



California Subject Examinations for Teachers®

TEST GUIDE

SCIENCE SUBTEST II: LIFE SCIENCES

Sample Questions and Responses and Scoring Information

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Sample Test Questions for CSET: Science Subtest II: Life Sciences

Below is a set of multiple-choice questions and constructed-response questions that are similar to the questions you will see on CSET: Science Subtest II: Life Sciences. You are encouraged to respond to the questions without looking at the responses provided in the next section. Record your responses on a sheet of paper and compare them with the provided responses.

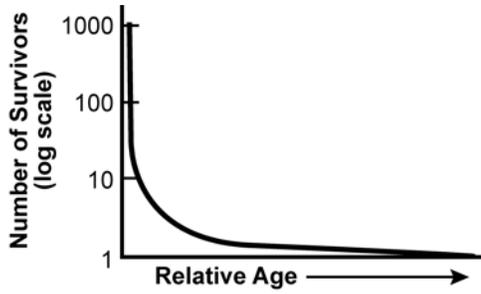
Scientific calculators **will be provided** for the examinees taking Science Subtest I: General Science, as well as the specialty subtests of Life Sciences, Chemistry, Earth and Space Sciences, and Physics. Refer to the California Educator Credentialing Examinations website for a list of the calculator models that may be provided. Directions for the use of the calculator will not be provided at the test administration. You will not be allowed to use your own calculator for CSET: Science subtests.

1. For a virus to infect a host cell, the virus must first adhere to the cell's surface. Viruses accomplish this by fitting specific sites on their surfaces to receptor sites on the surfaces of their host cells in a "lock and key" arrangement. The "lock and key" arrangement between a virus and receptor sites on its host cells is most important in determining the:
 - A. rate at which the virus normally replicates inside the host cell.
 - B. length of time the virus normally remains infective outside the cell.
 - C. specific type of cell that is normally infected by the virus.
 - D. amount of damage the virus normally inflicts upon the host cell.
2. An important role of histamine in the humoral response to infection is to:
 - A. deactivate an antigen through chemical denaturation.
 - B. speed the immune response to an antigen the body has previously encountered.
 - C. signal the presence of an antigen to other components of the immune system.
 - D. increase cell division among B cells to enhance the immune response.

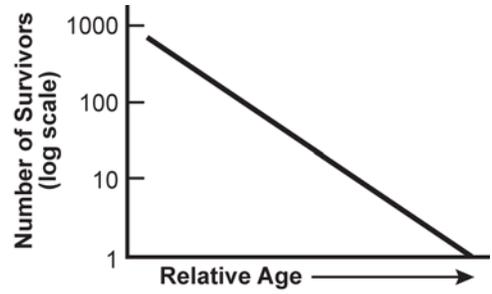
3. Which of the following descriptions correctly identifies the events of mitotic prophase?
- A. Doubled chromosomes align at the equatorial plate.
 - B. Daughter nuclei form, and cytokinesis may occur in some cells.
 - C. Chromosomes duplicate and the nucleus is visible.
 - D. Chromatin condenses and the nuclear membrane disappears.
4. Which of the following statements best explains why the catabolism of fats yields about twice as much energy as the catabolism of the same mass of carbohydrates?
- A. More energy is released as unusable heat in the breakdown of carbohydrates than of fats.
 - B. Fats contain a higher proportion of carbon-hydrogen bonds than carbohydrates do.
 - C. The breakdown of carbohydrates requires an initial input of ATP, while the breakdown of fats does not.
 - D. Energy used to make enzymes that break down carbohydrates reduces the efficiency of its catabolism.

5. Which of the following survivorship curves best matches a species in which parents provide little or no care to their offspring?

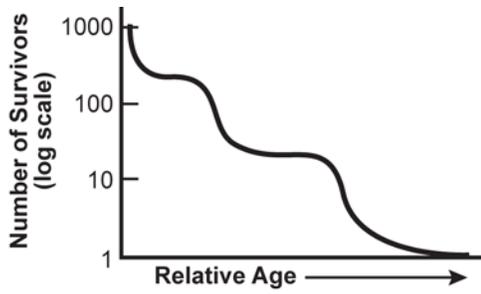
A.



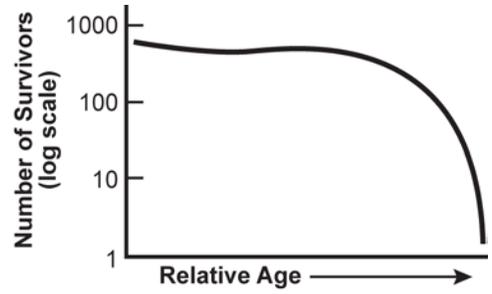
B.



C.



D.



6. Which of the following relationships is an example of commensalism?
- A. Barnacles on whales are transported to feeding areas.
 - B. Hawks and owls near a field feed on the same prey animals.
 - C. Protozoans in the guts of termites digest cellulose for the termite's nutrition.
 - D. Hookworms in a human's intestinal tract cause itching and anemia.
7. The effective cycling of nutrients in an ecosystem depends primarily on maintaining:
- A. rapid rates of decomposition of organic material.
 - B. a large standing crop biomass.
 - C. balanced rates of production, consumption, and decomposition.
 - D. high levels of species diversity.
8. Ecosystems with keystone species are more likely to be disrupted by natural events and human activities because keystone species:
- A. indicate by their presence or absence the overall health and biodiversity of an ecosystem.
 - B. determine the overall complexity of food webs in an ecosystem because they are the most numerous.
 - C. dominate ecosystems by representing the largest reserve of biomass in an ecosystem.
 - D. exert a disproportionate influence on an ecosystem's structure in relation to their actual numbers.
9. Which of the following examples best illustrates the idea that differential gene expression leads to specialization of cells in multicellular organisms instead of differences among the genes themselves?
- A. Epithelial cells in humans and other mammals have strong similarities in form and function.
 - B. Cells from the mammary gland of a sheep can provide the genetic material needed to clone a sheep.
 - C. Hormones produced by other mammals can be used to treat disorders in humans.
 - D. Alterations in pH levels can reverse normal differentiation of the dorsal and ventral sides of a chick embryo.

10. Variations in phenotypes are sometimes evident in individuals with abnormal chromosome numbers. Which of the following events accounts for a significant portion of the instances of abnormal chromosome numbers?
- A. nondisjunction during meiosis
 - B. deletion of DNA during translation
 - C. mutations during embryonic cell mitosis
 - D. transposition of DNA during replication
11. Which of the following is one consequence of the fact that natural selection acts on the phenotype of an individual rather than on its genotype?
- A. Harmful recessive alleles are less easily removed from a population than dominant alleles that are harmful.
 - B. Genetically similar individuals may have different phenotypes if they grow and develop under different environmental conditions.
 - C. A trait that is selectively neutral may increase in frequency in a population if it is genetically linked to a second trait that increases the fitness of the individual.
 - D. Differences in the behavior of individuals in a population are strongly influenced by differences in genotypes in the population.
12. Biologists use both phenetic and cladistic approaches to create phylogenetic trees that summarize the evolutionary history of different groups of organisms. A persistent problem for either approach is that presented by the:
- A. unreliability of the fossil record.
 - B. occurrence of convergent evolution.
 - C. number of variables to be analyzed.
 - D. existence of sympatric speciation.
13. A species of finch on an island is divided into two distinct morphs based on beak size. Finches with large beaks eat mostly large, hard-shelled seeds of a particular plant, while finches with small beaks eat smaller, softer seeds of a different plant. A smaller number of finches with beaks of intermediate size eat both large and small seeds. Which of the following scenarios would be most favorable for sympatric speciation of this finch species?
- A. The reproductive success of finches with intermediate beaks increases relative to that of finches with large or small beaks.
 - B. The plant species that produces either the large or small seeds becomes extinct on the island.
 - C. The population size of the finches on the island is sharply reduced by a natural disaster and then gradually increases to predisaster numbers.
 - D. Individual finches begin to choose mates with a beak size similar to their own.

14. Researchers studying northern elephant seals have found a remarkable lack of genetic diversity in the population. In contrast, the southern elephant seal population exhibits a normal amount of genetic variation. Which of the following is the most likely explanation for this difference in the two elephant seal populations?
- A. The northern elephant seal population was greatly reduced in the recent past, while the southern elephant seal population was not.
 - B. Southern elephant seals are exposed to many mutagenic substances from pollution, while northern elephant seals live in less polluted waters.
 - C. Northern elephant seals compete with many other seal species, while southern elephant seals have no close competitors.
 - D. Southern elephant seals mate primarily inside their own group, while northern elephant seals mate primarily outside their own group.
15. One pattern that early naturalists often observed when studying different ecosystems was the so-called "rule of three": when species with similar ways of making a living occur together in an ecosystem, they often occur in groups of three—for example, a small, a medium, and a large mammalian predator. Modern biologists usually interpret this pattern as resulting from which of the following processes?
- A. sympatric speciation and reproductive isolation
 - B. loss of energy passing through trophic levels
 - C. niche differentiation that reduces competition
 - D. geographic and temporal isolation

CONSTRUCTED-RESPONSE ASSIGNMENT DIRECTIONS

For each constructed-response assignment in this section, you are to prepare a written response.

Read each assignment carefully before you begin your response. Think about how you will organize your response. You may use the erasable notebooklet to make notes, write an outline, or otherwise prepare your response. **However, your final response must be either:**

- 1) typed into the on-screen response box,
- 2) written on a response sheet and scanned using the scanner provided at your workstation, or
- 3) provided using both the on-screen response box (for typed text) and a response sheet (for calculations or drawings) that you will scan using the scanner provided at your workstation.

Instructions for scanning your response sheet(s) are available by clicking the “Scanning Help” button at the top of the screen.

Your responses will be evaluated based on the following criteria.

PURPOSE: the extent to which the response addresses the constructed-response assignment's charge in relation to relevant CSET subject matter requirements

SUBJECT MATTER KNOWLEDGE: the application of accurate subject matter knowledge as described in the relevant CSET subject matter requirements

SUPPORT: the appropriateness and quality of the supporting evidence in relation to relevant CSET subject matter requirements

The assignments are intended to assess subject matter knowledge and skills, not writing ability. Your responses, however, must be communicated clearly enough to permit a valid judgment of your knowledge and skills. Your responses should be written for an audience of educators in the field.

Your responses should be your original work, written in your own words, and not copied or paraphrased from some other work. Please write legibly when using the response sheets. You may not use any reference materials during the testing session. Remember to review your work and make any changes you think will improve your responses.

Any time spent responding to an assignment, including scanning the response sheet(s), is part of your testing time. Monitor your time carefully. When your testing time expires, a pop-up message will appear on-screen indicating the conclusion of your test session. Only response sheets that are scanned before you end your test or before time has expired will be scored. Any response sheet that is not scanned before testing ends will NOT be scored.

16. **Complete the exercise that follows.**

In order for cells to carry out required life processes, there must be an exchange of materials between cells and their environment. This movement of molecules is regulated by the cell membrane, and there are a variety of mechanisms by which transport across the membrane occurs.

Using your knowledge of the structure and function of cell membranes and transport processes:

- identify two structural characteristics of a molecule that affect whether or not it will pass through a semipermeable membrane, and explain why they are important;
- discuss the role of concentration gradients with respect to the process of molecular movement across cell membranes; and
- describe a mechanism for moving molecules across cell membranes that does not involve concentration gradients.

17. Use the diagrams below to complete the exercise that follows.



A long-term ecological study surveyed an area of open ocean in which the primary producers are phytoplankton and the primary consumers are zooplankton. The diagrams above represent the results of that study.

Using your knowledge of ecosystems and your ability to interpret scientific information:

- explain how these types of diagrams are interpreted and describe the type of information they contain;
- identify a possible reason for the difference in shape between the productivity and the biomass diagrams; and
- explain why diagrams representing energy use never have the inverted shape shown in the biomass diagram but instead always have a pyramid shape.

18. Complete the exercise that follows.

Transgenic crop plants have been developed through genetic engineering to increase yield; improve quality; and confer resistance to herbicides, insect pests, and viral and fungal pathogens. The rapid adoption of these crops has raised concerns among biologists, health professionals, and the general public.

Using your knowledge of genetic engineering and plant ecology:

- briefly explain how genes from one species are transferred to another species; and
- describe two problems that could result from the widespread use of these crops.

Annotated Responses to Sample Multiple-Choice Questions for CSET: Science Subtest II: Life Sciences

1. **Correct Response: C.** (SMR Code: 1.1b) The distinct three-dimensional arrangement of proteins on the viral coat plays a critical role in how viruses recognize their host cells. The protein "key" of each type of virus has a different shape, which fits specific, corresponding "locks" on certain cell surfaces. As a result, the types of cells a particular virus can infect are limited, sometimes to a single species. Cells of different species and different types of cells within a particular organism have distinct specific "locks" on their surfaces.
2. **Correct Response: C.** (SMR Code: 1.2d) When damage occurs to tissues, such as from a scratch or by entry of pathogens, the damaged cells release histamine. The histamine triggers capillary dilation and increased capillary permeability, resulting in localized redness and swelling. Phagocytes in the blood, responding to the increased capillary blood flow and permeability, migrate to the site of injury, where they engulf and destroy pathogens.
3. **Correct Response: D.** (SMR Code: 1.3c) During the early stage of mitotic prophase, the chromatin condenses into chromosomes that are visible when cells are viewed under a light microscope. Also during prophase, the spindle begins to form, the nucleolus disappears, and the nuclear membrane begins breaking up.
4. **Correct Response: B.** (SMR Code: 1.4c) The energy released from the catabolism of macromolecules, such as fats and carbohydrates, comes from the breaking of bonds. Fats contain long carbon chains with many carbon-hydrogen bonds. The same mass of carbohydrates contains fewer of these types of bonds, so the energy yielded during catabolism is less for carbohydrates than for fats.
5. **Correct Response: A.** (SMR Code: 2.1b) Organisms that provide little or no care for their offspring usually have high mortality rates for the young due to predators and environmental factors. Once the offspring mature to a certain stage, however, the probability of survival improves. For example, mating shellfish may produce thousands of larvae, most of which soon die, but for the small minority that survive long enough to develop a shell, the odds of surviving to an older age improve.
6. **Correct Response: A.** (SMR Code: 2.1c) Commensalism describes an ecological relationship between two species in which one species benefits from the relationship and the other species derives neither benefit nor harm. The relationship between barnacles and whales is an example of commensalism because the whale provides a means of increasing the barnacles' access to food sources, and the presence of the barnacles does not affect the whale either negatively or positively.
7. **Correct Response: C.** (SMR Code: 2.2a) Effective nutrient cycling depends on balancing the exchange of essential nutrients that move through the bodies of organisms at all trophic levels. If the rate of production, consumption, or decomposition is not balanced with respect to the other processes, recycling in the whole system can be hampered by a deficiency of a single limiting nutrient. For example, if plants remove nitrogen from the soil more quickly than it is returned, the productivity of the entire system can be reduced. This results in reduced consumption and ultimately reduced decomposition. Thus, less nitrogen is returned to the soil.
8. **Correct Response: D.** (SMR Code: 2.3a) A keystone species is an organism that plays a crucial ecological role in the functioning of an ecosystem. The significance of the keystone species is not based on its abundance but rather its relationship with the other organisms in the community. For example, hummingbirds are a keystone species in some desert communities. The removal of the hummingbirds, which pollinate native cacti, results in the establishment of invasive species of grasses.

9. **Correct Response: B.** (SMR Code: 3.1b) Research has shown that differences in cells in an organism arise not from genetic differences, but because different types of cells express different portions of the same genetic material. That being the case, a somatic cell from any part of an organism should theoretically contain all of the genetic information necessary to form all parts of the organism. Researchers demonstrated this by successfully cloning a sheep using mammary gland cells. Although these cells were specialized in the adult sheep, they were able to provide all the information necessary to produce a sheep.
10. **Correct Response: A.** (SMR Code: 3.1d) Nondisjunction occurs when homologous chromosomes fail to move apart during meiosis I or sister chromatids do not separate during meiosis II. This results in a gamete with two copies of a particular chromosome and another gamete with no copies of that chromosome. If the gamete with two copies joins with a normal gamete that has one copy of the chromosome, the offspring will have three copies of the chromosome rather than the normal two copies. An offspring resulting from the joining of the gamete with no copy of the chromosome and a normal gamete will have only one copy of the chromosome in its cells.
11. **Correct Response: A.** (SMR Code: 3.2d) A harmful dominant allele is expressed in the phenotype, even in heterozygotes, and is usually removed from the gene pool through natural selection. A recessive allele, however, does not manifest itself unless an individual is homozygous recessive. Heterozygous individuals will not express the harmful trait, so natural selection does not select against them, even though they carry the harmful allele.
12. **Correct Response: B.** (SMR Code: 4.1d) In convergent evolution, organisms of two species that are not closely related, but experience similar environmental pressures, may evolve body parts that look similar and have similar functions. An example of such structures are the wings of a bird and the wings of a bat, both used for flight. However, using this similarity in form and function in the creation of a phylogenetic tree may not result in an accurate portrayal of the evolutionary relatedness between these two organisms.
13. **Correct Response: D.** (SMR Code: 4.2e) In animals, sympatric speciation, the development of separate species from a single species in a given geographic area, results when the random flow of genes in a population is interrupted by non-random mating. The preferential selection of mates based on beak size results in reproductive isolation of parts of the population, which could allow for speciation over time.
14. **Correct Response: A.** (SMR Code: 4.2e) The best explanation for the difference in the genetic diversity of the two populations is that the northern elephant seal population went through a recent reduction in size. Such bottlenecks usually result in decreased genetic diversity, because the small surviving population is unlikely to be genetically representative of the original population. During the population reduction, some alleles may have been eliminated completely from the population.
15. **Correct Response: C.** (SMR Code: 4.3a) Similar species of organisms can coexist in a community as long as there is some degree of resource partitioning. In this case, a difference in body size likely allows these mammalian predators to prey on different species, thus dividing up the available resources.

Examples of Strong Responses to Sample Constructed-Response Questions for CSET: Science Subtest II: Life Sciences

Question #16 (Score Point 3 Response)

Two structural components that affect whether or not a molecule will pass through a semipermeable membrane are:

1. Particle size.

Smaller particles have an easier time crossing the membrane, and larger molecules cannot cross the membrane. This is important because smaller particles such as water can pass through the membrane while larger particles are unable to do so. Thus, the cell can obtain small nutrient compounds needed and dispose of small waste compounds, while protecting itself from foreign genetic material such as foreign RNA and foreign DNA from easily entering the cell and altering the genetic composition of the cell.

2. Particle charge.

Non-polar particles without an ionic nature can cross the membrane while charged/ionic particles cannot cross the membrane. This is incredibly important, as the maintenance and use of electrochemical gradients across a cellular membrane are of vital importance to all cells, though most easily noticeable with such cell types as muscles and neurons. This readily allows the movement of non-ionic particles such as water while retaining precise control over the movement of the particles involved in the electrochemical gradients.

Concentration gradients drive the movement of particles from areas of high concentration to low concentration through the process known as diffusion. Diffusion allows the movement of nutrients in high concentration outside the cell to an area of low concentration inside the cell across the membrane and down the gradient. This also allows the movement of waste particles in high concentration inside the cell to low concentration outside the cell. This is a natural process requiring no addition of energy to the system.

One mechanism for moving molecules across cell membranes that does not involve concentration gradients is the use of active transport using a source of energy such as ATP to directly pump molecules across the membrane.

Question #17 (Score Point 3 Response)

Each level of the diagram represents a different trophic level of the ecosystem with producers at the base and progressing upward through primary, secondary, and tertiary consumers. The width of each level shows the relative value for that level in terms of energy consumption, biomass, or number of organisms. These diagrams illustrate the relationships among the trophic levels.

Trophic-level diagrams of biomass and energy are pyramidal because of the energy loss at each level as one progresses from the producer levels through the consumer levels. Less energy usually produces less biomass. The inverted shape of the biomass diagram is due to the rapid reproduction rate of phytoplankton and the rapid consumption by the zooplankton, the latter also having a longer lifespan than the former. The pyramidal shape of energy diagrams is due to the fact that the organisms at each trophic level use approximately 90% of the available energy for their own metabolic needs. Also, as much energy is lost as heat at each level.

Question #18 (Score Point 3 Response)

Transferring genes from one species of plant to another species in order to develop stronger, healthier plants is a new technology that has both supporters and detractors.

The technology consists of transferring the DNA for a trait from one species to another that does not have that trait; for example, a resistance to insect pests. This can be done by directly inserting the desired genetic material by using a bacterial vector or gene gun, and a promoter gene from a virus, which will activate the inserted gene in the host plant. Then selective breeding will establish that the introduced traits are in a viable crop.

The problems that trouble detractors are the unintended consequences such as might result from creating new species that have not evolved in nature. These might be things such as superweeds or organisms that have no natural enemies.

Scoring Information for CSET: Science Subtest II: Life Sciences

Responses to the multiple-choice questions are scored electronically. Scores are based on the number of questions answered correctly. There is no penalty for guessing.

There are three constructed-response questions in Subtest II: Life Sciences of CSET: Science. Each of these constructed-response questions is designed so that a response can be completed within a short amount of time—approximately 10–15 minutes. Responses to constructed-response questions are scored by qualified California educators using focused holistic scoring. Scorers will judge the overall effectiveness of your responses while focusing on the performance characteristics that have been identified as important for this subtest (see below). Each response will be assigned a score based on an approved scoring scale (see page 17).

Your performance on the subtest will be evaluated against a standard determined by the Commission on Teacher Credentialing based on professional judgments and recommendations of California educators.

Performance Characteristics for CSET: Science Subtest II: Life Sciences

The following performance characteristics will guide the scoring of responses to the constructed-response questions on CSET: Science Subtest II: Life Sciences.

| | |
|---------------------------------|---|
| PURPOSE | The extent to which the response addresses the constructed-response assignment's charge in relation to relevant CSET subject matter requirements. |
| SUBJECT MATTER KNOWLEDGE | The application of accurate subject matter knowledge as described in the relevant CSET subject matter requirements. |
| SUPPORT | The appropriateness and quality of the supporting evidence in relation to relevant CSET subject matter requirements. |

Scoring Scale for CSET: Science Subtest II: Life Sciences

Scores will be assigned to each response to the constructed-response questions on CSET: Science Subtest II: Life Sciences according to the following scoring scale.

| SCORE POINT | SCORE POINT DESCRIPTION |
|-------------|---|
| 3 | <p>The "3" response reflects a command of the relevant knowledge and skills as defined in the subject matter requirements for CSET: Science.</p> <ul style="list-style-type: none"> • The purpose of the assignment is fully achieved. • There is an accurate application of relevant subject matter knowledge. • There is appropriate and specific relevant supporting evidence. |
| 2 | <p>The "2" response reflects a general command of the relevant knowledge and skills as defined in the subject matter requirements for CSET: Science.</p> <ul style="list-style-type: none"> • The purpose of the assignment is largely achieved. • There is a largely accurate application of relevant subject matter knowledge. • There is acceptable relevant supporting evidence. |
| 1 | <p>The "1" response reflects a limited or no command of the relevant knowledge and skills as defined in subject matter requirements for CSET: Science.</p> <ul style="list-style-type: none"> • The purpose of the assignment is only partially or not achieved. • There is limited or no application of relevant subject matter knowledge. • There is little or no relevant supporting evidence. |
| U | <p>The "U" (Unscorable) is assigned to a response that is unrelated to the assignment, illegible, primarily in a language other than English, or does not contain a sufficient amount of original work to score.</p> |
| B | <p>The "B" (Blank) is assigned to a response that is blank.</p> |