level—length of time to germination
D. length of time to germination—variety of carrot

Correct Response: B. By convention, the factor being varied in an experiment (independent variable) is plotted on the horizontal axis, while the responding factor (dependent variable) is plotted on the vertical axis. In this experiment, soil temperature is the independent variable, so it should be on the horizontal axis. Length of time to germination is the dependent variable, so it should be on the vertical axis.
Objective 0005
Understand and apply principles and procedures of measurement used in the biological sciences.

5. A lab assistant preparing for an experiment needs to add 0.6 mL of a buffer solution to each of 10 test tubes. Which of the following measuring devices would be most appropriate and accurate for this purpose?

A. a 10 mL graduated cylinder
B. a 1 mL volumetric pipet
C. a 1 mL graduated pipet
D. a 0.5 mL graduated pipet

Correct Response: C. When selecting a measuring device, it is important to choose the smallest one available that will allow the full amount needed to be measured for one sample. This helps minimize measurement errors. It is also important that the device have measurement markings at appropriate intervals for the degree of precision required. Of the devices listed, the 1 mL graduated pipet is the smallest device available that has markings at the intervals necessary to measure 0.6 mL accurately as one sample.
Objective 0006
Understand the use of equipment, materials, chemicals, and living organisms in biological studies and the application of procedures for their proper, safe, and legal use.

6. A biologist using the chemical acetone in an experiment should first consult which of the following sources for information pertaining to proper use and laboratory practices to protect against injury or hazards?

A. the methods sections of papers by other researchers who use acetone

B. an emergency first-aid manual

C. the material safety data sheet for acetone

D. officials of the local public health department

Correct Response: C. The law requires that a material safety data sheet must be provided with each chemical purchased from a commercial source. This document includes detailed information about the properties, hazards, and proper use and storage of that specific chemical. This is the most accurate and comprehensive source of information about a particular chemical.
7. Which of the following distinguishes eukaryotic cells from prokaryotic cells?

A. the ability to tolerate the presence of oxygen
B. the presence of membrane-bound organelles
C. the ability to carry out photosynthesis
D. the presence of ribosomes

Correct Response: B. Of the traits listed, the only one that is unique to eukaryotes is the presence of membrane-bound organelles. All of the other traits can be found in certain types of prokaryotes as well.
Objective 0008
Understand chemistry and biochemistry to analyze the role of biologically important elements and compounds in living organisms.

8. When a person is very active, the CO₂ produced by respiration reacts with water to form carbonic acid, which lowers the tissue's pH. Which of the following best describes the consequence of this pH shift?

A. The carbonic acid accumulates in muscle tissue, causing muscles to ache.

B. The lowered pH interferes with oxygen dissociation, causing the person to feel out of breath.

C. The hydrogen ions that become available combine to form water with any available oxygen.

D. The lowered pH induces hemoglobin to release more O₂ for cellular respiration.

Correct Response: D. The conformation of hemoglobin, like that of most proteins, is sensitive to changes in the pH of its surroundings. At a lower pH, the hemoglobin has a lower affinity for oxygen, allowing it to be released to the tissues where it is needed.
Objective 0009
Understand the raw materials, products, and significance of photosynthesis and cellular respiration and the relationships of these processes to cell structure and function.

9. Which of the following is the summary equation for photosynthesis by green plants?

A. $6\text{ADP} + 6\text{P}_i + \text{energy} \rightarrow 6\text{ATP} + 6\text{H}_2\text{O}$

B. $\text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2 + 6\text{H}_2\text{O} \rightarrow 6\text{CO}_2 + 12\text{H}_2\text{O} + \text{energy}$

C. $6\text{ATP} + 6\text{H}_2\text{O} \rightarrow 6\text{ADP} + 6\text{P}_i + \text{energy}$

D. $6\text{CO}_2 + 12\text{H}_2\text{O} + \text{energy} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2 + 6\text{H}_2\text{O}$

Correct Response: D. The process of photosynthesis in green plants involves the use of light energy to produce sugars ($\text{C}_6\text{H}_{12}\text{O}_6$) and oxygen from carbon dioxide and water. Water is both consumed and produced during the process, which accounts for its appearing on both sides of the equation.
10. In eukaryotes, access to certain promoter sites on DNA by RNA polymerase is restricted by histones. For which of the following processes does this have the most direct consequence?

A. recognition of termination sites
B. control of gene expression
C. translocation of the tRNA along the ribosome
D. formation of the mitotic spindle

Correct Response: B. For a gene to be transcribed and subsequently expressed, the DNA of the promoter must be accessible to RNA polymerase. If histone proteins are binding to a promoter region for a particular gene, then that gene is unavailable for transcription and, therefore, expression.
Objective 0011
Understand the procedures involved in the isolation, manipulation, and expression of genetic material and the application of genetic engineering in basic and applied research.

11. Which of the following is a significant ethical concern associated with the genetic engineering of transgenic agricultural crops?

A. Efficient production of these crops could eventually eliminate the viability of traditional varieties of agricultural produce.

B. Sterility of these crops and patent law would force farmers to buy from the seed manufacturers instead of saving seed.

C. Crops may produce new substances that could harmfully affect humans in ways that are unpredictable.

D. Biodiversity would be enhanced by the large-scale farming these crops allow.

Correct Response: C. One of the most significant concerns that has been voiced about the genetic engineering of agricultural crops involves the process of taking genes for desirable traits (e.g., pest resistance) from another organism and putting them into a crop plant that people consume. This practice could, in some circumstances, result in crop plants forming compounds that might be toxic or to which certain individuals might be allergic.
**Objective 0012**

Understand the cell cycle, the stages and end products of meiosis and mitosis, and the role of cell division in unicellular and multicellular organisms.

12. In terms of the cell cycle, cancer cells differ from normal cells in which of the following ways?

   I. Cancer cells pass through the phases of the cell cycle in sequences different from that of normal cells.

   II. Cancer cells do not stop dividing when they come in contact with other cells as normal cells do.

   III. Cancer cells are able to divide an indefinite number of times, while normal cells divide a limited number of times.

   IV. Cancer cells are more sensitive to changes in external factors than are normal cells, and alter their division rates accordingly.

   A. I and III only

   B. II and III only

   C. II and IV only

   D. I, II, and IV only

Correct Response: B. Control mechanisms typically limit the growth and division of normal cells. One of these control mechanisms is contact inhibition; when normal cells in tissue come in contact with one another, they stop dividing. Another control mechanism is the ability of normal cells to undergo only a finite number of divisions before cell death. Cells that are transformed into cancer cells are freed of these controls and, therefore, divide without restraint.
Objective 0013
Understand concepts, principles, and applications of classical and molecular genetics.

13. Use the pedigree chart below to answer the question that follows.

The shading indicates those individuals affected by Huntington's disease, a degenerative disease of the nervous system. Genotypes for individuals 2 and 5 are given. Based on the chart, which of the following statements must be true?

A. Individual 1 must be heterozygous for the trait.

B. Huntington's disease is a recessively inherited disorder.

C. Individual 3 must be homozygous for the trait.

D. Huntington's disease is sex-linked.

Correct Response: A. Huntington's disease is the result of a dominant allele ($H$), since individual 2, who does not have the disease, carries two recessive alleles ($hh$). For individual 4 to be unaffected by the disease, her genotype must also be $hh$. That means that she received one $h$ allele from her unaffected father (individual 2) and one $h$ allele from her affected mother (individual 1). Therefore, individual 1 must be heterozygous for the trait, carrying one recessive and one dominant allele ($Hh$).
Objective 0014
Understand the principles of population genetics and the interaction between heredity and the environment, and apply this knowledge to problems involving populations.

14. Which of the following accounts for the relative rarity of diseases due to dominant lethal alleles as compared with diseases caused by recessive lethal alleles?

A. Recessive lethal alleles only manifest themselves later in life, following carriers' reproductive years.

B. Normal recessive alleles have conformations that resist pairing with lethal dominant alleles.

C. Dominant lethal alleles tend to occur in geographically isolated areas and are not prone to gene flow.

D. The lethal consequences of dominant alleles are not masked in heterozygous individuals.

Correct Response: D. Every individual who possesses at least one dominant lethal allele (i.e., homozygous dominant and heterozygous individuals) will die of the disease associated with that allele. If death occurs before any or many offspring are produced, then the frequency of the dominant lethal allele in a population will be greatly reduced. When lethal alleles are recessive, however, heterozygous individuals display normal phenotypes and are able to reproduce and pass on the recessive allele to their offspring. Only those offspring who receive two recessive alleles, one from each parent, will have the disease.
Objective 0015
Understand hypotheses about the origins of life, evidence supporting evolution, and evolution as a unifying theme in biology.

15. Biologist Lynn Margulis is a proponent of the theory of endosymbiosis, which suggests that the mitochondria of modern eukaryotic cells evolved from bacteria living symbiotically within early eukaryotic cells. Which of the following is supporting evidence for this theory?

A. Mitochondria require the internal environment of the eukaryotic cell to replicate.

B. Mitochondrial rRNA is more similar to bacterial rRNA than to eukaryotic rRNA transcribed from nuclear DNA.

C. Mitochondria are morphologically indistinguishable from free-living bacteria.

D. Mitochondria that are removed from eukaryotic cells and placed in a growth medium can generate fully functioning free-living cells.

Correct Response: B. The amount of similarity in the base sequences of nucleic acids from different organisms is a reliable indicator of the degree of relatedness among those organisms. In this case, the fact that mitochondria have their own genetic material, and that there is greater similarity of mitochondrial rRNA to bacterial rRNA than to eukaryotic rRNA, suggests that mitochondria evolved from bacteria rather than developing as new structures as eukaryotic cells became more complex and compartmentalized.
Objective 0016
Understand the mechanisms of evolution.

16. An ecologist discovers a new species of grass (species C) along a relatively small section of coastal dune where only two grass species (A and B) were previously known to occur. The ecologist suspects that species C, which is fertile, results from a polyploid hybrid of species A and B. Which of the following would provide the strongest evidence to support this hypothesis?

A. Species C exhibits morphological characteristics that are distinct from those of species A and B.

B. Other patches of species C occurring on dunes dominated by species A and B are discovered.

C. The number of chromosomes for species C equals the sum of the chromosomes of species A and B.

D. Species A, B, and C are each shown to be capable of asexual reproduction.

Correct Response: C. Polyploidy typically results when there is an error (e.g., nondisjunction) during meiosis or mitosis. While hybrids are often infertile because the chromosomes cannot pair properly during meiosis, many plants can reproduce asexually, which provides a mechanism for converting to a fertile polyploid species. In the situation described above, if a haploid gamete from species A fertilized an abnormal diploid gamete from species B, then a polyploid hybrid would result. If this polyploid hybrid were to reproduce asexually and eventually backcross with species A, then a full complement of homologous chromosomes would be present, allowing the hybrid to reproduce sexually as a new species with a number of chromosomes equal to the sum of the chromosomes of species A and B.
Objective 0017
Understand the principles of taxonomy and the relationship between taxonomy and the history of evolution.

17. The table below lists characteristics of four divisions of protists (protists). Which line in the table represents the division that is most closely related to members of the plant kingdom?

<table>
<thead>
<tr>
<th>Line</th>
<th>Photosynthetic Pigments</th>
<th>Carbohydrate Food Reserve</th>
<th>Cell Wall Components</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>chlorophyll a, carotenoids, phycobilins</td>
<td>floridean starch</td>
<td>cellulose with pectic materials</td>
</tr>
<tr>
<td>2</td>
<td>chlorophyll a, chlorophyll b, carotenoids</td>
<td>starch</td>
<td>cellulose</td>
</tr>
<tr>
<td>3</td>
<td>chlorophyll a, chlorophyll c, fucoxanthin</td>
<td>laminarin</td>
<td>cellulose with other polysaccharides</td>
</tr>
<tr>
<td>4</td>
<td>chlorophyll a, chlorophyll c, carotenoids</td>
<td>starch</td>
<td>cellulose</td>
</tr>
</tbody>
</table>

A. Line 1
B. Line 2
C. Line 3
D. Line 4

Correct Response: B. Taxonomists generally consider organisms that have the greatest number of characteristics in common to be the most closely related. Members of the plant kingdom have chloroplasts that contain chlorophyll $a$, chlorophyll $b$, and a variety of carotenoids to help carry out photosynthesis. In addition, plants store food in the form of starch, and cellulose is a primary component of their cell walls. Looking at the table, it is apparent that the division described in Line 2 has characteristics that are identical to those of plants. Therefore, this division of protoctists (protists) is most closely related to plants.
Objective 0018
Understand the unity and diversity of life, including common structures and functions.

18. Which one property listed below would provide the strongest evidence that an unknown object is a living organism?

A. It has a highly ordered structure.
B. It is made up of cells.
C. It uses energy to do work.
D. It grows in size.

Correct Response: B. A cellular makeup is unique to living organisms. The other three characteristics apply to both living and nonliving things.
Objective 0019
Understand the general characteristics, functions, and adaptations of prions, viruses, bacteria, protoctists (protists), and fungi.

19. Among infectious agents that are known to affect organisms, prions are unique in that they:

A. contain circular chromosomes.
B. lack metabolic machinery.
C. consist of a glycoprotein envelope.
D. lack nucleic acids.

Correct Response: D. Prions consist only of protein. All other known infectious agents, such as viruses or bacteria, contain nucleic acids (DNA or RNA).
**Objective 0020**

Understand the general characteristics, life functions, and adaptations of plants.

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20. Which of the following best describes a significant difference between vascular and nonvascular plants?

   A. Vascular plants have lignified cell walls to provide mechanical support, whereas nonvascular plants do not.

   B. Nonvascular plants are homosporous, whereas vascular plants are heterosporous.

   C. In nonvascular plants, the cells of the xylem and phloem are living, whereas in vascular plants they are not.

   D. In vascular plants, the sporangia grow above the rest of the plant for easy dispersal of spores, whereas in nonvascular plants they do not.

**Correct Response:** A. Vascular plants, such as gymnosperms and angiosperms, have cell walls that contain lignin; nonvascular plants, such as mosses, lack lignified cell walls. The support provided by the lignin explains why, in general, vascular plants are able to grow larger than nonvascular plants.
Objective 0021
Understand the general characteristics, life functions, and adaptations of animals.

21. Early in their life cycles, amphibians and most invertebrates go through a larval stage that is distinctly different from the adult body form. Which of the following is often a consequence of this phenomenon?

A. The young and adults of a species occupy different habitats or eat different foods, thereby reducing intraspecific competition.

B. Predators are less likely to prey on the young, thereby increasing the young animals' survival rates.

C. The life cycles of the animals of a particular species are synchronized, thereby ensuring that all the animals become sexually mature at the same time.

D. The young are more sensitive than the adults to selection factors in the environment, thereby increasing the rate at which these species evolve.

Correct Response: A. The larvae and adults of organisms that undergo metamorphosis are morphologically distinct and often vary greatly in size. This usually means that individuals in the different stages occupy different niches in the environment. Such niche separation reduces competition between the young and adults of a species for limited resources in the environment.
Objective 0022
Understand the structures and functions of the human skeletal, muscular, and integumentary systems; common malfunctions of these systems; and their homeostatic relationships within the body.

22. **Use the graph below to answer the question that follows.**

![Graph showing isometric tetanic tension vs. percent muscle length.](image)

The graph above shows the variation in the isometric tetanic tension produced by a skeletal muscle as a function of its length. A length of 100% represents the normal resting length of the muscle, and a tension of 100% represents the maximum tension the muscle is able to produce. Which of the following best explains the decrease in muscle tension as the muscle is stretched beyond its normal resting length?

A. Stretching causes the membranes of the muscle fibers to become leaky to ions; therefore they are unable to initiate and propagate the action potentials that cause contractions.

B. Stretching distorts the structure of the thin filaments in the muscle fibers so that cross bridges cannot bind to the actin and muscle tension cannot be created.

C. Stretching reduces the amount of overlap between the thin and thick filaments in the muscle fibers, so fewer active cross bridges form and less tension is produced.

D. Stretching interferes with the production of ATP in a muscle fiber, so there is little energy available for muscular contraction.

Correct Response: C. In a muscle at normal resting length, there is significant overlap of thick and thin filaments, with many active cross bridges between them. Since the thick and thin filaments cannot change length, when the muscle is stretched, the amount of overlap between the filaments is reduced. Active cross bridges still form, but there are fewer of them, which means less tension can be generated.
Objective 0023
Understand the structures and functions of the human respiratory and excretory systems, common malfunctions of these systems, and their homeostatic relationships within the body.

23. When antidiuretic hormone (ADH) is released by the pituitary gland it acts on the distal tubules and collecting ducts of the nephrons to increase their permeability to water and promote water retention by the body. This action of ADH on the kidneys has which of the following effects on the body?

A. lowering blood osmolarity
B. raising blood pH
C. lowering blood pressure
D. raising blood glucose

Correct Response: A. Osmolarity is a measure of the amount of solutes in a given volume of solution. If blood osmolarity rises above a certain level, ADH is released, which causes the kidneys to reabsorb water and return it to the blood. This process effectively lowers the concentration of the solutes in the blood, lowering blood osmolarity.
Objective 0024

Understand the structures and functions of the human circulatory and immune systems, common malfunctions of these systems, and their homeostatic relationships within the body.

24. Hypertension can arise as a secondary symptom of some other problem or as essential hypertension, which is of unknown cause (idiopathic). In essential hypertension, the most severe cases are likely to be treated with:

A. biofeedback training to improve physical responses to stress.

B. dietary modifications and diuretics to increase sodium levels.

C. vasodilators to broaden the diameter of the arteries.

D. barbiturates or other sedatives to induce relaxation.

Correct Response: C. In cases where hypertension is not caused by some identifiable factor, such as stress or diet, the only effective treatment may be medications that cause dilation of blood vessels. Relaxation of the smooth muscles in the walls of the blood vessels decreases peripheral resistance to blood flow, causing blood pressure to drop.
Objective 0025

Understand human nutrition and the structures and functions of the human digestive system and accessory organs, common malfunctions of the digestive system, and its homeostatic relationships within the body.

25. Vitamins are important components of the human diet because they:

A. raise the osmolarity of the blood, maintaining the pressure needed for waste filtration in the kidney.

B. regulate the activities of the liver as it metabolizes and stores energy.

C. alter the molecular structure of digested food, enabling nutrients to be absorbed into the bloodstream.

D. are involved in the catalytic processes of cells as cofactors of enzymes.

Correct Response: D. Many enzymes must combine with other molecules (cofactors) to function properly. If an enzyme lacks its specific cofactor, it is inactive or much less efficient at catalyzing reactions. Vitamins serve as cofactors for many enzymes and are essential for proper enzyme functioning.
Objective 0026
Understand the structures and functions of the human nervous and endocrine systems, common malfunctions of these systems, and their homeostatic relationships within the body.

26. Which of the following correctly describes the location and a function of the identified endocrine gland?

A. The thyroid gland is located in the neck and is involved in regulating circadian rhythms through the release of melatonin.

B. The pituitary gland is located in the head and stimulates metabolic functions through the release of growth hormone.

C. The adrenal medulla is located in the abdomen and promotes retention of water by the kidneys through the release of norepinephrine.

D. The pancreas is located in the pelvis and regulates glucose levels in the blood through the release of calcitonin.

Correct Response: B. Of the endocrine glands listed, only the pituitary gland’s location and function are accurately identified. The pituitary gland is located at the base of the hypothalamus in the lower brain. Among its many functions is the release of growth hormone.
Objective 0027
Understand the structures and functions of the human reproductive systems, the processes of embryonic development, common malfunctions of the reproductive systems, and their homeostatic relationships within the body.

27. During human development, maternal nutrition and fetal wastes move across the placenta by which of the following processes?

A. diffusion between maternal and fetal capillaries
B. activation of sodium-potassium pumps
C. exchange of maternal and fetal blood
D. use of selective protein channels

Correct Response: A. In the placenta, the tissues of the mother and the fetus are closely associated, but their blood supplies remain independent and do not mix. Exchange of materials between the maternal and fetal blood supplies is dependent on diffusion across the capillary walls due to concentration gradients.
Objective 0028
Understand the characteristics of populations and communities and use this knowledge to interpret population growth and interactions of organisms within an ecosystem.

28. In a given geographic area, the size of the grizzly bear (*Ursus arctos*) population is relatively stable over time. The most probable explanation for the stability in numbers is that this bear population has:

A. built up a relatively large number of individuals in the prereproductive age group.

B. reached its carrying capacity and is prevented from growing by limiting factors in the environment.

C. balanced the number of bears immigrating into the area with bears emigrating out of the area.

D. attained a reproductive rate equal to the innate capacity for increase of the species.

Correct Response: B. A stable population size generally indicates that an established population has reached its carrying capacity, the maximum population size that can be supported by resources available in the environment. If the population had not yet reached its carrying capacity, a steady increase in numbers would be expected. Conversely, if the population had exceeded its carrying capacity, a decline in numbers would be expected.
Objective 0029
Understand the development and structure of ecosystems and the characteristics of major biomes.

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

The pyramid above shows the net productivity by trophic level in a grassland ecosystem. Which of the following statements best accounts for the reduction in net productivity at successively higher trophic levels?

A. Organisms lose energy as heat from metabolic activities, leaving less energy available for consumers at the next trophic level.

B. The recycling activities of decomposers tend to benefit producers more than consumers in an ecosystem.

C. At higher trophic levels, organisms use less efficient metabolic pathways to convert energy to biomass.

D. Limited availability of space tends to have a greater effect on large consumers than on smaller consumers and producers.

Correct Response: A. At each trophic level, organisms use the energy they obtain from the food they consume for growth (including reproduction) and other metabolic functions. Much of the energy is also lost from the food chain as waste products. The only energy that is potentially available to consumers at the next trophic level is the energy that was put into growth, but even that cannot be used with 100% efficiency. As a result, there is less total energy available for productivity by organisms at successively higher levels.
Objective 0030
Understand the connections within and among the biogeochemical cycles and analyze their implications for living things.

30. Scientists have noted that the levels of atmospheric carbon dioxide rise significantly in winter in the Northern Hemisphere. Which of the following best accounts for this phenomenon?

A. Use of motor vehicles increases in winter.
B. Decomposition of organic materials slows in winter.
C. Sublimation rates of frozen carbon dioxide rise in winter.
D. Photosynthetic activity declines in winter.

Correct Response: D. Actively photosynthesizing plants take in large amounts of carbon dioxide for use in carbohydrate synthesis. During the winter in the Northern Hemisphere, many plants stop photosynthesizing completely when they lose their leaves or become covered by snow. Other plants photosynthesize significantly less than in the summer due to colder temperatures, lower light intensities, and fewer hours of daylight.
Objective 0031
Understand concepts of human ecology and the impact of human decisions and activities on the physical and living environment.

31. The concept of stewardship applies most clearly to which of the following scenarios?

A. A forester forms a land management collective that helps landowners by connecting them with markets for their timber, while requiring ecologically sound and sustainable harvesting practices by members.

B. Independent commercial fishermen form an organization whose mission is to set standard prices on fish, which would protect them from the economic instability of a consumer-driven pricing system.

C. Students form a coalition to protest the government's decision to reduce funding for biotechnology research, arguing that the results of research will be privately controlled if the research is funded by corporations.

D. An ornithologist offers an extracurricular program for students interested in exploring birds of prey, which includes field trips to owl habitat to collect pellets and look for other signs of the birds' presence.

Correct Response: A. The concept of stewardship is based on responsible use of resources through sustainable, economically viable practices. The primary objective is to manage and use resources in ways that ensure their continued viability. Of the available choices, only the steps described in Choice A will meet these long-term goals.
WRITTEN ASSIGNMENT SECTION

On the following pages are:

- Sample test directions for the written assignment section
- A sample written assignment
- An example of a strong response to the assignment
- The performance characteristics and scoring scale
- An evaluation of the strong response

On the actual test, candidates will be given a different written assignment from the one provided as a sample in this preparation guide.
DIRECTIONS FOR THE WRITTEN ASSIGNMENT

This section of the test consists of a written assignment. You are to prepare a written response of about 150–300 words on the assigned topic. The assignment can be found on the next page. You should use your time to plan, write, review, and edit your response to the assignment.

Read the assignment carefully before you begin to write. Think about how you will organize your response. You may use any blank space provided on the following pages to make notes, write an outline, or otherwise prepare your response. However, your score will be based solely on the response you write on the lined pages of your answer document.

Your response will be evaluated on the basis of the following criteria.

• **PURPOSE:** Fulfill the charge of the assignment.

• **APPLICATION OF CONTENT:** Accurately and effectively apply the relevant knowledge and skills.

• **SUPPORT:** Support the response with appropriate examples and/or sound reasoning reflecting an understanding of the relevant knowledge and skills.

Your response will be evaluated on the criteria above, not on writing ability. However, your response must be communicated clearly enough to permit valid judgment of your knowledge and skills. The final version of your response should conform to the conventions of edited American English. This should be your original work, written in your own words, and not copied or paraphrased from some other work.

Be sure to write about the assigned topic. Please write legibly. You may not use any reference materials during the test. Remember to review what you have written and make any changes that you think will improve your response.
A researcher is studying the natural history of springtails, which are small, drab-colored insects that are abundant in soil and leaf litter. As part of the study, the researcher wants to obtain an estimate of the number of springtails present in a meadow. The meadow measures 100 m × 100 m and contains a heterogeneous mixture of soil and vegetation types. The researcher's proposed experimental procedures are described below.

1. Identify 10 sites in the meadow where springtails are most likely to be found and place a square of plywood measuring 50 cm × 50 cm flat on the ground at each site.
2. The next morning, turn over the plywood squares that were placed in the meadow on the previous day.
3. Capture and count the springtails found in the area under each plywood piece and release them well outside the meadow.
4. Replace the plywood on the same spot and repeat the procedure each morning for two weeks.
5. Calculate the average number of springtails found per square meter of plywood per day. Estimate the total number of springtails in the meadow by multiplying this figure by the total number of square meters in the meadow.

Using your knowledge of the principles of experimental design (e.g., controls, experimental groups, sampling, dependent and independent variables), prepare a response in which you identify two weaknesses of the experimental design used by this researcher and explain why, from a scientific perspective, they are weaknesses. Describe two modifications that should be made to the experimental design and explain how these changes would enhance the scientific validity of the investigation.
STRONG RESPONSE TO THE SAMPLE WRITTEN ASSIGNMENT

A researcher is interested in estimating the number of springtails present in a meadow. There are several weaknesses in the proposed sampling protocol.

One significant weakness is the selection of sites for sampling within the 100m x 100m area. The researcher describes choosing areas where springtails are most likely to be found. This plan would result in an overestimation of the actual population because it is based on a nonrandom sample, which will skew the results. To get a more valid estimate, the researcher should sample randomly in the meadow space. The researcher could improve the procedure by making a grid of the area and then randomly selecting sites within the grid to sample.

A second significant weakness of the procedure is the removal of specimens from the experimental area. The researcher’s plan is to capture and count springtails daily, releasing them outside the experimental area. This could decrease the number of individuals present in the population during subsequent sampling. The resulting population estimate would be inaccurate. To improve the procedure, the researcher should release the springtails to their original location in the meadow.

The scientific validity of estimating the number of springtails would be enhanced by using these modifications. In addition, the impact of the study on the natural springtail population and to the ecology of the area would be minimized.
# PERFORMANCE CHARACTERISTICS AND SCORING SCALE

## Performance Characteristics

The following characteristics guide the scoring of responses to the written assignment.

<table>
<thead>
<tr>
<th>Purpose:</th>
<th>Fulfill the charge of the assignment.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application of Content:</td>
<td>Accurately and effectively apply the relevant knowledge and skills.</td>
</tr>
<tr>
<td>Support:</td>
<td>Support the response with appropriate examples and/or sound reasoning reflecting an understanding of the relevant knowledge and skills.</td>
</tr>
</tbody>
</table>

## Scoring Scale

Scores will be assigned to each response to the written assignment according to the following scoring scale.

<table>
<thead>
<tr>
<th>Score Point</th>
<th>Score Point Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>The &quot;4&quot; response reflects a thorough command of the relevant knowledge and skills.</td>
</tr>
<tr>
<td></td>
<td>- The response completely fulfills the purpose of the assignment by responding fully to the given task.</td>
</tr>
<tr>
<td></td>
<td>- The response demonstrates an accurate and highly effective application of the relevant knowledge and skills.</td>
</tr>
<tr>
<td></td>
<td>- The response provides strong support with high-quality, relevant examples and/or sound reasoning.</td>
</tr>
<tr>
<td>3</td>
<td>The &quot;3&quot; response reflects a general command of the relevant knowledge and skills.</td>
</tr>
<tr>
<td></td>
<td>- The response generally fulfills the purpose of the assignment by responding to the given task.</td>
</tr>
<tr>
<td></td>
<td>- The response demonstrates a generally accurate and effective application of the relevant knowledge and skills.</td>
</tr>
<tr>
<td></td>
<td>- The response provides support with some relevant examples and/or generally sound reasoning.</td>
</tr>
<tr>
<td>2</td>
<td>The &quot;2&quot; response reflects a partial command of the relevant knowledge and skills.</td>
</tr>
<tr>
<td></td>
<td>- The response partially fulfills the purpose of the assignment by responding in a limited way to the given task.</td>
</tr>
<tr>
<td></td>
<td>- The response demonstrates a limited, partially accurate and partially effective application of the relevant knowledge and skills.</td>
</tr>
<tr>
<td></td>
<td>- The response provides limited support with few examples and/or some flawed reasoning.</td>
</tr>
<tr>
<td>1</td>
<td>The &quot;1&quot; response reflects little or no command of the relevant knowledge and skills.</td>
</tr>
<tr>
<td></td>
<td>- The response fails to fulfill the purpose of the assignment.</td>
</tr>
<tr>
<td></td>
<td>- The response demonstrates a largely inaccurate and/or ineffective application of the relevant knowledge and skills.</td>
</tr>
<tr>
<td></td>
<td>- The response provides little or no support with few, if any, examples and/or seriously flawed reasoning.</td>
</tr>
</tbody>
</table>
EVALUATION OF THE STRONG RESPONSE

This response is considered a strong response because it reflects a thorough command of relevant knowledge and skills.

Purpose. The response identifies two weaknesses in the experimental design that would adversely affect the scientific validity of the outcome. The weaknesses are identified and explanations are provided as to how they would lead to an over- or underestimation of the number of springtails present in the meadow. These weaknesses are significant in that the validity of the scientific investigation would be undermined if they were not corrected. Specific modifications that would correct these weaknesses are also described, thus indicating a good understanding of principles of experimental design.

Application of Content. The response demonstrates an understanding of principles of experimental design and the ability to apply this knowledge. Specifically, the response applies the principles of appropriate sampling techniques for a given scientific investigation.

Support. The response supports the identified weaknesses and modifications by explaining the importance of random as opposed to nonrandom sampling in order to obtain a more accurate reflection of the actual springtail population. The response also explains the importance of returning the insects to their original location by noting that removal of the insects not only affects the overall population estimate, but can disrupt the population of springtails and the ecosystem.