AP® Biology
2005 Scoring Commentary

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Question 1

Overview

The intent of this question was to test students' ability to construct a graph, interpret the role of enzymes in respiration, and design a feasible controlled experiment. Students were asked to analyze data from the graph and to determine the optimal temperature for respiration. Additionally, they had to demonstrate knowledge of how temperature related to the results that were described.

Sample: 1A
Score: 10

In part (a) 3 points were earned for setup of the graph (title and correct labeling of the X and Y axes with correct units and scaling) (1 point), for the correct plotting of points with the graph in the proper orientation (1 point), and for identifying the optimum temperature (1 point). In part (b) 4 points were earned for giving an analysis of results by describing the increase and decrease of the gas bubbles on either side of the optimum (1 point), for explaining structure/function relationship of lowering the energy of activation and induced fit of substrate and enzyme (1 point), for linking below optimal temperature to increasing kinetic energy with an increase in gas bubbles as a function of rising temperature (1point), and for explaining that denaturation is a result of high temperature resulting in breaking of ionic and H bonds and Van Der Waals forces or attractions, thereby altering structure (1 point). In part (c) 3 points were earned for a reasonable design indicating the range of pH/independent variable (1 point), description of the control (1 point), and measurement of product per unit time (1 point). An additional point could have been awarded for repetition of the experiment.

Sample: 1B
Score: 7

In part (a) 3 points were earned for setup of the graph (title and correct labeling of the X and Y axes with correct units and scaling) (1 point), for the correct plotting of points with the graph in the proper orientation (1 point), and for identifying the optimum temperature (1 point). In part (b) 2 points were earned for analysis of the result and explanation of hydrogen bonds breaking (1 point) and change in structure as a result of above optimum temperature related to the experiment (1 point). In part (c) the response describes a reasonable design that includes an organism and sugar solutions at variable pH. One point was earned for pH range (independent variable) and 1 point for indicating a specific pH for the prediction.

Sample: 1C
Score: 5

In part (a) 1 point was earned for accuracy of the data plotting; the shape and orientation of the graph are correct. The optimum temperature is not initially identified but is identified and described correctly as the maximum on the second page (1 point). In part (b) 3 points were earned for analysis concerning the amount of bubbles increasing to 30°C and then decreasing (1 point), independent variable/range of pH (1 point), and measuring product per minute (1 point). In part (c) no points were earned.

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Question 2

Overview

The intent of this question was to allow students to demonstrate knowledge of the eukaryotic chromosome by describing the structure and function of its components (part [a]), explaining the evolutionary significance of organizing genes into chromosomes (part [b]), and discussing differences in the function and structure of the prokaryotic chromosome and the eukaryotic chromosome (part [c]). Parts (a) and (c) were concerned with chromosomal, rather than cellular, structure and function, while part (b) required applying knowledge of the structure and function of chromosomes to the evolutionary significance. In part (a) students were expected to describe, not simply name, the parts of a eukaryotic chromosome. They could approach this task from any level of organization (molecular, chromatin form, and/or metaphase chromosome). The structure and function points were not linked; students could earn their points from any combination of structural and/or functional descriptions, but they could not earn more than 1 point from either the structure or the function of the chromatin form. Part (b) required students to synthesize information across several areas of the curriculum. They could not earn points for simply stating that variation could be increased by crossing over or by independent assortment without a brief description of the mechanism.

Sample: 2A
Score: 10

In part (a) the response earned the maximum 5 points for identifying the structure and function of the nucleosome (2 points), for explaining that the chromosome is composed of two sister chromatids joined by the centromere (2 points), and for noting DNA codes for proteins (1 point). Additional points could have been awarded for euchromatin and kinetochores. In part (b) 1 point was earned for stating that organizing genes into chromosomes allows for genetic variation. The description of crossing over earned 1 point. In part (c) 1 point was awarded for prokaryotes lacking histones, 1 point for operons as regulators of gene expression, and 1 point for the chromosome shape being circular. An additional point could have been awarded for prokaryotes having less repetitive DNA and only having exons.

Sample: 2B
Score: 8

In part (a) the response earned 4 points: 1 point for the nucleosome structure, 1 point for the centromere function, 1 point for chromatid structure, and 1 point for spindle fibers attaching to the kinetochores. Efficiency of transfer of genetic information earned 1 point in part (b), even though it was described in the first paragraph. A second point for part (b) was earned for genetic variation. In part (c) the student earned 1 point for the shape of the chromosome and 1 point for one origin of replication.

Sample: 2C
Score: 6

In part (a) the essay earned 1 point for the nucleosome structure, stating that DNA is wrapped around proteins, 1 point for the description of the chromatin structure, and 1 point for the chromatin function in gene expression. The student earned 2 points in part (b) for stating that the DNA is more condensed and tightly packed, taking up less space (1 point), and for genetic variation (1 point). In part (c) 1 point was earned for prokaryotic DNA lacking introns (noncoding) sequences.

Question 3

Overview

The main focus of this question was the evolution of life cycles and reproductive strategies in plants. In part (a) students were asked to describe four angiosperm structures involved in reproduction and the evolutionary significance of each. The scoring guideline took a broad perspective, accepting not only the four modified whorls of leaves that form the sepals, petals, stamens, and carpels of a flower, but also seeds and fruits. Students could also use more specific reproductive structure examples, such as the stigma, style, and ovary. Since each specific structure has its own adaptive significance, the guideline offered the student a large number of possible ways to earn points. Part (b) asked how the anatomy and reproductive strategies for mosses limit their distribution, which pointed students in the direction of the role of water in the bryophyte life cycle. Part (c) required an explanation of alternation of generations in angiosperms or mosses. Although students could choose either group of plants, all plant types share a common life cycle. Therefore, the scoring guideline was applicable to either student choice, as it stressed the basic biological processes of fertilization and meiosis in the formation of sporophytes and gametophytes. An additional point could have been earned for a more detailed explanation of the specific life cycle chosen.

Sample: 3A
Score: 10

This response earned the maximum score of 6 points in part (a) for the structure/function of the stigma (1 point), the style (1 point), and the petal (1 point). Evolutionary significance points were earned for the stigma (1 point), style (1 point), and pollen (1 point). In part (b) an explanation is given for how each of two characteristics of mosses would limit their distribution. The two characteristics identified are lack of vascular tissue for water and nutrient acquisition (1 point) and dependence on swimming sperm (1 point). In part (c) 2 points were earned for correctly describing haploid/diploid (1 point) and gametophyte/sporophyte generations (1 point). These concepts are spread over several sentences but still earned the points. Additional points could have been earned for the roles of mitosis, meiosis, and fertilization.

Sample: 3B
Score: 7

Six points were earned in part (a), no points in part (b), and 1 point in part (c). In part (a) points were earned for the proper structure and function of stamen (1 point), flowers (1 point), and fruits (1 point) and for the evolutionary significance of pollen (1 point), flowers (1 point), and fruits (1 point). An additional point could have been awarded for the structure and function of seeds, but the internal maximum had already been reached. There were no points earned in part (b). In part (c) 1 point was earned for the haploid/diploid alternation in angiosperm life cycles.

Question 3 (continued)

Sample: 3C
Score: 6

The response earned 4 points in part (a) and 2 points in part (c). In part (a) points were earned for the structure/function of seeds (1 point), pollen (1 point), flowers (1 point), and fruit (1 point). No points were earned for the adaptive significance portion of the question. In part (b) the focus of the response was on angiosperm anatomy instead of bryophyte anatomy, and thus no points were earned. In part (c) the response was awarded 1 point for haploid/diploid and 1 point for gametophyte/sporophyte generations. A third point could not be awarded because the student confuses the meaning of dominance in life cycles with that of dominance in genetic expression.

Question 4

Overview

This question required students to recall specific processes that are found in the immune system in vertebrates. Four independent parts of the questions were presented in a bulleted fashion, and students needed to answer only three of the four options. The first option was an explanation of how the nonspecific immune response functions; for the second option, students were asked to relate how T and B cells are activated in response to an infection; the third option asked how vertebrates respond to a later exposure to the same infectious agent; and the fourth option asked students to describe how a vertebrate distinguishes self from nonself.

Sample: 4A
Score: 10

In addressing the first topic, the response earned a total of 4 points by describing how "dilation of the capillaries … provides more blood" to the injury (1 point) and stating that macrophages consume "foreign particles" (1 point). The word "consuming" was accepted as a synonym for engulfing or phagocytosis. Additional points were earned for describing how a blood clot seals a wound by forming a physical barrier (1 point) and for explaining the role of mucus in washing away pathogens (1 point). In addressing the second topic, the response earned 4 points for the following: macrophages become antigen-presenting cells (1 point), helper T cells bind to the MHC-II (1 point), antigen-presenting cells activate helper T cells (1 point), and interleukins stimulate B cells (1 point). An additional point could have been earned for stating that B cells produce antibodies specific to the antigen, but the internal maximum had already been reached. In addressing the third topic, the essay earned 2 points for: the response is faster (1 point), and it is mediated by memory cells (1 point). An additional point could have been earned for stating that memory cells are specific to the previous antigen.

Sample: 4B
Score: 8

In addressing the first topic, the student earned 1 point for explaining how skin acts as a physical barrier and 1 point for an elaboration of how mucous membranes also act as a barrier. The description of phagocytosis and information on how the inflammatory response brings more blood and phagocytes to the site of the injury each earned 1 point. In addressing the second topic, the student demonstrates a good understanding of the immune system but does not fully address the question on how T and B cells are activated. One point was awarded for stating that "B cells make the antibodies." In addressing the third topic, points were earned for describing memory cells (1 point) and their specificity for antigens previously encountered (1 point). Another point was earned because the student indicates (in the last sentence) that the antibody concentration is much higher ("millions of antibodies").

Sample: 4C
Score: 6

In addressing the first topic, the response earned 1 point for describing phagocytosis by macrophages. In addressing the second topic, the response earned 1 point for identifying memory cells and 1 point for indicating that they are long lived. A point was earned for identifying that the secondary immune response is faster. In addressing the fourth topic, the response earned 1 point for information about unique tags and 1 point for giving a description of self/nonself incompatibility.