

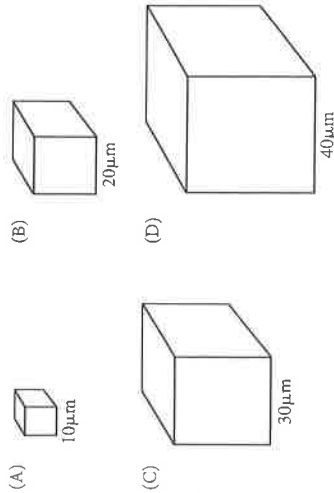
## Sample Multiple-Choice Questions

**Part A Directions:** Each of the questions or incomplete statements below is followed by four suggested answers or completions. Select the answer that is best in each case. When you have completed part A, you should continue on to part B.

- By discharging electric sparks into a laboratory chamber atmosphere that consisted of water vapor, hydrogen gas, methane, and ammonia, Stanley Miller obtained data that showed that a number of organic molecules, including many amino acids, could be synthesized. Miller was attempting to model early Earth conditions as understood in the 1950s. The results of Miller's experiments best support which of the following hypotheses?
  - The molecules essential to life today did not exist at the time Earth was first formed.
  - The molecules essential to life today could not have been carried to the primordial Earth by a comet or meteorite.
  - The molecules essential to life today could have formed under early Earth conditions.
  - The molecules essential to life today were initially self-replicating proteins that were synthesized approximately four billion years ago.

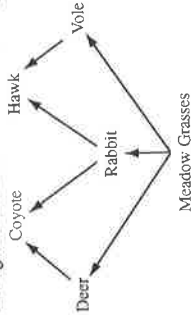
- Simple cuboidal epithelial cells line the ducts of certain human exocrine glands. Various materials are transported into or out of the cells by diffusion. (The formula for the surface area of a cube is  $6 \times S^2$ , and the formula for the volume of a cube is  $S^3$ , where  $S$  = the length of a side of the cube.)
 

Which of the following cube-shaped cells would be most efficient in removing waste by diffusion?



- When DNA replicates, each strand of the original DNA molecule is used as a template for the synthesis of a second, complementary strand. Which of the following figures most accurately illustrates enzyme-mediated synthesis of new DNA at a replication fork?
  - 
  - 
  - 
  -

- The following is a food web for a meadow habitat that occupies  $25.6 \text{ km}^2$ . The primary producers' biomass is uniformly distributed throughout the habitat and totals  $1,500 \text{ kg/km}^2$ .

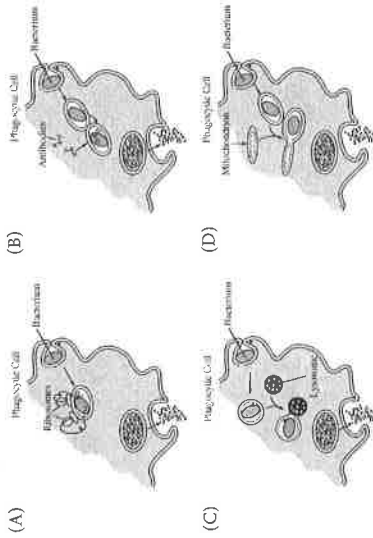


Developers have approved a project that will permanently reduce the primary producers' biomass by 50 percent and remove all rabbits and deer.

Which of the following is the most likely result at the completion of the project?

- The biomass of coyotes will be 6 kg, and the biomass of hawks will be 0.5 kg.
- The biomass of coyotes will be dramatically reduced.
- The coyotes will switch prey preferences and outcompete the hawks.
- There will be 50 percent fewer voles and 90 percent fewer hawks.

- A pathogenic bacterium has been engulfed by a phagocytic cell as part of the nonspecific (innate) immune response. Which of the following illustrations best represents the response?



### Questions 8–10

An experiment to measure the rate of respiration in crickets and mice at  $10^\circ\text{C}$  and  $25^\circ\text{C}$  was performed using a respirometer, an apparatus that measures changes in gas volume. Respiration was measured in mL of  $\text{O}_2$  consumed per gram of organism over several five-minute trials, and the following data were obtained.

Organism	Temperature ( $^\circ\text{C}$ )	Average respiration (mL $\text{O}_2$ /g/min)
Mouse	10	0.0518
Mouse	25	0.0321
Cricket	10	0.0013
Cricket	25	0.0038

- During aerobic cellular respiration, oxygen gas is consumed at the same rate as carbon dioxide gas is produced. In order to provide accurate volumetric measurements of oxygen gas consumption, the experimental setup should include which of the following?
  - A substance that removes carbon dioxide gas
  - A plant to produce oxygen
  - A glucose reserve
  - A valve to release excess water

- According to the data, the mice at  $10^\circ\text{C}$  demonstrated greater oxygen consumption per gram of tissue than did the mice at  $25^\circ\text{C}$ . This is most likely explained by which of the following statements?
  - The mice at  $10^\circ\text{C}$  had a higher rate of ATP production than the mice at  $25^\circ\text{C}$ .
  - The mice at  $10^\circ\text{C}$  had a lower metabolic rate than the mice at  $25^\circ\text{C}$ .
  - The mice at  $25^\circ\text{C}$  weighed less than the mice at  $10^\circ\text{C}$ .
  - The mice at  $25^\circ\text{C}$  were more active than the mice at  $10^\circ\text{C}$ .

- According to the data, the crickets at  $25^\circ\text{C}$  have greater oxygen consumption per gram of tissue than do the crickets at  $10^\circ\text{C}$ . This trend in oxygen consumption is the opposite of that in the mice. The difference in trends in oxygen consumption among crickets and mice is due to their
  - relative size
  - mode of nutrition
  - mode of internal temperature regulation
  - mode of ATP production

- Which of the following statements most directly supports the claim that different species of organisms use different metabolic strategies to meet their energy requirements for growth, reproduction, and homeostasis?
  - During cold periods pond-dwelling animals can increase the number of unsaturated fatty acids in their cell membranes while some plants make antifreeze proteins to prevent ice crystal formation in tissues.
  - Bacteria lack introns while many eukaryotic genes contain many of these intervening sequences.
  - Carnivores have more teeth that are specialized for ripping food while herbivores have more teeth that are specialized for grinding food.
  - Plants generally use starch molecules for storage while animals use glycogen and fats for storage.

14. The most probable cause for the difference in mean stem length between plants in dish A and plants in dish B is which of the following?

- (A) Shortening of cells in the stem in response to the lack of light
- (B) Elongation of seedlings in response to the lack of light
- (C) Enhancement of stem elongation by light
- (D) Genetic differences between the seeds

15. Which of the following best supports the hypothesis that the difference in leaf color is genetically controlled?

- (A) The number of yellow-leaved seedlings in dish A on day 7
  - (B) The number of germinated seeds in dish A on days 7 and 14
  - (C) The death of all the yellow-leaved seedlings
  - (D) The existence of yellow-leaved seedlings as well as green-leaved ones on day 14 in dish B
16. Additional observations were made on day 21, and no yellow-leaved seedlings were found alive in either dish. This is most likely because
- (A) yellow-leaved seedlings were unable to absorb water from the paper towels
  - (B) taller green-leaved seedlings blocked the light and prevented photosynthesis
  - (C) yellow-leaved seedlings were unable to convert light energy to chemical energy
  - (D) a higher rate of respiration in yellow-leaved seedlings depleted their stored nutrients

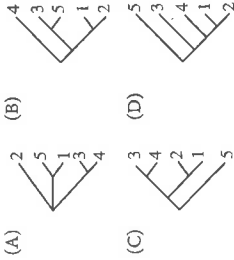
17. The endocrine system incorporates feedback mechanisms that maintain homeostasis. Which of the following demonstrates negative feedback by the endocrine system?

- (A) During labor, the fetus exerts pressure on the uterine wall, inducing the production of oxytocin, which stimulates uterine wall contraction. The contractions cause the fetus to further push on the wall, increasing the production of oxytocin.
- (B) After a meal, blood glucose levels become elevated, stimulating beta cells of the pancreas to release insulin into the blood. Excess glucose is then converted to glycogen in the liver, reducing blood glucose levels.
- (C) At high elevation, atmospheric oxygen is more scarce. In response to signals that oxygen is low, the brain decreases an individual's rate of respiration to compensate for the difference.
- (D) A transcription factor binds to the regulatory region of a gene, blocking the binding of another transcription factor required for expression.

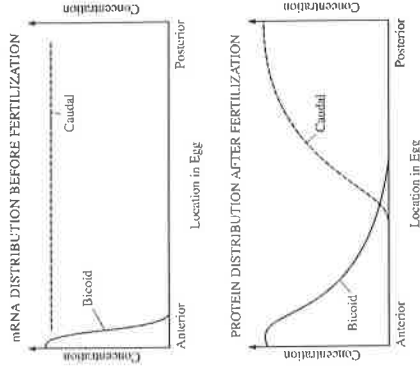
18. Five new species of bacteria were discovered in Antarctic ice core samples. The nucleotide (base) sequences of rRNA subunits were determined for the new species. The table below shows the number of nucleotide differences between the species.

NUCLEOTIDE DIFFERENCES					
Species	1	2	3	4	5
1	-	3	19	18	27
2		-	-	18	26
3			-	1	27
4				-	27
5					-

#18 (cont.)

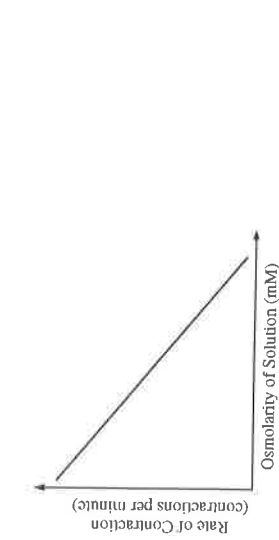


19. The first diagram below shows the levels of mRNA from two different genes (*bicoid* and *caudal*) at different positions along the anterior-posterior axis of a *Drosophila* egg immediately before fertilization. The second diagram shows the levels of the two corresponding proteins along the anterior-posterior axis shortly after fertilization.



Which of the following conclusions is best supported by the data?

- (A) Bicoid protein inhibits translation of *caudal* mRNA.
  - (B) Bicoid protein stabilizes *caudal* mRNA.
  - (C) Translation of *bicoid* mRNA produces caudal protein.
  - (D) Caudal protein stimulates development of anterior structures.
20. Sickle-cell anemia results from a point mutation in the *HBB* gene. The mutation results in the replacement of an amino acid that has a hydrophilic R-group with an amino acid that has a hydrophobic R-group on the exterior of the hemoglobin protein. Such a mutation would most likely result in altered
- (A) properties of the molecule as a result of abnormal interactions between adjacent hemoglobin molecules
  - (B) DNA structure as a result of abnormal hydrogen bonding between nitrogenous bases
  - (C) fatty acid structure as a result of changes in ionic interactions between adjacent fatty acid chains
  - (D) protein secondary structure as a result of abnormal hydrophobic interactions between R-groups in the backbone of the protein



12. Paramecia are unicellular protists that have contractile vacuoles to remove excess intracellular water. In an experimental investigation, paramecia were placed in salt solutions of increasing osmolarity. The rate at which the contractile vacuole contracted to pump out excess water was determined and plotted against osmolarity of the solutions, as shown in the graph. Which of the following is the correct explanation for the data?
- (A) At higher osmolarity, lower rates of contraction are required because more salt diffuses into the paramecia.
  - (B) The contraction rate increases as the osmolarity decreases because the amount of water entering the paramecia by osmosis increases.
  - (C) The contractile vacuole is less efficient in solutions of high osmolarity because of the reduced amount of ATP produced from cellular respiration.
  - (D) In an isotonic salt solution, there is no diffusion of water into or out of the paramecia, so the contraction rate is zero.

Questions 13-16

A student placed 20 tobacco seeds of the same species on moist paper towels in each of two petri dishes. Dish A was wrapped completely in an opaque cover to exclude all light. Dish B was not wrapped. The dishes were placed equidistant from a light source set to a cycle of 14 hours of light and 10 hours of dark. All other conditions were the same for both dishes. The dishes were examined after 7 days, and the opaque cover was permanently removed from dish A. Both dishes were returned to the light and examined again at 14 days. The following data were obtained.

	Dish A		Dish B	
	Day 7 Covered	Day 14 Uncovered	Day 7 Uncovered	Day 14 Uncovered
Germinated seeds	12	20	20	20
Green-leaved seedlings	0	14	15	15
Yellow-leaved seedlings	12	6	5	5
Mean stem length below first set of leaves	8 mm	9 mm	3 mm	3 mm

13. According to the results of this experiment, germination of tobacco seeds during the first week is

- (A) increased by exposure to light
- (B) unaffected by light intensity
- (C) prevented by paper towels
- (D) accelerated in green-leaved seedlings

cont...

26. Plates I and III were included in the experimental design in order to
- (A) demonstrate that the *E. coli* cultures were viable
  - (B) demonstrate that the plasmid can lose its *amp<sup>r</sup>* gene
  - (C) demonstrate that the plasmid is needed for *E. coli* growth
  - (D) prepare the *E. coli* for transformation

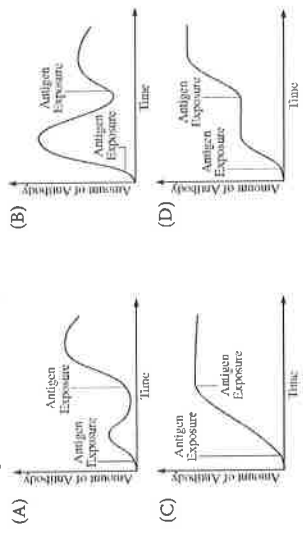
27. Which of the following statements best explains why there are fewer colonies on plate IV than on plate III?
- (A) Plate IV is the positive control.
  - (B) Not all *E. coli* cells are successfully transformed.
  - (C) The bacteria on plate III did not mutate.
  - (D) The plasmid inhibits *E. coli* growth.

28. In a second experiment, the plasmid contained the gene for human insulin as well as the *amp<sup>r</sup>* gene. Which of the following plates would have the highest percentage of bacteria that are expected to produce insulin?
- (A) I only
  - (B) III only
  - (C) IV only
  - (D) I and III

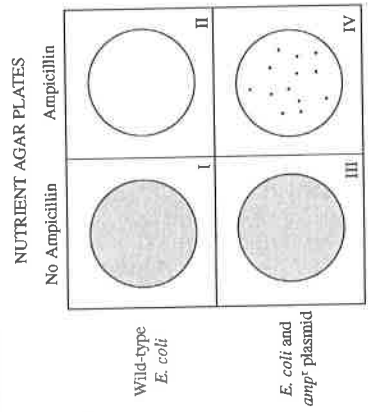
29. Experimental evidence shows that the process of glycolysis is present and virtually identical in organisms from all three domains, Archaea, Bacteria, and Eukarya. Which of the following hypotheses could be best supported by this evidence?
- (A) All organisms carry out glycolysis in mitochondria.
  - (B) Glycolysis is a universal energy-releasing process and therefore suggests a common ancestor for all forms of life.
  - (C) Across the three domains, all organisms depend solely on the process of anaerobic respiration for ATP production.
  - (D) The presence of glycolysis as an energy-releasing process in all organisms suggests that convergent evolution occurred.

30. A human kidney filters about 200 liters of blood each day. Approximately two liters of liquid and nutrient waste are excreted as urine. The remaining fluid and dissolved substances are reabsorbed and continue to circulate throughout the body. Antidiuretic hormone (ADH) is secreted in response to reduced plasma volume. ADH targets the collecting ducts in the kidney, stimulating the insertion of aquaporins into their plasma membranes and an increased reabsorption of water.
- If ADH secretion is inhibited, which of the following would initially result?
- (A) The number of aquaporins would increase in response to the inhibition of ADH.
  - (B) The person would decrease oral water intake to compensate for the inhibition of ADH.
  - (C) Blood filtration would increase to compensate for the lack of aquaporins.
  - (D) The person would produce greater amounts of dilute urine.

23. An individual's humoral response to a particular antigen differs depending on whether or not the individual has been previously exposed to that antigen. Which of the following graphs properly represents the humoral immune response when an individual is exposed to the same antigen more than once?



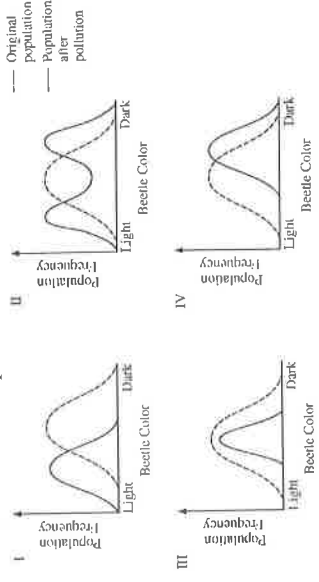
- Questions 24–28
- In a transformation experiment, a sample of *E. coli* bacteria was mixed with a plasmid containing the gene for resistance to the antibiotic ampicillin (*amp<sup>r</sup>*). Plasmid was not added to a second sample. Samples were plated on nutrient agar plates, some of which were supplemented with the antibiotic ampicillin. The results of *E. coli* growth are summarized below. The shaded area represents extensive growth of bacteria; dots represent individual colonies of bacteria.



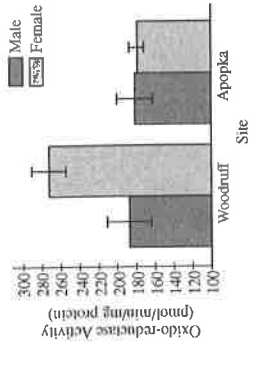
24. Plates that have only ampicillin-resistant bacteria growing include which of the following?
- (A) I only
  - (B) III only
  - (C) IV only
  - (D) I and II

25. Which of the following best explains why there is no growth on plate II?
- (A) The initial *E. coli* culture was not ampicillin-resistant.
  - (B) The transformation procedure killed the bacteria.
  - (C) Nutrient agar inhibits *E. coli* growth.
  - (D) The bacteria on the plate were transformed.

21. In a hypothetical population of beetles, there is a wide variety of color, matching the range of coloration of the tree trunks on which the beetles hide from predators. The graphs below illustrate four possible changes to the beetle population as a result of a change in the environment due to pollution that darkened the tree trunks.

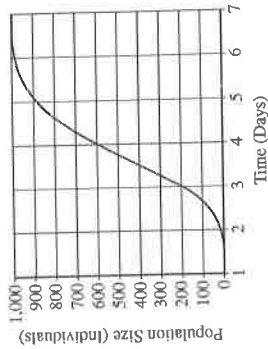


- Which of the following includes the most likely change in the coloration of the beetle population after pollution and a correct rationale for the change?
- (A) The coloration range shifted toward more light-colored beetles, as in diagram I. The pollution helped the predators find the darkened tree trunks.
  - (B) The coloration in the population split into two extremes, as in diagram II. Both the lighter-colored and the darker-colored beetles were able to hide on the darker tree trunks.
  - (C) The coloration range became narrower, as in diagram III. The predators selected beetles at the color extremes.
  - (D) The coloration in the population shifted toward more darker-colored beetles, as in diagram IV. The lighter-colored beetles were found more easily by the predators than were the darker-colored beetles.



22. Testosterone oxidoreductase is a liver enzyme that regulates testosterone levels in alligators. One study compared testosterone oxidoreductase activity between male and female alligators from Lake Woodruff, a relatively pristine environment, and from Lake Apopka, an area that has suffered severe contamination. The graph above depicts the findings of that study.
- The data in the graph best support which of the following claims?
- (A) Environmental contamination elevates total testosterone oxidoreductase activity in females.
  - (B) Environmental contamination reduces total testosterone oxidoreductase activity in females.
  - (C) Environmental contamination elevates total testosterone oxidoreductase activity in males.
  - (D) Environmental contamination reduces total testosterone oxidoreductase activity in males.

Part B Directions: Part B consists of questions requiring numeric answers. Calculate the correct answer for each question.



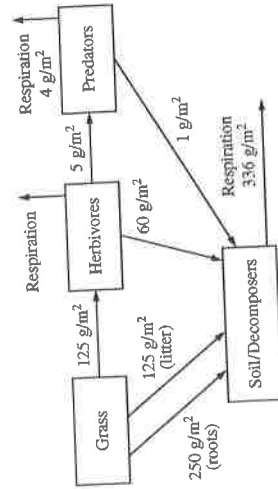
1. Use the graph above to calculate the mean rate of population growth (individuals per day) between day 3 and day 5. Give your answer to the nearest whole number.

2. In a certain species of flowering plant, the purple allele *P* is dominant to the yellow allele *p*.

A student performed a cross between a purple-flowered plant and a yellow-flowered plant. When planted, the 146 seeds that were produced from the cross matured into 87 plants with purple flowers and 59 plants with yellow flowers.

Calculate the chi-squared value for the null hypothesis that the purple-flowered parent was heterozygous for the flower-color gene. Give your answer to the nearest tenth.

CARBON FLOW IN A GRASSLAND ECOSYSTEM



3. How much carbon (in  $\text{g}/\text{m}^2$ ) is released into the atmosphere as a result of the metabolic activity of herbivores? Give your answer to the nearest whole number.

### Answers to Multiple-Choice Questions

#### Part A

1. C	9. A	17. B	25. A	33. C
2. A	10. C	18. C	26. A	34. A
3. D	11. D	19. A	27. B	35. D
4. B	12. B	20. A	28. C	36. B
5. C	13. A	21. D	29. B	37. B
6. A	14. B	22. B	30. D	38. A
7. D	15. D	23. A	31. A	39. D
8. A	16. C	24. C	32. D	40. C

#### Part B

1. 340-360
2. 5.3-5.4
3. 60