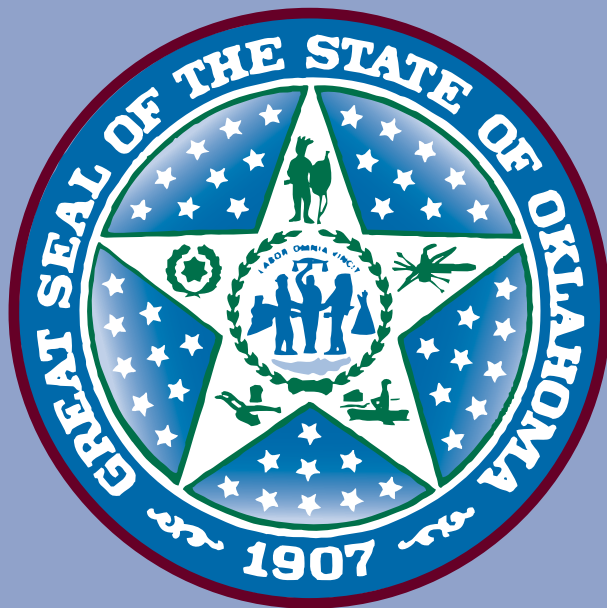


Certification Examinations for Oklahoma Educators™

Oklahoma Subject Area Tests™

STUDY GUIDE

010 Biological Sciences



Oklahoma Commission
for Teacher Preparation

OK-SG-FLD010-03

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STUDY GUIDE INTRODUCTION AND GENERAL INFORMATION ABOUT THE CERTIFICATION EXAMINATIONS FOR OKLAHOMA EDUCATORS

The first two sections of the study guide are available in a separate PDF file. Click the link below to view or print these sections.

[Study Guide Introduction and General Information About the Certification Examinations for Oklahoma Educators](#)



FIELD-SPECIFIC INFORMATION

- Test Competencies
 - Practice Test Questions and Answers
 - Constructed-Response Assignment Scoring
-

INTRODUCTION

This section includes a list of the test competencies, as well as a set of practice selected-response (multiple-choice) questions and one or more practice constructed-response assignments (if applicable), for the test field included in this study guide.

Test Competencies

The test competencies are broad, conceptual statements that reflect the subject-matter skills, knowledge, and understanding an entry-level educator needs to teach effectively in Oklahoma public schools. The list of test competencies for each test field represents the **only** source of information about what a specific test will cover and therefore should be reviewed carefully.

The descriptive statements that follow the competencies are included to provide examples of possible content covered by each competency. These descriptive statements are neither exhaustive nor exclusionary.

Practice Test Questions

The practice selected-response questions and any practice constructed-response assignments included in this section are designed to give you an introduction to the nature of the questions included in this OSAT test field. The practice test questions represent the various types of 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 to predict your performance on the test as a whole.

To help you prepare for your OSAT, each practice selected-response question in this section is preceded by the competency it measures and followed by a brief explanation of the correct response. On the actual test, the competencies, correct responses, and explanations will **not** be given.

If the test field included in this guide has a constructed-response assignment, a sample response is provided immediately following the practice constructed-response assignment. The sample response in this guide is for illustrative purposes only. Your written response should be your original work, written in your own words, and not copied or paraphrased from some other work.

A description of the process that is used for scoring the constructed-response assignment is provided in addition to the OSAT performance characteristics and score scale.

When you are finished with the practice test questions, you may wish to go back and review the entire list of test competencies and descriptive statements for your test field.

TEST COMPETENCIES: BIOLOGICAL SCIENCES

SUBAREAS:

- I. Foundations of Scientific Inquiry
- II. Cell Structure and Function
- III. Heredity and Biological Adaptation
- IV. Matter, Energy, and Organization in Organisms
- V. Interdependence of Organisms

SUBAREA I—FOUNDATIONS OF SCIENTIFIC INQUIRY

Competency 0001

Understand unifying concepts among the sciences and the relationships that connect science and technology.

The following topics are examples of content that may be covered under this competency.

Recognize conceptual and procedural themes that unify the disciplines of science (e.g., structure and function, models, measurement).

Analyze similarities among systems (e.g., stability, equilibrium, scale).

Apply concepts and theories from other sciences to a biological system.

Analyze the use of biology and other sciences in the design of a technological solution to a given problem.

Competency 0002

Understand the nature of science including the historical and contemporary contexts of biological study.

The following topics are examples of content that may be covered under this competency.

Recognize science as an ongoing human endeavor that is based on empirical standards, logical arguments, and questioning.

Analyze the significance of key events in the history of biological study (e.g., development of the microscope, understanding the structure of DNA).

Recognize the societal implications of recent developments in biology and biotechnology (e.g., medical technology, genetic engineering, wastewater treatment).

Analyze the role of science and technology in local, national, and global challenges.

Competency 0003

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

The following topics are examples of content that may be covered under this competency.

Analyze processes by which scientific knowledge and hypotheses are generated and revised.

Analyze ethical practices related to the process of scientific research and reporting.

Evaluate the appropriateness of a specified experimental design to test a hypothesis.

Analyze the use of models in explaining and investigating natural phenomena.

Competency 0004

Understand principles of measurement and the processes of gathering, interpreting, and communicating scientific data.

The following topics are examples of content that may be covered under this competency.

Evaluate the appropriateness and limitations of units of measurement, measuring devices, or methods of measurement.

Evaluate the appropriateness of a given method or procedure for collecting data for a specified purpose.

Make inferences, predictions, or conclusions based on given data.

Select an effective graphic representation (e.g., graph, table, diagram) for organizing, reporting, and analyzing given experimental data.

Competency 0005

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

The following topics are examples of content that may be covered under this competency.

Demonstrate knowledge of the appropriate use of laboratory instruments and equipment (e.g., balance, glassware, microscope, Bunsen burner, centrifuge, spectrophotometer).

Demonstrate knowledge of the use of technologies to model and solve problems in biology.

Apply proper methods for identifying, storing, and dispensing chemicals used in biology and identify sources for such information.

Demonstrate an understanding of the proper and humane treatment of living organisms in biological studies.

Apply proper procedures for promoting laboratory safety and responding to accidents and injuries in the biology laboratory.

SUBAREA II—CELL STRUCTURE AND FUNCTION

Competency 0006

Understand basic chemistry and biochemistry, and use this understanding to analyze the role of biologically important elements and compounds in living organisms.

The following topics are examples of content that may be covered under this competency.

Compare and contrast hydrogen, ionic, and covalent bonds.

Relate the structure and function of carbohydrates, lipids, proteins, and nucleic acids to cellular activities, including hydrolysis and dehydration synthesis (condensation).

Analyze the properties of water and the significance of these properties to living organisms.

Analyze the structure and function of enzymes and factors that affect the rate of enzyme action.

Competency 0007

Understand the functions and interrelatedness of cell structures, and identify the structural features of different types of cells.

The following topics are examples of content that may be covered under this competency.

Compare and contrast prokaryotic and eukaryotic cells.

Demonstrate knowledge of the primary functions, processes, products, and interactions of various cellular structures (e.g., lysosomes, microtubules, cell membrane).

Analyze the importance of active and passive transport processes in maintaining homeostasis in cells and the relationships between these processes and the cellular membranes.

Competency 0008

Understand the processes of photosynthesis and cellular respiration and their relationships to cell structure and function.

The following topics are examples of content that may be covered under this competency.

Recognize the importance of the processes of photosynthesis and respiration to organisms.

Analyze limiting factors that affect the yield of energy from the breakdown of organic molecules in a cell.

Analyze limiting factors that affect the storage of energy from the production of organic molecules in a cell.

Analyze the biochemical pathways of photosynthesis and respiration (e.g., Calvin cycle, glycolysis, Krebs cycle).

Evaluate the significance of chloroplast structure and mitochondrion structure in the processes of photosynthesis and respiration.

Competency 0009

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

The following topics are examples of content that may be covered under this competency.

Interpret the results of experiments relating to the eukaryotic cell cycle.

Compare chromosomal changes during the stages of meiosis and mitosis.

Analyze the significance of meiosis and fertilization in relation to phylogeny and genetic diversity.

Demonstrate an understanding of the process of cell differentiation.

Recognize the relationship between unrestricted cell division and cancer.

SUBAREA III—HEREDITY AND BIOLOGICAL ADAPTATION

Competency 0010

Understand the structure and function of DNA and RNA.

The following topics are examples of content that may be covered under this competency.

Demonstrate an understanding of the mechanism of DNA replication and the types of errors that can occur.

Analyze the roles of DNA and ribosomal, messenger, and transfer RNA in protein synthesis.

Analyze the implications of mutations in DNA molecules for protein structure and function.

Analyze the control of gene expression in prokaryotes (e.g., *lac* operon in *E. coli*) and eukaryotes.

Competency 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.

The following topics are examples of content that may be covered under this competency.

Recognize the role of genetic engineering techniques in the basic discoveries of molecular genetics.

Analyze the role of genetic engineering in the development of microbial cultures capable of producing valuable products (e.g., human insulin).

Demonstrate an understanding of genetic engineering techniques and their uses (e.g., plasma probes, sequencing, DNA hybridization).

Competency 0012

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

The following topics are examples of content that may be covered under this competency.

Analyze the significance of Mendel's pea plant experiments and their implications regarding basic principles of heredity (e.g., dominance, segregation, independent assortment).

Analyze techniques used to determine the presence of human genetic diseases (e.g., PKU, cystic fibrosis).

Analyze genetic inheritance problems involving genotypic and phenotypic frequencies.

Recognize the role of nonnuclear inheritance (e.g., mitochondrial DNA, chloroplastic DNA) in phenotypic expression.

Competency 0013

Understand the processes of natural selection and biological adaptation.

The following topics are examples of content that may be covered under this competency.

Recognize adaptations as products of selection of naturally occurring variations in populations.

Analyze factors that contribute to speciation (e.g., geographic and reproductive isolation).

Analyze proposed mechanisms of evolution (e.g., gradualism, punctuated equilibrium).

Apply principles of population genetics to explain evolutionary change or stasis in a population.

Evaluate observations made in various areas of biology (e.g., embryology, biochemistry, anatomy) in terms of evolutionary theory.

Competency 0014

Understand the principles of classification and taxonomy.

The following topics are examples of content that may be covered under this competency.

Analyze criteria used to classify organisms (e.g., morphology, biochemical comparisons, dichotomous keys).

Interpret a given phylogenetic tree or cladogram of related species.

Demonstrate knowledge of the contributions of Linnaeus to the modern system of classification.

Relate changes in the structure and organization of the classification system to developments in biological thought (e.g., evolution, modern genetics).

SUBAREA IV—MATTER, ENERGY, AND ORGANIZATION IN ORGANISMS

Competency 0015

Understand the characteristics of life and the organization of organisms.

The following topics are examples of content that may be covered under this competency.

Identify characteristics of living organisms (e.g., differences between organisms and nonliving things) and requirements needed to sustain life.

Recognize levels of organization in organisms (e.g., cells, tissues, systems) and the relationships among the levels.

Compare the organization and structures of diverse organisms from single-celled to complex multicellular organisms.

Recognize the functions of specialized structures at all levels of complexity (e.g., leaves on trees, wings on birds).

Competency 0016

Understand matter and energy in organisms.

The following topics are examples of content that may be covered under this competency.

Demonstrate an understanding of the need for organisms to obtain, transform, transport, release, and eliminate matter and energy.

Compare ways in which organisms obtain, transform, transport, release, and eliminate matter and energy.

Recognize sources of energy used by various organisms (e.g., archaeobacteria, plants, animals).

Recognize the implications of conservation of energy and matter for living systems.

Competency 0017

Understand regulatory processes in organisms.

The following topics are examples of content that may be covered under this competency.

Identify anatomical structures and physiological processes that are involved in maintaining homeostasis.

Analyze behavioral responses (e.g., taxes, tropisms) to internal and external stimuli (e.g., light, gravity, chemical concentrations).

Recognize ways in which organisms monitor internal and external conditions (e.g., light-sensing cells, nervous system, endocrine system).

Evaluate the adaptive significance of a given behavior.

Competency 0018

Understand reproduction, development, and life cycles of organisms.

The following topics are examples of content that may be covered under this competency.

Compare and contrast asexual and sexual reproduction.

Recognize characteristics of the reproductive strategies of common organisms.

Recognize developmental processes of plants and animals.

Analyze the adaptive significance of various reproductive strategies (e.g., development of seeds, internal fertilization).

Compare the life cycles of various organisms (e.g., insect, plant, vertebrate).

Competency 0019

Understand human biology.

The following topics are examples of content that may be covered under this competency.

Identify structures of the body systems and their related functions.

Analyze physiological processes (e.g., excretion, respiration) and their role in regulation.

Demonstrate knowledge of the human life cycle, including reproduction, growth, and development.

Recognize characteristics of human diseases, their causes, and methods of prevention and treatment.

SUBAREA V—INTERDEPENDENCE OF ORGANISMS

Competency 0020

Understand the characteristics of populations and communities, and use this knowledge to analyze population growth and community interactions.

The following topics are examples of content that may be covered under this competency.

Demonstrate an understanding of factors that affect population size and growth rate (e.g., carrying capacity, limiting factors).

Determine and interpret population growth curves, and utilize sampling methods.

Analyze relationships among organisms in a community (e.g., competition, predation, symbiosis).

Competency 0021

Understand the characteristics of ecosystems and major biomes.

The following topics are examples of content that may be covered under this competency.

Compare different types of ecosystems (e.g., terrestrial, aquatic) in terms of biotic and abiotic factors.

Recognize the importance of the process of ecological succession and the role of biotic and abiotic factors in this process.

Analyze factors that influence the characteristics of the major types of biomes.

Recognize the effect of biome degradation and destruction on biosphere stability (e.g., climate changes, deforestation, reduction of species diversity).

Competency 0022

Understand the flow of energy and matter through living systems and between living systems and the physical environment.

The following topics are examples of content that may be covered under this competency.

Demonstrate an understanding of the flow of energy through the trophic levels of an ecosystem.

Compare the strengths and limitations of various pyramid models (e.g., biomass, numbers, energy).

Demonstrate an understanding of the role of bacteria in nutrient cycling in ecosystems.

Analyze biogeochemical cycles.

Evaluate the effects of limiting factors on ecosystem productivity (e.g., light intensity, gas concentrations, mineral availability).

Competency 0023

Understand concepts of human ecology and the impact of human decisions and activities on the abiotic and biotic environments.

The following topics are examples of content that may be covered under this competency.

Recognize the importance and implications of influencing factors (e.g., nutrition, public health, biodegradation) on human population dynamics.

Predict the impact of human use of natural resources (e.g., forests, rivers) on organisms.

Analyze types of resource misuse and their long- and short-term effects.

Evaluate methods and technologies that reduce or mitigate environmental degradation.

PRACTICE TEST QUESTIONS AND ANSWERS: BIOLOGICAL SCIENCES

Practice Selected-Response Questions

Competency 0001

Understand unifying concepts among the sciences and the relationships that connect science and technology.

1. A biologist is using a computer modeling program simulating the population growth and dispersal patterns of an insect species known to damage crops. The primary advantage of using a simulation program is that it allows the biologist to:
 - A. draw conclusions about the population growth and dispersal patterns of a wide variety of other insect species.
 - B. study in detail the reproductive anatomy and physiology of this insect species.
 - C. explore how various combinations of factors are likely to affect the population growth and dispersal patterns of this insect species.
 - D. develop chemicals that are likely to be effective in limiting the damage to crops this insect species causes.

Correct Response: C. The population growth and dispersal patterns of an insect species are likely to be influenced by many factors, some of which may interact in complex ways. An advantage of using simulation programs is that computers are capable of processing large amounts of complex data quickly. Once known information about the insect species under study is incorporated into a modeling program, scientists can take full advantage of the power of computers to explore various scenarios involving the factors that may affect the insect's population growth and dispersal.

Competency 0002

Understand the nature of science including the historical and contemporary contexts of biological study.

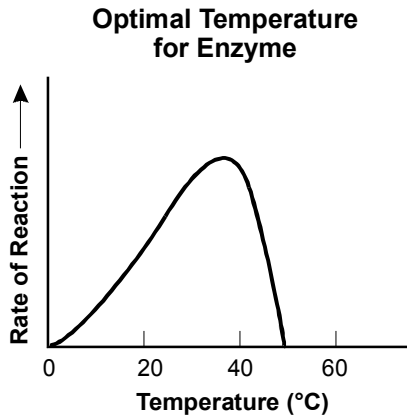
2. In the field of biology, the discovery of the structure and function of DNA is a good example of how scientific knowledge:
- A. is accidentally stumbled upon during the course of an unrelated experiment.
 - B. is built gradually through the conduction of a series of carefully thought out investigations.
 - C. is revolutionized through the results of a single seminal experiment.
 - D. undergoes a paradigm shift once seemingly unrelated data are finally put together in the right way.

Correct Response: B. The discovery of the structure and function of DNA came about as the result of several experiments that systematically narrowed the focus of investigation. Once scientists understood that the units of inheritance, genes, were located on chromosomes, they needed to determine which of the chemical components of chromosomes, DNA or protein, was the genetic material. Investigations by various researchers definitively demonstrated that DNA was the genetic material, which then led other researchers to focus on determining its structure. Once DNA's structure was elucidated, other researchers conducted additional investigations to determine the mechanisms by which DNA replicates and codes for proteins.

Competency 0006

Understand basic chemistry and biochemistry, and use this understanding to analyze the role of biologically important elements and compounds in living organisms.

3. Use the diagram below to answer the question that follows.



The most likely explanation for the sharp drop in the rate of reaction for the enzyme above 40°C is that at increased temperatures:

- A. the strong bonds holding together the amino acids that make up the enzyme are broken, and the molecules separate into their constituent amino acids.
- B. all the available active sites on the enzyme become filled, and further reaction of the enzyme with the substrate molecules is blocked.
- C. the positively charged active sites on the enzyme become negatively charged and can no longer bind with the negatively charged substrate molecules.
- D. the weak bonds stabilizing the enzyme break, causing the enzyme to lose its natural shape so that it can no longer interact with the substrate molecules.

Correct Response: D. The rate of reaction between enzymes and their substrate molecules increases as temperature increases. The increasing temperature causes the molecules to move faster, resulting in more frequent collisions between the enzyme and substrate molecules. Enzyme molecules are held together in an active three-dimensional conformation by hydrogen bonds, ionic bonds, and other weak interactions. Above a certain temperature, these weak interactions are disrupted and the enzyme denatures, losing its active conformation and ability to catalyze reactions, which for this enzyme occurs above 40°C.

Competency 0009

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

4. 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 normal cells are, and cancer cells 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 limit the growth and division of normal cells. One of these 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 divide a set number of times before cell death. These controls no longer function normally in cancer cells and thus they divide without these restraints.

Competency 0010

Understand the structure and function of DNA and RNA.

5. A team of researchers has isolated a chemical from a tropical tree that causes insects to die when they ingest it. The researchers determine that the chemical deactivates the enzyme RNA polymerase. This chemical likely causes the insects to die by interfering directly with:
- A. transcription of RNA from the DNA template.
 - B. transport of RNA from the nucleus to the cytoplasm.
 - C. translation of polypeptides from RNA molecules.
 - D. excision of transcribed introns from an RNA molecule.

Correct Response: A. RNA polymerase is specifically involved in the process of transcription where it links together ribonucleotides to form a chain of RNA. Therefore, if an insect were exposed to a chemical that deactivates RNA polymerase, its cells would be unable to carry out transcription.

Competency 0012

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

6. In watermelons, the alleles for green color and short fruit are dominant over the alleles for striped color and long fruit. Two watermelon plants that are heterozygous for both characteristics are bred. What fraction of offspring from this cross would be expected to have green color and long fruit?
- A. $\frac{9}{16}$
- B. $\frac{7}{16}$
- C. $\frac{3}{16}$
- D. $\frac{1}{16}$

Correct Response: C. If G = green color, g = striped color, S = short fruit, and s = long fruit, then the genotype of both parent plants is $GgSs$. A Punnett square can be used to determine what fraction of the offspring are expected to have green color and long fruit.

	GS	Gs	gS	gs
GS	$GGSS$	$GGsS$	$GgSS$	$GgSs$
Gs	$GGsS$	$GGss^*$	$GgSs$	$Ggss^*$
gS	$GgSS$	$GgsS$	$ggSS$	$ggSs$
gs	$GgsS$	$Ggss^*$	$ggSs$	$ggss$

The asterisks indicate the offspring genotypes that would produce the green color, long fruit phenotype. Therefore, $\frac{3}{16}$ of the offspring would be expected to have green color and long fruit.

Competency 0018

Understand reproduction, development, and life cycles of organisms.

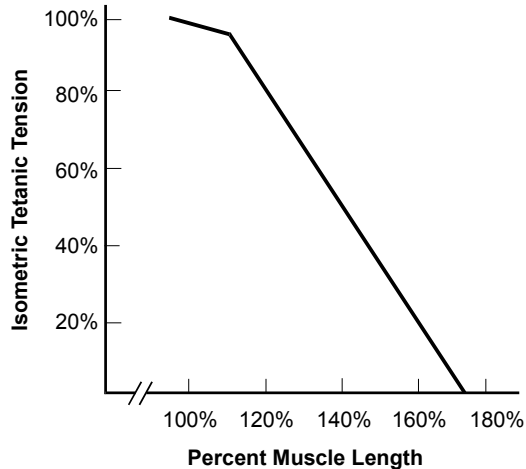
7. In contrast to reproduction in other divisions of plants, reproduction in angiosperms:
- A. results in distinct and independent sporophyte and gametophyte generations.
 - B. involves the union of male and female gametes that are identical in appearance.
 - C. produces offspring that have different genotypes than the parent plants.
 - D. results in the production of endosperm to provide nutrition for the developing embryo.

Correct Response: D. One of the distinguishing features of angiosperm reproduction is the formation of triploid endosperm tissue to nourish the developing embryo in the seed. In the process of double fertilization, two sperm cells are delivered by the pollen grain to the embryo sac. One sperm nucleus unites with the egg to form the diploid zygote, while the other sperm nucleus fuses with two nuclei in the embryo sac, forming the triploid endosperm.

Competency 0019

Understand human biology.

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



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.

Competency 0020

Understand the characteristics of populations and communities, and use this knowledge to analyze population growth and community interactions.

9. 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.

Competency 0023

Understand concepts of human ecology and the impact of human decisions and activities on the abiotic and biotic environments.

10. The Ogallala Aquifer is a major underground source of fresh water that underlies the high plains from Texas to South Dakota. For many years, water has been pumped from this aquifer much faster than it is replaced by natural processes. Which of the following is one likely long-term effect of the overuse and depletion of this aquifer?
- A. Reduced water volume in the aquifer will lead to higher concentrations of mineral salts in the remaining water.
 - B. Increased evaporation from groundwater sources will lead to greater precipitation in the area.
 - C. Lowered water tables will lead to the drying up and loss of many aquatic habitats such as streams, marshes, and ponds.
 - D. Reduced soil moisture will lead to decreased vegetation cover and removal of topsoil by wind erosion.

Correct Response: C. A common problem associated with drawing water out of an aquifer faster than it can be replenished through natural processes is the lowering of the aquifer's water table, which represents the topmost layer of rocks or soil that is saturated with water. Streams, ponds, and marshes often represent areas where the ground surface level extends below the level of the water table, causing these areas to fill with water to the level of the water table. When the water table drops, so does the water level in these bodies, even causing them to dry up completely if the water table drops far enough.

Practice Constructed-Response Assignment

11. **Read the information below; then complete the exercise that follows.**

A researcher is interested in testing the effects of caffeine and ethanol on the heart rate of a species of *Daphnia*. *Daphnia* is a genus of small crustacean that is common in ponds and streams. The researcher obtains several *Daphnia* of the same species from a biological supply company. Individuals of the species average 1.5 mm long. The researcher keeps the *Daphnia* in small jars on a lab table until they are to be used. The researcher's proposed procedures are described below.

1. Use a pipette to transfer one *Daphnia* and a drop of water from the storage jar to a clean microscope slide. Place a cover slip over the drop.
2. Place the slide on a microscope, locate the *Daphnia* under low power, and then transfer to high power. Find the *Daphnia's* beating heart and count the number of beats per minute.
3. Use a Pasteur pipette to apply a drop of solution containing caffeine to the edge of the cover slip. Use a piece of filter paper on the opposite side of the cover slip to draw water out from under the cover slip, which will help draw the caffeine solution under the cover slip.
4. Wait one minute, then re-locate the *Daphnia's* heart in the field of view and measure the heart rate again.
5. Use the same procedure described in step 3 to apply a drop of solution containing ethanol to the slide.
6. Again, wait one minute, re-locate the *Daphnia's* heart in the field of view, and measure the heart rate.
7. Repeat steps 1–6 with at least 10 more *Daphnia*.

Using your knowledge of the principles and procedures for conducting scientific investigations (e.g., sampling, data analysis, dependent and independent variables), prepare a response in which you:

- identify two weaknesses in the proposed procedures and explain why, from a scientific perspective, they are weaknesses;
- describe two modifications that should be made to the procedures that would address these weaknesses and explain how these changes would enhance the scientific validity of the investigation; and
- discuss an effective way to analyze or report the data that will be collected during this investigation.



FOR YOUR REFERENCE ONLY—*The constructed-response item is written to assess understanding in Subarea I, Foundations of Scientific Inquiry, which consists of the competencies listed below.*

Understand unifying concepts among the sciences and the relationships that connect science and technology.

Understand the nature of science including the historical and contemporary contexts of biological study.

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

Understand principles of measurement and processes of gathering, interpreting, and communicating scientific data.

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

A Very Good Response to the Practice Constructed-Response Assignment

There are several weaknesses in the described procedures. One significant weakness is the lack of an adequate control group. In this situation, there may be factors that would affect the Daphnia's heart rate other than exposure to the caffeine or ethanol. For instance, putting the Daphnia on a regular microscope slide rather than a depression slide could interfere with its heart's normal functioning. Also, heat generated by the light on the microscope could affect the heart rate, since metabolic rate tends to increase as temperature increases. Unless these or other factors can be ruled out, then the results of the entire investigation are likely to be challenged.

A second weakness is exposing a Daphnia to both drugs with no recovery time in between and always in the same order. There could be interactive effects between the caffeine and ethanol, which would skew the results. Any data collected on the effects of the ethanol specifically would be questionable because there might still be some caffeine present in the fluid surrounding the Daphnia, in the Daphnia's body, or both. Even assuming that all the caffeine was gone, it could still take a while for the Daphnia to recover physiologically from the effects of the caffeine.

To address the first weakness, the lack of an adequate control, some Daphnia should be observed under the same conditions (for example, same type of slide, same amount of time on the microscope) as the experimental subjects, except without addition of the chemicals. This allows the researcher to determine whether changes in the heart rate are due to factors other than the presence of the caffeine or ethanol. If the use of a proper control group rules out that other factors are influencing the results, then the researcher and other scientists can have greater confidence in the conclusions drawn from the investigation.

To address the second weakness, possible interactions between the caffeine and ethanol, the chemicals should be tested one at a time, with ample time between trials if the same Daphnia are to be reused. Having separate trials for each chemical would ensure that only one chemical is present at a time. Also, giving a Daphnia more time between trials with the different chemicals will allow it to recover physiologically from the effects of the first chemical before the second one is applied. Making this change to the procedures will reduce questions or concerns that other researchers might raise about unintended interactions between caffeine and ethanol. It will also strengthen the validity of any conclusions that are drawn based on the results of the investigation.

An effective way to report the data generated by this investigation would be to calculate the mean heart rates for three groups: the control group, the group exposed to caffeine, and the group exposed to ethanol. Mean values are a convenient way to

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A Very Good Response to the Practice Constructed-Response Assignment (continued)

summarize many data points into a single number for analysis and reporting. An appropriate statistical analysis could also be run on the data to determine if differences in the heart rates between the experimental groups and the control group are, in fact, statistically significant. For reporting purposes, the summarized data could be presented effectively in a table or in a histogram showing the mean heart rates for the three groups.

CONSTRUCTED-RESPONSE ASSIGNMENT SCORING

All responses to OSAT constructed-response assignments (written and oral) are scored using scoring scales that describe varying levels of performance. These scales were approved by committees of Oklahoma educators who reviewed both the performance characteristics and the scoring scales.

Each response is scored by multiple scorers according to standardized procedures during scoring sessions held immediately after each administration of the CEOE. Scorers with relevant professional backgrounds are oriented to these procedures before the scoring session and are carefully monitored during the scoring sessions.

A constructed-response assignment response is designated unscorable if it is blank, not on the assigned topic, illegible or unintelligible, not in the appropriate language, or of insufficient length to score. If you do not provide a scorable response for each constructed-response assignment on your test, you cannot pass the test regardless of your scores on the other section(s) of the test.

Sample Performance Characteristics for Constructed-Response Assignments

PURPOSE	The extent to which the response achieves the purpose of the assignment
SUBJECT MATTER KNOWLEDGE	Accuracy and appropriateness in the application of subject matter knowledge
SUPPORT	Quality and relevance of supporting details
RATIONALE	Soundness of argument and degree of understanding of the subject matter

Sample Scoring Scale for Constructed-Response Assignments

SCORE POINT	SCORE POINT DESCRIPTION
4	<p>The "4" response reflects a thorough knowledge and understanding of the subject matter.</p> <ul style="list-style-type: none"> • The purpose of the assignment is fully achieved. • There is a substantial, accurate, and appropriate application of subject matter knowledge. • The supporting evidence is sound; there are high-quality, relevant examples. • The response reflects an ably reasoned, comprehensive understanding of the topic.
3	<p>The "3" response reflects a general knowledge and understanding of the subject matter.</p> <ul style="list-style-type: none"> • The purpose of the assignment is largely achieved. • There is a generally accurate and appropriate application of subject matter knowledge. • The supporting evidence generally supports the discussion; there are some relevant examples. • The response reflects a general understanding of the topic.
2	<p>The "2" response reflects a partial knowledge and understanding of the subject matter.</p> <ul style="list-style-type: none"> • The purpose of the assignment is partially achieved. • There is a limited, possibly inaccurate or inappropriate application of subject matter knowledge. • The supporting evidence is limited; there are few relevant examples. • The response reflects a limited, poorly reasoned understanding of the topic.
1	<p>The "1" response reflects little or no knowledge and understanding of the subject matter.</p> <ul style="list-style-type: none"> • The purpose of the assignment is not achieved. • There is little or no appropriate or accurate application of subject matter knowledge. • The supporting evidence, if present, is weak; there are few or no relevant examples. • The response reflects little or no reasoning about or understanding of the topic.
U	The response is unscorable because it is illegible, not written to the assigned topic, written in a language other than English, or of insufficient length to score.
B	There is no response to the assignment.

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