

4. **Ciprofloxacin is an antibiotic frequently prescribed for traveler's diarrhea and urinary tract *E. coli* infections. It acts by binding to and interfering with bacterial topoisomerases. Which of the following is the most accurate explanation of ciprofloxacin's mechanism of action?**
- A. Ciprofloxacin prevents the unwinding of double-stranded DNA and thus both DNA transcription and replication.
 - B. Ciprofloxacin prevents the relief of supercoiling caused by unwinding of double-stranded DNA and thus DNA replication.
 - C. Ciprofloxacin prevents the conversion of RNA primers to DNA and thus accurate DNA replication.
 - D. Ciprofloxacin prevents replication of the lagging strand.
 - E. Ciprofloxacin prevents the binding of DNA polymerases to DNA and thus both DNA transcription and replication.
5. **Due to the widespread use of ciprofloxacin, many bacterial populations are now resistant to ciprofloxacin. You are studying a ciprofloxacin-resistant clinical isolate of *E. coli*. You have a hunch that this population does not harbor any plasmids. Given this information, which of the following best explains your isolate's resistance mechanism?**
- A. Your resistant bacteria pump ciprofloxacin out of the cell and thus minimize its effect.
 - B. Your resistant bacteria produce an enzyme that modifies the binding site of ciprofloxacin.
 - C. Your resistant bacteria have mutant topoisomerases that have less affinity for ciprofloxacin.
 - D. Your resistant bacteria produce a chemical compound that reacts with ciprofloxacin and reduces its affinity for topoisomerases.
 - E. Your resistant bacteria do not require the activity of topoisomerases.
6. **In classical Michaelis-Menten enzyme kinetics, the two constants V_{\max} and K_m determine the activity of an enzyme that acts on one substrate. You are studying the effects of various chemicals on these constants for your favorite enzyme, and find one molecule that increases its K_m but leaves V_{\max} constant. Your molecule is most likely to be:**
- A. a substrate analog
 - B. the enzyme's substrate
 - C. a coenzyme that increases catalytic efficiency
 - D. an allosteric inhibitor that decreases the enzyme's affinity for the substrate
 - E. an allosteric enhancer that increases the enzyme's affinity for the substrate

- 7. Eukaryotic transcription seems to be a wasteful process because so many proteins need to assemble on a large array of DNA sequences to initiate transcription. What might be the evolutionary advantage that allows such a complex process to be maintained throughout all eukaryotic organisms?**
- A. Since eukaryotes are larger than prokaryotes, you need a larger transcription process for initiation.
 - B. There are more genes that need to be transcribed in a eukaryote than in a prokaryote.
 - C. The use of large number of proteins and regulatory sequences in DNA is essential for alternative splicing in eukaryotes.
 - D. The use of large numbers of proteins and regulatory sequences in DNA opens many possibilities for sophisticated gene regulation by eukaryotes.
 - E. Since transcription happens in the cytoplasm, you need so many proteins to prevent it from being broken up.
- 8. All amino acids except lysine and leucine can be broken down into precursors for gluconeogenesis. What are the products produced by the breakdown of lysine and leucine that prevent them from functioning in that pathway?**
- A. Oxaloacetate and acetyl-CoA
 - B. Pyruvate and succinate
 - C. Acetyl-CoA and acetoacetate
 - D. Succinyl-CoA and acetoacetate
 - E. Acetaldehyde and pyruvate
- 9. When a mammal ingests a carbohydrate-rich meal after a long fast, the metabolic behavior of its hepatocytes undergoes many changes. Which of the following responses would not occur after a large influx of glucose?**
- A. Dephosphorylation and activation of PFK-2
 - B. Increased glucokinase activity
 - C. Glycogen phosphorylase R → T transition
 - D. Decreased phosphoglucomutase activity
 - E. Rise in concentration of NADPH
- 10. Which of the following is the primary interaction accounting for the majority of proteins in aqueous solution?**
- A. Salt bridges
 - B. Hydrogen bonding
 - C. Dipole-dipole
 - D. Disulfide bonds
 - E. Hydrophobic interactions

11. You are given four unlabeled samples of polysaccharides and told that each contains either amylopectin, amylose, cellulose, or glycogen, (one of each). Given the following information, which sample contains which type of polysaccharide?

Sample #1: Many 1-6 linkages of α -glucose monomers

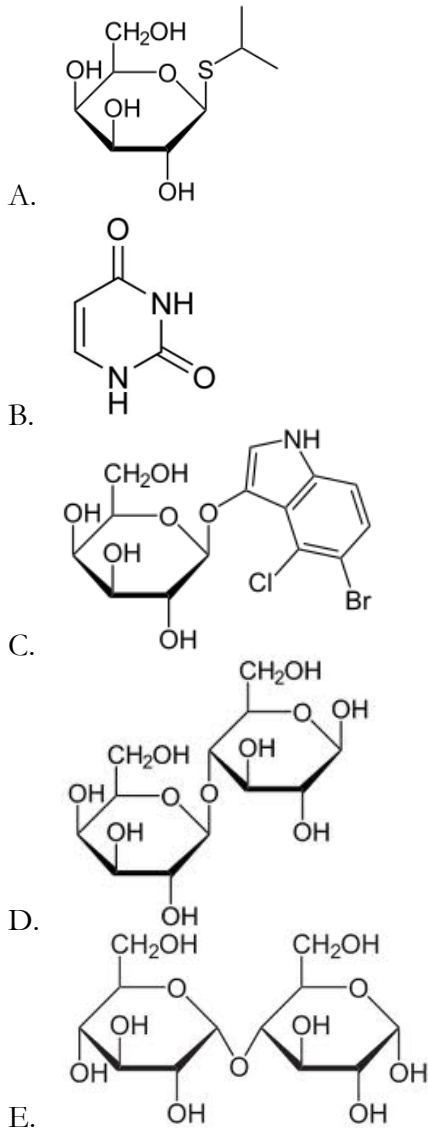
Sample #2: Composed of β -glucose monomers

Sample #3: Many 1-4 linkages of α -glucose monomers

Sample #4: Some 1-6 linkages of α -glucose monomers

- A. #1 – amylose, #2 – cellulose, #3 – amylopectin, #4 – glycogen
- B. #1 – cellulose, #2 – glycogen, #3 – amylose, #4 – amylopectin
- C. #1 – amylopectin, #2 – cellulose, #3 – amylopectin, #4 – glycogen
- D. #1 – glycogen, #2 – amylopectin, #3 – cellulose, #4 – amylase
- E. #1 – glycogen, #2 – cellulose, #3 – amylose, #4 – amylopectin

12. You are looking for a lactose analog to induce long-term expression of a gene under the control of the *lac* promoter. Which of the following molecules is the most suitable choice?



13. Which of the following statements about gravity perception is **FALSE**?

- A. Statoliths are specialized amyloplasts.
- B. Statoliths are found in statocytes.
- C. Gravity is sensed from the root cap acropetally through the zone of division.
- D. Columella cells sense gravity through statolith pressure on the endoplasmic reticulum
- E. Auxin is the main hormone involved in gravity response.

14. What characterizes a short-day plant?

- A. They flower only after a sequence of short days followed by long days.
- B. They flower only after a sequence of long days followed by short days.
- C. They flower in fall or early spring.
- D. Flowering can be induced by an interruption of a long day with a period of darkness.
- E. They need to be vernalized in order to flower.

15. Which of the following statements about flowering is true?

- A. A long-day plant will flower when it has been stimulated to produce the correct ratio of phytochromes to cryptochromes.
- B. A long-day plant will flower when its ratio of P_r to P_{fr} that is greater than 1.
- C. A long-day plant will flower if its night is interrupted by a flash of red and then a flash of far-red light.
- D. A long-day plant will flower when most of its phytochromes are in the P_{fr} form and the days are long enough for its flowering gene to accumulate to high enough levels to induce flowering.
- E. A long-day plant requires a short night so the flowering inhibitor protein can be removed to low-enough levels to allow flowering.

16. A researcher's new houseplant exhibits photoperiodism because of the presence of phytochromes. Which of the following statements about plant phytochromes is NOT true?

- A. Each phytochrome molecule is a dimer composed of two identical subunits. Each subunit contains a photosensitive chromophore.
- B. The conformational change of P_r to P_{fr} is irreversible, so over the night the plant recycles the P_{fr} that was produced during the day and synthesizes new P_r phytochromes.
- C. When exposed to red light, P_r is converted to P_{fr} in the plant.
- D. Plants shaded by other plants commonly have the equilibrium of P_r to P_{fr} more shifted toward P_r during the day.
- E. ALL of the above are true

17. Which of the following statements is TRUE about leaves in vascular plants?

- A. Leaves are found on all species in the kingdom Plantae
- B. Secondary (woody) growth is found in some leaves
- C. All plants with microphylls are extinct
- D. Megaphylls may have evolved from sporangia on the side of the stem
- E. Microphylls may have evolved from a series of branches lying close to each other on a stem

18. Which of the following is an accurate description of alternation of generations in vascular and nonvascular plants?

- A. Nonvascular plants and seedless vascular plants have a dominant gametophyte
- B. Seedless and seed-producing vascular plants have an independent gametophyte
- C. Nonvascular plants and seedless vascular plants have dominant sporophyte
- D. Seedless and seed-producing vascular plants have a dominant gametophyte
- E. Seedless and seed-producing vascular plants have a reduced gametophyte

19. Arrange the following five events in an order that explains the bulk flow of substances in the phloem.

- I. Water diffuses into the sieve tube elements**
- II. Leaf cells produce sugar by photosynthesis**
- III. Solute are actively transported into sieve elements**
- IV. Sugar is transported from cell to cell via the apoplast and/or symplast**
- V. Sugar moves down the stem**

- A. II, I, IV, III, V
- B. I, II, III, IV, V
- C. II, IV, III, I, V
- D. IV, II, I, III, V
- E. II, IV, I, III, V

20. What is the relationship between pollination and fertilization in flowering plants?

- A. Fertilization precedes pollination.
- B. Pollination easily occurs between plants of different species.
- C. Pollen is formed within megasporangia so that male and female gametes are near each other.
- D. If fertilization occurs, pollination is unnecessary.
- E. Pollination brings gametophytes together such that fertilization can occur.

21. You are growing plants hydroponically, measuring CO₂ usage. The plants initially grow robustly, but soon CO₂ assimilation drops. Young leaves continue to grow normally, but older leaves begin to yellow. Which of the following is the MOST likely cause for the observed changes?

- A. The hydroponic medium lacks oxygen, causing the roots to suffocate.
- B. The plants are preparing to flower.
- C. The plants are mutants which overproduce gibberellins.
- D. The hydroponic medium lacks magnesium.
- E. The plants are not exposed to enough light.

22. Which of the following has the greatest total cross-sectional area in the human body?

- A. Arteries
- B. Arterioles
- C. Capillaries
- D. Venules
- E. Veins

23. Which of the following is a feature of muscles that have mainly oxidative metabolism?

- A. Have low blood supply
- B. Store more fat
- C. Commonly identified as fast twitch
- D. Have few mitochondria
- E. Susceptible to fatigue

24. Place the following events related to the allergic response in order of occurrence.

- I. IgE antibodies bind to mast cells.
- II. Mast cells degranulate.
- III. IgE antibodies recognize and bind to allergen.
- IV. Allergy symptoms appear.
- V. IgE antibodies are produced in response to exposure to an allergen.
- VI. Histamine is released into the blood.

- A. VI, V, I, II, III, IV
- B. V, II, I, III, VI, IV
- C. V, III, I, VI, II, IV
- D. IV, VI, V, III, I, II
- E. V, I, III, II, VI, IV

25. Which region of the brain is LEAST related to processing of visual signals?

- A. Occipital lobe
- B. Cerebellum
- C. Hypothalamus
- D. Optic chiasm
- E. Lateral geniculate nuclei

26. You compliment a friend on his recent weight loss. When you are playing video games at his house later, you notice he seems disinterested in the game and is frequently going to the kitchen to get snacks. After one too many sodas, you go to the bathroom, where you see his medicine cabinet stocked full of Rogaine (a hair loss medication), Imodium (a diarrhea medication), Viagra (an impotence medication) and Ritalin (a hyperactivity medication). Finally understanding his illness, you tell your friend he needs to see a doctor about his:

- A. Hyperthyroidism
- B. Type I diabetes
- C. Hyperparathyroidism
- D. Hypopituitarism
- E. Hypogonadism

27. When comparing the mammal's respiratory system with the arthropod's tracheal system, which of the following is **FALSE**?

- A. The mammal's respiratory system is limited to a certain region of its body, while the tracheal system of the arthropod is throughout its body
- B. Both systems are adaptations for living in air
- C. Both systems have a closed circulatory system adjacent to a gas exchange surface
- D. Both systems possess highly branched tubes
- E. Both systems possess invaginated surfaces

28. List the following Orthoptera appendage segments in order from most proximal to most distal.

- I. Coxa
- II. Femur
- III. Tarsus
- IV. Tibia
- V. Trochanter

- A. III, II, IV, V, I
- B. I, II, IV, III, V
- C. II, V, IV, III, I
- D. V, I, II, IV, III
- E. I, V, II, IV, III

29. When stimulated, which of the following will cause an accelerated heartbeat, pupil dilation, blood pressure rise, and more blood to flow to the peripheral muscles?

- A. Parasympathetic nervous system
- B. Parathyroid gland
- C. Somatic nervous system
- D. Sympathetic nervous system
- E. Thyroid gland

30. Without harming the *Lumbricus* (earthworm) specimen, a researcher carefully removed the liquid in each body segment. Which of the following descriptions of earthworm movement would you expect to observe?
- A. Movement by the setae only
 - B. Neither extension nor contraction
 - C. Normal contraction and extension
 - D. Normal extension, but not full contraction
 - E. Normal contraction, but not full extension
31. A patient meets with his doctor and presents the following symptoms: low metabolic rate, goiter, and weight gain to the point of obesity. Which of the following best describes the cause of these symptoms?
- A. High body temperature
 - B. High levels of thyrotropic hormone (TSH) in the blood
 - C. High levels of thyroxin in the blood
 - D. Increased production of thyrotropic releasing hormone
 - E. Lack of sufficient iodine in the diet
32. Which of the following are common precursors in hormone synthesis?
- A. Carbohydrates, polypeptides, and steroids
 - B. Carbohydrates, fats, and polypeptides
 - C. Fats, polypeptides, and steroids
 - D. Amino acids, polypeptides, and steroids
 - E. Amino acids, fats, and minerals
33. In a capillary bed if the hydrostatic pressure at the arteriole ends is 32 mm Hg and at the venule ends is 14 mm Hg with an osmotic pressure of 22 mm Hg, the net flow of fluids from the capillary bed will occur with a pressure of
- A. 2 mm Hg
 - B. 8 mm Hg
 - C. 10 mm Hg
 - D. 18 mm Hg
 - E. 22 mm Hg
34. Upon examination of an unknown animal, you determine the following: it has an excretory system with blind-ended tubules emerging as outgrowths in the digestive system, is terrestrial, and has an open circulatory system. You also could predict that it might have which of the following?
- A. Book gills
 - B. Lungs
 - C. Four-chambered heart
 - D. Nephridia
 - E. Tracheal system

35. Which of the following pH series MOST closely matches the pH series for the following solutions?

blood, 10^{-5} M HCl, pure water*, gastric fluids, salt water

** at STP (Standard Temperature and Pressure)*

- A. 7.4 5.0 7.0 2.5 8.3
- B. 8.3 10.0 7.0 1.2 7.2
- C. 7.5 10.5 7.0 4.0 8.3
- D. 5.0 7.4 7.0 8.3 2.4
- E. 6.8 5.0 7.0 2.4 8.3

36. While examining a small mammal's skull, you observe that there are no canines and that the premolars and molars are flat. Which of the following characteristics would this mammal likely possess?

- A. Lacks maltase and sucrase in its intestine
- B. Lacks amylase in its saliva
- C. Possesses a high concentration of pepsin in its saliva
- D. Possesses a long large intestine
- E. Possesses a spiral valve in its intestine

37. Which of the following is an example of an ethological study?

- A. The ability of wood rats to run mazes
- B. The behavior of cows held in small barns
- C. The effect of freezing temperature on mating in Amazonian fishes
- D. The preference of honeybees for different flower colors
- E. Both B and D are correct

38. During a long period when there is no rainfall, a mountain lion may temporarily leave its usual hunting territory to drink from a farm pond. This behavior is probably due to:

- A. Its need to find different foods to eat
- B. A change in an abiotic factor in its environment
- C. Its need to find a new habitat
- D. A change in a biotic factor in its environment
- E. The need to increase its territory

39. Which of the following roles have humans NOT traditionally taken in the process of domesticating animals?

- A. Parent in imprinting
- B. Nature in selection
- C. Dominant male in social organization
- D. Landmark in spatial learning
- E. Bottleneck effects

40. The freshwater fish *Apteronotus albifrons* (black ghost) is found off the coast of Ecuador. Suppose there are no close relatives and you have the ability to prevent black ghosts from immigrating or emigrating from their present population and there would be no further mutations. Which of the following statements is the best description of the future of this black ghost population?

- A. The population will deteriorate after a few generations due to excessive inbreeding
- B. All evolution will stop immediately
- C. The population will continue to evolve for a long time as selection acts on the variability produced by recombination
- D. The population will stop evolving, but will continue for many generations as long as the environment remains constant
- E. Major evolutionary changes will continue due to genetic drift

41. Suppose a researcher is planning to use the Dideoxy Chain-Termination method for sequencing DNA but does not add fluorescently tagged ddGTP to the incubation tube. What are his results from the sequencing?

- A. The DNA polymerase will sense that ddGTP is missing and fail to replicate DNA according to the template strand.
- B. The spectrogram printed from the detector reading the polyacrylamide gel will be as expected because the other three dideoxynucleotides were present in the incubation tube.
- C. The DNA polymerase will make many strands of DNA of equal lengths, but none will contain fluorescently tagged G nucleotides.
- D. The spectrogram will contain gaps in its detected peaks of fluorescence where ddGTP would have terminated certain strands of DNA.
- E. The DNA polymerase will produce DNA strands of all different lengths, but some will terminate in Guanine instead of ddGTP.

In questions 42 to 44, you have two true-breeding strains of pea plants with white flowers. Crossing these two strains yields an F1 generation that only has purple flowers. Self-crossing these purple flowered plants yields the following ratio of progeny with purple and white flowers: 9 purple: 7 white.

42. How many genes in this cross are involved in determining flower color?

- A. 0
- B. 1
- C. 2
- D. 3
- E. 4

43. What fraction of the purple-flowered F2 progeny do you expect to produce only purple progeny when self crossed?

- A. 1/9
- B. 1/4
- C. 1/3
- D. 4/9
- E. 1

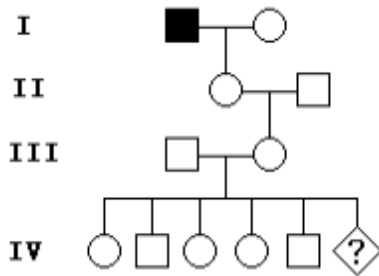
44. What fraction of the purple-flowered F2 progeny, when selfed, do you expect to produce the same 9:7 ratio of purple to white progeny?

- A. 0
- B. 1/3
- C. 4/9
- D. 1/2
- E. 5/9

45. You have two true-breeding squash strains with white flowers instead of the normal yellow flowers. When crossed, the F1 generation exhibits yellow flowers only. Your colleague makes the following hypothesis to explain this result: Each parental strain has a mutation in the same gene, the protein product of which forms a homodimer that catalyzes an important step in yellow pigment production. It happens by chance that the two distinct mutant subunits, each produced in a parental strain, can bind to each other and function normally, but not when bound with itself or the wild type subunit. What ratio of yellow-flowered to white-flowered progeny would you expect from a self-cross of the F1 generation if your colleague's hypothesis were correct?

- A. 1:1
- B. 9:7
- C. 7:9
- D. 3:1
- E. 1:3

46. The following pedigree depicts inheritance of hemophilia, an X-linked recessive disorder. The great-grandfather of the child marked with "?" suffered from hemophilia. Assume the great-grandmother has no past history of hemophilia, and could not have been a carrier of the disease. What is the probability that the child marked with "?" will be born male AND suffer from hemophilia given that that the other five children in Generation IV do not have hemophilia?

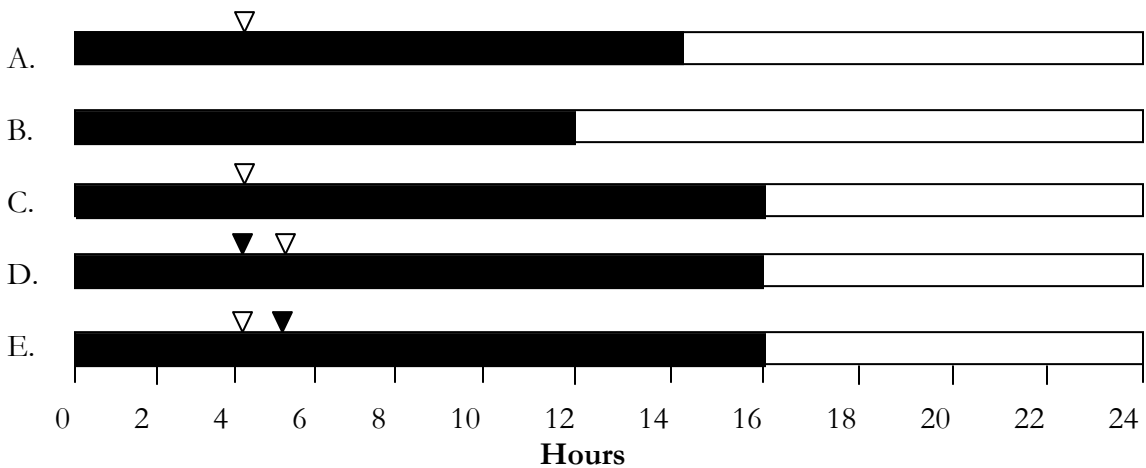


- A. $1/8$
 B. $1/10$
 C. $1/12$
 D. $1/20$
 E. $1/32$
47. Using the following information, approximate the number of nucleotide triphosphates required to translate an mRNA molecule with a coding region (including start and stop codons, excluding untranslated regions) that is X base pairs long.
- I. 1 ATP is required to attach an amino acid to tRNA.
 - II. 1 ATP is required to break myosin from actin.
 - III. 2 GTP are required to dissociate ribosome subunits and mRNA and release a finished polypeptide.
 - IV. 1 GTP is hydrolyzed to bind the large subunit of the ribosome to an mRNA.
 - V. 1 GTP is produced per round of the citric acid cycle.
 - VI. 1 GTP is required for codon recognition per each new aminoacyl-tRNA added.
 - VII. 1 GTP is required for translocation of peptidyl-tRNAs per each cycle of elongation.
- A. $X + 3$
 B. $3X$
 C. $3X + 3$
 D. $4X/3 + 3$
 E. $X/3 + 3$

48. With the movement to land from an aquatic environment, all of the following were problems facing plants **EXCEPT**:

- A. UV radiation
- B. Desiccation of the embryo and zygote
- C. Pollen production
- D. Temperature fluctuations
- E. Winds

49. If a short-day plant flowers only when the night is at least 14 hours long, in which of the following light conditions will the plant flower? Place your response on your scantron.



Key

- ▽ = Intense flash of red light
- ▼ = Intense flash of far-red light
- = Daylight
- = Night

50. Cyclic and noncyclic pathways for photophosphorylation are present in most plants. If you assume that the cyclic pathway is not affected, which of the following processes would cease if the noncyclic pathway were inhibited?

- A. Chemiosmosis in mitochondria
- B. Active transport of Na^+ across the cell membrane
- C. Oxidation of FAD_{re} to FAD_{ox}
- D. $6\text{CO}_2 + 6\text{RuBP} + 12\text{ATP} + 12\text{NADPH}_{\text{re}} \rightarrow 12\text{ glucose phosphate} + 12\text{NADPH}_{\text{ox}} + 12\text{ADP}$
- E. Osmosis

51. The difference between the action spectrum and the absorption spectrum of plants suggests that:
- A. Chlorophyll is not involved in the dark reactions
 - B. Pigments other than chlorophyll are involved
 - C. Two photosystems are involved
 - D. Chlorophyll is green
 - E. Green light is not effective for photosynthesis
52. Which of the following statements is NOT true about the Nitrogen Cycle?
- A. The atmospheric reservoir of nitrogen makes up only a small amount of the total amount of the element in the Nitrogen Cycle.
 - B. Most nitrogen is fixed in the root nodules in plants of the family Fabaceae.
 - C. The process of returning nitrogen to inorganic forms in the soil by decomposers is called ammonification.
 - D. Some species of nitrifying bacteria are responsible for converting NO_2^- to NO_3^- .
 - E. ALL of the above are true.
53. You wish to know the population of a certain group of gorillas on your wildlife preserve. You captured and tagged 45 gorillas with a microchip and released them back into the wild. After six months, you returned and captured 64 gorillas and 8 had the tags that you have previously placed in them. Given that no births or deaths occur in the population, what is the size of the population of gorillas on your wildlife preserve?
- A. 140
 - B. 150
 - C. 180
 - D. 270
 - E. 360
54. You are working for a biotech company that produces a genetically engineered bacterium. The species that you are responsible for will grow until the population reaches a density of 1.2×10^6 cells/cm³. To maximize the sustainable yield of these bacteria, you should adjust the density to:
- A. 1.2×10^6 cells/cm³
 - B. Between 1.2 and 2.4×10^6 cells/cm³
 - C. 0.6×10^6 cells/cm³
 - D. 1.2×10^3 cells/cm³
 - E. 0.6×10^3 cells/cm³