



California
Subject
Examinations for
Teachers®

TEST GUIDE

SCIENCE SUBTEST III: BIOLOGY/LIFE SCIENCE

Sample Questions and Responses and Scoring Information

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CS-TG-QR120X-04

Sample Test Questions for CSET: Science Subtest III: Biology/Life Science

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 III: Biology/Life Science. 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 General Science Subtests I and II, as well as the specialty subtests of Biology/Life Science, Chemistry, Earth and Planetary Science, 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. A primary function of gap junctions between cell membranes is to:
 - A. integrate the metabolic or electrical activity of a group of cells through permeable channels.
 - B. allow all surfaces of a functional unit of cells to contact the extra-cellular matrix.
 - C. permit the exchange of genetic information between adjacent cells.
 - D. reinforce the structural cohesion of cells that form a particular tissue.

3. Which of the following 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.
4. 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.
5. What is the role of helper T cells in the function of the human immune system?
- A. to lyse and destroy infected cells for removal from the body
 - B. to generate B cells for the production of antibodies
 - C. to mobilize both the humoral and cell-mediated responses to antigens
 - D. to distinguish an antigen from a normally occurring substance in the body

6. The ability to identify particular loci associated with a given genetic trait has the greatest implications for which of the following areas of medicine?
- A. assistive reproductive technologies
 - B. screening for hereditary diseases
 - C. diagnosis of cardiopulmonary diseases
 - D. DNA replication technologies
7. 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
8. Which of the following examples best illustrates the idea that differential gene expression accounts for specialization of cells in multicellular organisms rather than 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.
9. Genetic engineering has the potential to correct some human genetic diseases in individuals. In gene therapy, a defective gene is replaced or supplemented by using a genetically engineered retrovirus to insert a normal gene in the DNA of some of the patient's cells. This treatment will be most successful if the retrovirus is inserted into cells that:
- A. are found throughout the body rather than in one specific organ.
 - B. are recycled after death rather than removed from the body.
 - C. continue to divide during the life of the patient.
 - D. carry out one specific function rather than multiple functions.

10. 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.
11. 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.

12. A species of finch on an island is divided into two distinct morphs based on bill size. Finches with large bills eat mostly large, hard-shelled seeds of a particular plant, while finches with small bills eat smaller, softer seeds of a different plant. A smaller number of finches with bills 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 bills increases relative to that of finches with large or small bills.
 - 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 bill size similar to their own.

13. 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.

14. **Use the passage below to answer the question that follows.**

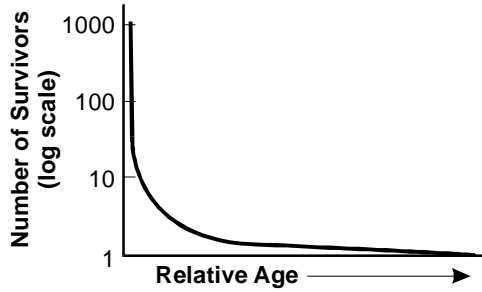
Brown-headed cowbirds are members of the blackbird family that lay their eggs in other birds' nests. Usually a single egg is laid in the nest of a smaller species. The egg hatches sooner than those of the host species, and after it hatches, the baby cowbird often pushes the other eggs out of the nest. The cowbird is then raised by the foster parents, whom it often dwarfs in size.

The relationship between the brown-headed cowbird and its host species is an example of:

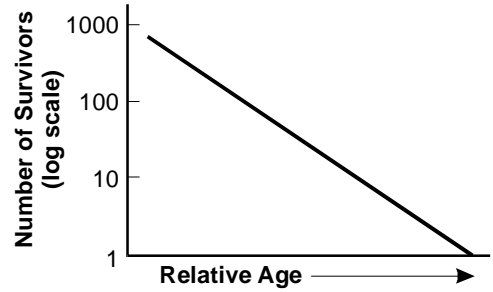
- A. competition.
- B. predation.
- C. commensalism.
- D. parasitism.

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

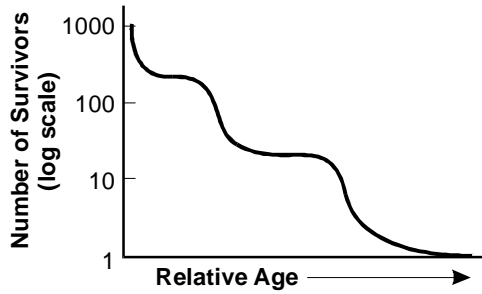
A.



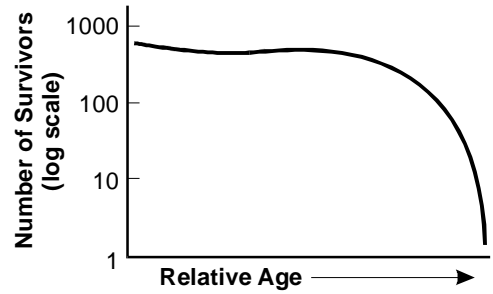
B.



C.



D.



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.**

An animal cell with a diploid chromosome number of 4 is just about to begin mitosis.

Using your knowledge of cell biology and mitosis:

- draw diagrams showing the cell at each of the distinct stages of mitosis in order, and label which stage each diagram represents; and
- for each stage, list two characteristic events that occur during that stage of mitosis.

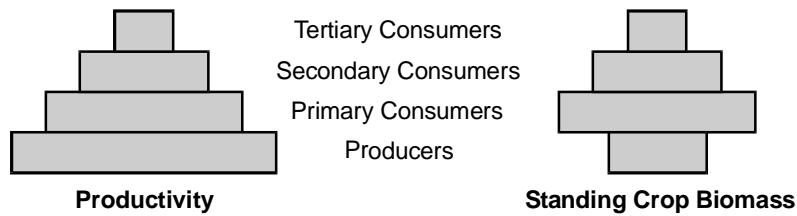
17. **Complete the exercise that follows.**

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.

18. 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:

- 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.

Annotated Responses to Sample Multiple-Choice Questions for CSET: Science Subtest III: Biology/Life Science

Cell Biology and Physiology

1. **Correct Response: C.** (SMR Code: 1.1) 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: A.** (SMR Code: 1.3) Gap junctions are pores that connect the cytoplasm of neighboring cells. The pores permit passage of ions, sugars, and other small molecules, allowing cells to communicate chemically with one another. In this way, the metabolic or electrical activity of cells in specific tissues and organs can be integrated and coordinated.
3. **Correct Response: B.** (SMR Code: 1.3) 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.
4. **Correct Response: C.** (SMR Code: 1.5) 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.
5. **Correct Response: C.** (SMR Code: 1.5) Helper T cells are central components in the human immune system. These cells recognize the presence of antigens in pathogen-consuming macrophages and then stimulate both B cells and other T cells into activity. B cells mobilize against pathogens in the blood and lymph (humoral response), while other T cells target pathogens in infected cells (cell-mediated response).

Genetics

6. **Correct Response: B.** (SMR Code: 2.1) The ability to locate a known gene on a chromosome may provide better methods of screening for hereditary diseases. Once the gene associated with a particular hereditary disease is mapped and the gene's DNA sequence known, DNA can be analyzed for patterns associated with the disease.
7. **Correct Response: A.** (SMR Code: 2.2) 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.

8. **Correct Response: B.** (SMR Code: 2.3) 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 cell from any part of an organism should theoretically contain all of the genetic information necessary to form all parts of the organism. Researchers recently 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.
9. **Correct Response: C.** (SMR Code: 2.4) For gene therapy to be long lasting, the retrovirus carrying the normal gene should be inserted into cells that continue to divide. This will allow the transplanted normal gene to be replicated, increasing the chances that the benefits of the therapy will last for the lifetime of the patient.

Evolution

10. **Correct Response: A.** (SMR Code: 3.1) 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.
11. **Correct Response: A.** (SMR Code: 3.2) 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.
12. **Correct Response: D.** (SMR Code: 3.3) 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 bill size results in reproductive isolation of parts of the population, which could allow for speciation over time.

Ecology

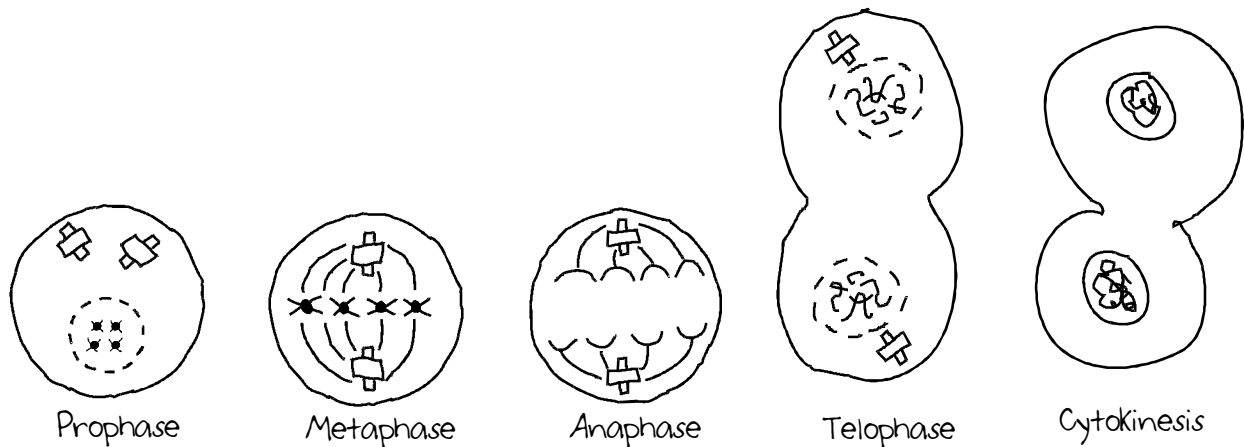
13. **Correct Response: C.** (SMR Code: 4.2) Effective nutrient cycling depends on balancing the exchange of essential nutrients that move through the bodies of organisms at all trophic levels. If the rate of production, consumption, or decomposition is not balanced with respect to the other processes, 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.
14. **Correct Response: D.** (SMR Code: 4.3) Parasitism is a type of relationship between two different species in which one species benefits at the expense of the other. Parasites usually impair, but do not kill their hosts, since killing their hosts would be detrimental to the parasite. In this example, the cowbirds exploit the nurturing instincts of other birds that are unable to distinguish between their real offspring and the parasite. While the cowbird benefits, the host birds are harmed in that energy and resources are being used to increase the survival chances of organisms that will not pass on the host's genetic information.

15. **Correct Response: A.** (SMR Code: 4.3) 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.

Examples of Strong Responses to Sample Constructed-Response Questions for CSET: Science Subtest III: Biology/Life Science

Cell Biology and Physiology

Question #16 (Score Point 3 Response)



Prophase - 1st active stage of mitosis

a) nuclear membrane breaks down

b) replicated chromosomes shorten and coil and become visible

Metaphase - chromosomes attach to spindle fibers at centromere

chromosomes line up singly and perpendicular to spindle fibers on equatorial plate

Anaphase - (a) spindles shorten

(b) chromosomes move to opposite ends of cell

Telophase - chromosomes reach opposite ends of cell

nuclear membrane reforms around each group of chromosomes

Cytokinesis: cell membrane indentation complete and division of cytoplasm is complete

Genetics

Question #17 (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.

Ecology

Question #18 (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.

Scoring Information for CSET: Science Subtest III: Biology/Life Science

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 III: Biology/Life Science 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 18).

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 III: Biology/Life Science

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

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 III: Biology/Life Science

Scores will be assigned to each response to the constructed-response questions on CSET: Science Subtest III: Biology/Life Science 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>