CollegeBoard
Advanced Placement Program

Student Performance Q&A:

2007 AP® Biology Free-Response Questions

The following comments on the 2007 free-response questions for AP® Biology were assembled by the Chief Reader, John Lepri of the University of North Carolina at Greensboro. They give an overview of each free-response question and of how students performed on the question, including typical student errors. General comments regarding the skills and content that students frequently have the most problems with are included. Some suggestions for improving student performance in these areas are also provided. Teachers are encouraged to attend a College Board workshop to learn strategies for improving student performance in specific areas.

Question 1

What was the intent of this question?

The intent of this question was to assess students' understanding of membrane structure and function. The two-part question asked them to describe the structure and function of macromolecular components of the plasma membrane and to discuss the role of membranes in several cellular and biological processes.

How well did students perform on this question?

Students could earn a maximum of 6 points in part (a) and a maximum of 6 points in part (b). Most were able to describe two of the macromolecular membrane components, usually phospholipids and proteins, and the chemiosmotic production of ATP. The mean was 3.58 out of 10 possible points.

What were common student errors or omissions?

Although the question asked specifically about the plasma membrane, some students dicussed the membranes of organelles. Many were able to describe chemiosmosis, but they had difficulty understanding membrane involvement in muscle contraction and egg fertilization. Students discussed neuronal function within cells in great detail; however, because the question asked about intercellular signaling, this did not earn points unless the student described synaptic events, which occur between two cells. Quite a few understood the interaction between actin and myosin during muscle contraction but could not connect membrane involvement to the process. Many students included superfluous information about various other processes, such as a description of mitosis in egg fertilization.

Based on your experience of student responses at the AP Reading, what message would you like to send to teachers that might help them to improve the performance of their students on the exam?

Concerning this particular topic, teachers should emphasize the utility of membranes in many cellular processes and how plasma membrane components work collectively in many biological processes to provide both protection and communication for cells. Generally, they should make it clear that students should not waste precious exam time by repeating the question's introductory sentence in their answers.

Question 2

What was the intent of this question?

This question was designed to measure students' ability to integrate evolution, development, and processes of the nervous system. Part (a) concerned cephalization as it relates to animal diversity, followed in part (b) by embryonic development of the nervous system in vertebrates, and ending in part (c) with a discussion of how the human nervous system responds to a stimulus.

How well did students perform on this question?

Many students earned points only in part (c). Students understood how the nervous system works, but they often answered only in general terms. There were excellent discussions of neuronal structure and depolarization and repolarization of the membrane, the details of changes at the neuromuscular junction and accompanying muscle contraction, or the detailed pathway of sound waves through the ear. Nevertheless, the overall mean was 1.84 out of 10 possible points.

What were common student errors or omissions?

Many students did not understand the different levels of specificity required by the different parts of the question: part (a), various phyla; part (b), vertebrates; part (c), humans. Others were confused by the term "cephalization" and treated it as if it were the same as individual brain development. In some instances, cephalization was confused with other terms, including cell differentiation, segmentation, compartmentalization, socialization, or even civilization. The response to adaptive significance in part (a) often focused on Darwin and natural selection—"survival of the fittest," evolution of reproductive strategies, or the Lamarkian idea that brains developed because we needed them. Some thought that cephalization originated in cephalopods. In part (b) quite a few students thought that the notochord gave rise to the nerve or spinal cord. A significant percentage did not identify the correct germ layer for the origin of the nervous system. Rather than embryonic development, many students focused on fetal development and the ability of the fetus to hear and react to stimuli. They also described brain parts instead of nervous system development, with origins of the brain ranging from the mitochondria to the coelom. In part (c) the reaction to shattering glass was variously described as the result of a fixed action pattern, classical/operant conditioning, learned behavior, habituation, imprinting, instinct, or memory. Many students failed to discuss a mechanism or to use any biological terms relating to the neural pathway. They would start with a signal and continue it from cell to cell and to the muscle without central nervous system involvement. Another major error was confusing the terms "neuron" and "nephron."

Based on your experience of student responses at the AP Reading, what message would you like to send to teachers that might help them to improve the performance of their students on the exam?

Teachers should encourage students to use the reading period to determine what information is given versus what they are asked to explain, and to make an outline of their intended response. Tell them not to restate the question, but do stress the use of scientific terminology in explanations. In addition, remind students to use specific examples, as applicable.

Another possible consideration might be to teach animal diversity (evolutionary history with invertebrates and vertebrates) in conjunction with the comparison of evolutionary development of systems rather than each system in isolation. This approach would require planning for the coordination of both textbook reading selections and lecture presentations.

Question 3

What was the intent of this question?

This question's purpose was to evaluate students' ability to combine ecological concepts with basic plant physiology and to make an evolutionary connection. Part (a) asked how certain abiotic factors limited productivity in a desert biome. Part (b) asked students to describe a four-organism food chain and to identify each trophic level. Part (c) required an interpretation of a graph showing the carbon dioxide uptake patterns of two different desert plants. Students were expected to relate those uptake differences to an anatomical and physiological difference between the two plants. Lastly, students were asked to discuss the evolutionary significance of each of the differences they chose in the previous section of the question.

How well did students perform on this question?

The scoring guidelines provided 13 ways to earn up to 10 points. The mean for this question was 3.43. Most students attempted to answer the question, and the majority scored at least a few points in the graph interpretation and the food chain portion. Many were able to relate the graphs to a physiological difference between the two types of plants, but anatomical differences posed more of a problem.

What were common student errors or omissions?

In part (a) many students failed to link their description of the abiotic factor to *how* that factor affects productivity. They often stated that because of harsh desert conditions plants could not grow there, ignoring the many types of desert plants. In part (b) the most frequent errors were omitting or incorrectly identifying the trophic levels. In part (c) some students interpreted the graphs as representing animal species. Some discussed temperature or day length instead of carbon dioxide uptake and time. Others reversed species *A* and *B*, stating that plant *A* performed photosynthesis in the daytime and that plant *B* photosynthesized at night. A number of students launched into a discussion of photoperiodism in this portion of the question. Many confused the metabolic differences between C3, C4, and CAM plants. The weakest area of performance was the discussion of the evolutionary significance of the plant differences. Very few students related anatomy and physiology to selective advantage and improved reproductive success.

Based on your experience of student responses at the AP Reading, what message would you like to send to teachers that might help them to improve the performance of their students on the exam?

Students need to practice analyzing and interpreting graphs. Learning to recognize the variables and determining what is being compared in a graph, as well as analyzing what conclusions can genuinely be drawn from graphs are all skills that will serve them well on both essays and multiple-choice questions.

Furthermore, keep in mind that plants must be covered in class. Plants often get "shortchanged" in the curriculum owing to time constraints, despite the fact that the Topic Outline in the *AP Biology Course Description* suggests that 32 percent of the course should be devoted to the "Structure and Function of *Plants* and Animals."

Finally, students need to practice writing essays. Part of that practice should include focusing on what the question is actually asking and outlining a possible response before beginning the actual writing.

Question 4

What was the intent of this question?

The intent of this question was to test students' ability to describe biotechnology techniques and interpret the data obtained using these techniques. Students needed a working understanding of Lab 6 recommended in the Course Description (bacterial transformation and gel electrophoresis analysis) to adequately answer the question. In addition, they had to apply critical-thinking skills to the task of using the gel electrophoresis data to construct and explain their restriction map in part (a). Part (b) of the question required students to explain the essential steps used to insert a gene of interest into a bacterium. In addition, they were asked to describe how these recombinant bacteria could be identified and how the expression of the gene could be ensured. Part (c) addressed the application of biotechnology to genetically modified organisms (GMOs). Students were expected to name a specific GMO with an identified modified trait and discuss how it would be both beneficial to humans and a potential threat to a population or ecosystem.

How well did students perform on this question?

Many students did not attempt to construct the restriction map in part (a). Most of those who did try it did not earn the 2 points for a correct response. In part (b) they frequently knew that restriction enzymes are used to cut DNA, and quite a few were able to describe the basic steps required to insert a gene into a bacterium, usually by means of a plasmid. Heat shock, ligase, and using the same enzyme were steps generally understood. Fewer students were able to describe a method of identifying the recombinants or ensuring gene expression. In part (c) most students attempted to discuss GMOs; however, many failed to identify a specific organism, as the question required. The mean score for this question was 2.52 out of a possible 10 points.

What were common student errors or omissions?

Most students did not attempt, or made a poor attempt, to construct the restriction map. They stated that they did not know what to do with the circle, and many drew the electrophoresis gel bands in the plasmid (circle) given. They could not earn points for a description of gel electrophoresis, but some spent valuable time doing so. Although most students knew that restriction enzymes “cut” DNA, some used the term “splice” as though it meant “to cut.” After isolating the gene of interest, they often described inserting it in the bacteria’s genomic DNA rather than in the plasmid. Transformation was equated with transduction, transcription, translation, or transpiration. Students did not understand the scale of the materials and equipment used in the lab. Many thought that recombinant plasmids could be seen if dyed, could be examined with a light microscope, or weighed on a scale or balance. Students often failed to earn points in part (c) because they did not name a specific GMO but rather talked in vague terms of the benefits and threats of GMOs in general. Some believed that genetic modification was at times accomplished through spraying with pesticides or hormones. Students were also perplexed about GMOs and natural mutations, hybrids, and selective breeding (e.g., seedless oranges and polyploidy fruit). There was confusion about GMOs and gene therapy as well.

Based on your experience of student responses at the AP Reading, what message would you like to send to teachers that might help them to improve the performance of their students on the exam?

In general, students should be given instruction in how to read questions, heeding the boldface terms and directions. For practice, teachers could have students analyze sample essays and use the AP Biology Scoring Guidelines to determine correct interpretations of exam questions. They also need to stress to students that concise descriptions are quite acceptable in their essays.

Specifically, students should practice the application of restriction mapping of plasmids, or at least work with the concept of plasmids. There was little understanding of the number of cuts required to result in two fragments on a gel. Students must understand gene expression and the role of the promoter, particularly as it applies to the transformation lab. After completing Lab 6, teachers could ask students to demonstrate their understanding of the purposes of the materials and equipment used to conduct the lab. Citing specific examples, as opposed to making very broad and general comments, is another skill that students need to develop. Teachers should use specific examples to explain genetic modification and GMOs (e.g., corn, soybeans, tomatoes, a bacterium such as *E. coli*, pigs, cows, and sheep). Students also need practice with distinguishing cause and effect. Too many of them based their evaluation of good versus bad decisions on “feelings” (e.g., to cure diseases, to create an ideal organism, to help humanity), rather than on good science.