

# USA Biology Olympiad 2004

## Open Exam

### Annotated Answer Key

Note: This answer key is based on Exam Version 101. However, all questions on each version of the exams are identical.

1. Assume a person is placed on cortisol medication, a glucocorticoid. How would you expect the rates of ACTH and CRF hormone production to change in the person?
  - A. ACTH production would increase, CRF production would increase
  - B. ACTH production would increase, CRF production would decrease
  - C. ACTH production would decrease, CRF production would decrease
  - D. ACTH production would decrease, CRF production would increase**
  - E. ACTH and CRF production would not change

Answer: D (Animal form and function, pp. 969-972)

The adrenal cortex reacts to stress and responds to endocrine signals. Stressful stimuli cause the hypothalamus to secrete a releasing hormone that stimulates the anterior pituitary to release the tropic hormone ACTH. When ACTH reaches its target via the bloodstream, it stimulates cells of the adrenal cortex to synthesize and secrete a family of steroids called corticosteroids [There are two main types in humans: glucocorticoids, such as cortisol and the mineralocorticoids, such as aldosterone]. The elevated levels of corticosteroids in the blood suppress the secretion of ACTH. The production of ACTH therefore decreases and CRF, corticotropin-releasing factor/hormone, increases.

2. Carbon particles were injected into the blood of mice. In which of the following places would you most likely find the particles?
  - A. In the glomerular filtrate
  - B. In the adipose tissue of the liver
  - C. In monocytes of the spleen**
  - D. In plasma cells of the bone marrow
  - E. In the loops of Henle

Answer: C (Animal form and function, pp. 901-2)

Monocytes constitute 5% of leukocytes, which are part of a phagocytic defense (ingestion of invading organisms by white blood cells). New monocytes circulate in the blood for only a few hours and then migrate into tissues, developing into large macrophages. Organs of the lymphatic system that trap “foreign” molecules and particles are the spleen, lymph nodes, adenoid, tonsil, appendix and Peyer’s patch, which is located in the small intestine.

3. Kidneys provide osmoregulation for the body. Consumption of which nutrient creates the greatest need for osmoregulation?
  - A. Cellulose
  - B. Fat
  - C. Oil
  - D. Protein**
  - E. Starch

Answer: D (Animal form and function, pp. 944-5)

Osmoregulation is the control of water balance in organisms living in hypertonic, hypotonic, or terrestrial environments. Osmoregulation also holds the concentration of solutes in the blood (and indirectly, the concentration in tissues) at appropriate levels. The kidney has two distinct regions, the outer renal cortex

and the inner renal medulla, which are packed with nephrons. Nephrons consist of the glomerulus and Bowman's capsule. Bowman's capsule contains porous capillaries that are permeable to water and small solutes. Proteins are large molecules, which generally do not filter. The high concentration of proteins in the blood creates high osmotic pressure. Osmoregulation in the kidneys maintains the body's water balance and solute concentration in the blood.

4. During translation in prokaryotes, the ribosome binds to:
- A. the TATA box.
  - B. the mRNA cap.
  - C. the terminator sequence.
  - D. an enhancer sequence.
  - E. the Shine-Dalgarno sequence.

Answer: E (Genetics, pp. 305-6)

Translation is the synthesis of a polypeptide, which occurs under the direction of mRNA. In prokaryotes, the DNA is not segregated from ribosomes and the other protein-synthesizing equipment. Transcription and translation are coupled, with ribosomes attaching to the leading end of an mRNA molecule, at the Shine-Dalgarno sequence while transcription is still in progress. A short stretch of nucleotides on a prokaryotic mRNA molecule, upstream of the translational start site that serves to bind to ribosomal RNA, bring the ribosome to the initiation codon on the mRNA.

5. The quaternary structure of a protein is determined by:
- A. interactions between distant amino acids of the same polypeptide.
  - B. interactions between close amino acids of the same polypeptide.
  - C. interactions between amino acids of different polypeptide chains.
  - D. the arrangement of the alpha helices and beta sheets in the protein.
  - E. binding of a coenzyme or cofactor to the protein.

Answer: C (The structure and functions of macromolecules, pp. 78-9)

Quaternary structure is the association between two or more polypeptides that make up a protein. Proteins that contain more than one chain of amino acids are called oligomeric proteins, and each chain is called a protomer. These chains are held together to form the larger protein by bonds that exist between the side groups of different chains. As with tertiary structure, the bonds involved in holding these separate chains together can be van der Waals bonds, hydrogen bonds, ionic bonds or covalent bonds.

6. Which of the following is not a function of the parasympathetic division of the nervous system?
- A. Constriction of the bronchii in the lungs
  - B. Constriction of the pupil of the eye
  - C. Slowing of the heart rate
  - D. Stimulation of the adrenal medulla
  - E. Stimulation of activity of the stomach and the intestines

Answer: D (Nervous system, pp. 1040-2)

Activity of the parasympathetic nerves decrease heart rate, constrict the pupils of the eye, stimulate salivary glands, constrict bronchii in the lungs, stimulate activity of the stomach and the intestines, stimulate activity of the pancreas, stimulate the gallbladder, promote voiding from the bladder and erection of the genitals.

7. You place a growing seedling in an east-facing window. On which side of the plant will active auxin accumulate?
- A. North side
  - B. South side
  - C. East side
  - D. West side
  - E. Equally distributed on all sides of the plant

Answer: D (Plant form and function, pp. 806-10)

A houseplant in a window will grow towards light. If you rotate the plant, it will soon re-orient its growth such that the terminal portions of the branches again bend toward the window. Auxin is a term used for a group of plant hormones that stimulate stem elongation, root growth and cell differentiation. In angiosperms active auxins accumulate in its shaded side and stimulate cell elongation such that the shaded side overgrows the more brightly lighted side which results in a bending toward the light.

8. Which of the following is NOT a characteristic of all mammalian species?
- A. Dorsal nerve cord
  - B. Endothermic metabolism
  - C. Lungs
  - D. Mammary glands
  - E. Placenta

Answer: E (Vertebrate evolution and diversity, pp. 702)

Mammalian species were first defined by their possession of mammary glands, which produce milk. Other mammalian characteristics are the possession of hair, a four-chamber heart, lungs, variety of teeth size and shape, and endothermic metabolism. Some mammals however do not have placentas, such as monotremes and marsupials.

9. Suppose the *lac* repressor of *E. coli* is mutated so that it never binds to the operator. Which of the following is true?
- A. Glucose digesting enzymes are never produced
  - B. Lactose digesting enzymes are never produced
  - C. Lactose digesting enzymes are always produced
  - D. The result depends on the concentration of glucose
  - E. The result depends on the concentration of lactose

Answer: D (Genetics, fig. 18.21, pp. 347-9)

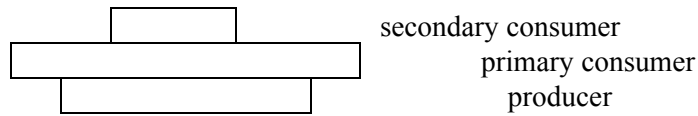
*E. coli* uses three enzymes to take up and metabolize lactose. The genes for these three enzymes are clustered in the *lac* operon. One gene, *lacZ*, codes for B-galactosidase, which hydrolyzes lactose to glucose and galactose. The second gene, *lacY*, codes for a permease, the membrane protein that transports lactose into the cell. The third gene, *lacA*, codes for an enzyme called transacetylase, whose function in lactose metabolism is still unclear. If the *lac* repressor of *E. coli* is mutated such that it never binds to the operator, the enzymes for lactose metabolism are not induced.

10. You examine a leaf cross-section under a microscope and find many loosely packed cells. These cells have many chloroplasts and relatively thin cell walls. These cells are:
- A. collenchyma.
  - B. endodermis.
  - C. parenchyma.
  - D. sclerenchyma.
  - E. xylem.

Answer: C (Plant structure and growth, pp. 726-7)

Parenchyma cells have primary walls that are relatively thin and flexible. Parenchyma cells are often depicted as “typical” plant cells because they generally are the least specialized. Tissue comprised of parenchyma may contain few or many air spaces and the cells may or may not contain chloroplasts. Chloroplast containing parenchyma cells are often referred to as Chlorenchyma.

11. For the biomass pyramid shown below, choose the correct statement.



- A. Producers reproduce quickly but are also consumed at a rapid rate
- B. Biomass decreases with higher trophic levels
- C. Humans represent the lowest trophic level (bottom rectangle)
- D. This biomass pyramid is consistent with an algal bloom
- E. This biomass pyramid is not possible

Answer: A (Ecosystems, fig. 54.11, pp. 1206-7)

Low trophic efficiencies can be represented in a biomass pyramid, where each tier represents the standing crop (the total dry weight of all organisms) in a trophic level. Most biomass pyramids, which are inverted, expand from primary producers at the base of the pyramid to the top-level carnivores (also called consumers). Energy transfers between trophic levels are inefficient. Some producers grow, reproduce and are consumed rapidly. They have a short turnover time, which means they have a small standing crop biomass compared to their production.

12. Which of the following would be most likely to increase competition among the members of the vole population in a given area?
- A. An increase in the number of hawk predators
  - B. An increase in the reproduction rate of voles
  - C. An increase in temperature
  - D. An increase in the food supply
  - E. An epidemic of rabies within the vole population

Answer: B (Population ecology, fig. 52.14, pp. 1164-1165)

Resource limitation in crowded populations can stop population growth. Population density intensifies intraspecific competition for declining nutrients, resulting in a lower birth rate.

13. Tobacco mosaic virus has RNA rather than DNA as its genetic material. If the RNA genome from a tobacco mosaic virus is mixed with proteins from a human rhinovirus, the result is a mixed virus. If that virus could infect a cell and reproduce, what would you expect the resulting viruses to be like?
- A. A hybrid including genetic material from tobacco mosaic virus and proteins from the rhinovirus
  - B. A hybrid including proteins from tobacco mosaic virus and genetic material from the rhinovirus
  - C. Rhinovirus
  - D. Tobacco mosaic virus
  - E. No viruses would result because no viral DNA was present

Answer: D (Microbial models: The genetics of viruses and bacteria, fig. 18.3 and fig. 18.4, pp. 328-333)  
Virus genomes may consist of double-stranded DNA, single-stranded DNA, double-stranded RNA, or single-stranded RNA depending on the specific type of virus. Tobacco mosaic virus has a rigid, rod-shaped capsid. The genetic material from the tobacco mosaic virus serves as the template for the human rhinovirus to replicate itself and produce new capsid proteins by transcription and translation. The new viral DNA and capsid proteins assemble into tobacco mosaic virus particles, which then leave the cell.

14. An amphipathic molecule is a molecule that is characterized by:
- A. 2 different forms that are mirror images of each other.
  - B. an amino group.
  - C. a hydrophilic end and a hydrophobic end.
  - D. a positively charged end and a negatively charged end.
  - E. rarely being found in cell membranes.

Answer: C (Membrane structure and function, pp. 138) An amphipathic molecule is a phospholipid that has both a hydrophilic region and a hydrophobic region.

15. The function of a molecular chaperone is to:
- A. act as an energy source during the polymerization of amino acids into a polypeptide.
  - B. act as a carrier molecule and bring “activated” monomers to a polymer for incorporation.
  - C. bind to specific structures on the polypeptide in order to assist the folding of a protein into its correct three dimensional shape.
  - D. unfold proteins with the incorrect three-dimensional shape and refold them into the proper shape.
  - E. transport rRNA from the nucleus to the cytoplasm.

Answer: C (The structure and function of macromolecules, fig. 5.26, pp. 79–80)  
Chaperonins (also called chaperone proteins) are protein molecules that assist in the proper folding of other proteins. Molecular chaperones do not actually specify the correct final structure of a polypeptide. They work instead by keeping the new polypeptide segregated from “bad influences” in the cytoplasmic environment while it spontaneously folds.

16. Ethidium Bromide is used in electrophoresis of DNA fragments because it:
- A. makes the fragments visible under UV light.
  - B. makes the DNA fragments more mobile in the gel.
  - C. increases the conductivity of electricity through the gel.
  - D. helps determine the size of the fragments.
  - E. maintains a stable pH.

Answer: A (DNA technology and genomics, fig. 20.9 and fig. 20.10, pp. 383–385)  
Gel electrophoresis separates macromolecules – nucleic acids or proteins – on the basis of size, electrical charge and other physical properties. It sorts a mixture of DNA molecules into bands, each consisting of DNA molecules of the same length. Ethidium Bromide is a DNA-binding dye that fluoresces the DNA restriction fragments under UV light.

17. The species *Homo sapiens* first appeared in which geologic epoch?
- A. Miocene
  - B. Paleocene
  - C. Pleistocene
  - D. Pliocene
  - E. Eocene

Answer: C (Phylogeny and systematics, table 25.1, pp. 487)  
In the Cenozoic era, quaternary period, *Homo sapiens* first appeared in the Pleistocene epoch (about 1.8 million years ago).

18. Which of the following marine communities would be LEAST affected by a volcanic eruption or meteor impact that injected enough debris into the atmosphere to reduce sunlight by 50% for two years?
- A. Benthic community
  - B. Coral reef community
  - C. Deep sea vent community
  - D. Estuary community
  - E. Pelagic community

Answer: C (An introduction to ecology and the biosphere, pp. 1111 – 1112)

Deep-sea hydrothermal vents of volcanic origin in mid-ocean ridges are a unique assemblage of organisms. In the dark, hot, oxygen-deficient environment, the food producers are not photosynthesizing organisms. They are chemoautotrophic prokaryotes, which do not need light. The organic molecules they synthesize support a food chain that includes giant polychaete worms, arthropods, echinoderms and fishes.

19. 19. A *unique* feature of fertilization in angiosperms is that:
- A. it is a double fusion event; one sperm fertilizes the egg, the other sperm combines with the polar or fusion nucleus.
  - B. the sperm may be carried by the wind to the female gametophyte.
  - C. a pollen tube carries two sperm nuclei into the female gametophyte.
  - D. a chemical attractant guides the sperm toward the egg.
  - E. the sperm cells have flagella for locomotion.

Answer: A (Angiosperm Reproduction and Biotechnology, pp. 774 – 777)

Angiosperm, unlike Gymnosperms or other plant groups, have a double fusion event, one that involves fusion of egg and sperm (fertilization) resulting in a zygote, the second that involves the fusion of a sperm with a double fusion nucleus or the two polar nuclei if they have not yet fused. This second fusion process results in formation of a triple fusion nucleus that gives rise to the endosperm. Sperm are not carried to the female gametophyte by wind but the male gametophyte or pollen may be. Two sperm do enter the female gametophyte via a pollen tube but this is not unique to angiosperm but occurs in gymnosperms as well. Chemical attractants are involved in all plant fertilizations processes. Sperm of angiosperm do not have flagella.

20. Which statement describing plant structure is appropriate?
- A. Sclerenchyma cells provide support for the plant body
  - B. Collenchyma cells may form the outer cell layer of the plant
  - C. Wood is formed from old epidermal cells
  - D. Stomates are pores in the roots that allow nutrients to enter
  - E. Parenchyma cells have thicker cell walls than other plant cells

Answer: A (Plant structure and growth, fig. 35.11, pp. 726–728)

Parenchyma cells are relatively unspecialized cells with thin, flexible primary walls. Collenchyma cells have unevenly thickened primary walls and provide support to parts of the plant that are still growing. Sclerenchyma cells are specialized for plant support and have secondary walls hardened with lignin. They may be dead at functional maturity and are much more rigid than collenchyma cells. Mature sclerenchyma cells cannot elongate. They occur in regions of the plant that have stopped growing in length.

21. The Hardy-Weinberg equilibrium principle assumes all of the following statements EXCEPT:
- A. the proportion of alleles in a population tends to remain stable.
  - B. the frequencies of dominant and recessive alleles for a given trait in a gene pool of a large population can be determined mathematically.
  - C. genotype frequencies in a large population are unaffected by Mendelian segregation and recombination of alleles.
  - D. for a given trait the frequency of dominant alleles is greater than that of recessive alleles.
  - E. for a given trait the frequency of the genotype of the heterozygous population can be determined mathematically.

Answer D: (The evolution of populations, pp. 448–449)

When a population's gene pool is in a state of equilibrium, it is referred to as Hardy-Weinberg equilibrium. Allele frequencies in a gene pool can be calculated with the Hardy-Weinberg equation ( $p^2 + 2pq + q^2 = 1$ ). The dominant allele has no tendency to increase in frequency from one generation to the next related to the recessive allele. The allele frequencies tend to remain relatively constant.

22. Professor Jones is running an experiment with his graduate students in his physiology lab. One group of students drinks a liter of water, another group drinks a liter of coffee, and a third group drinks a liter of concentrated salt solution. The volume of urine produced by all individuals in the three groups is measured over a period of several hours. At the end of the monitoring period, which group will have produced the greatest volume of urine and which group the least?
- A. Those who drank coffee will produce the most urine, while those who drank water will produce the least
  - B. Those who drank coffee will produce the most urine, while those who drank the salt solution will produce the least
  - C. Those who drank the salt solution will produce the most urine, while those who drank water will produce the least
  - D. Those who drank the salt solution will produce the most urine, while those who drank coffee will produce the least
  - E. There will be no difference between the three groups

Answer: B (Regulating the internal environment, fig. 44.22 and fig. 44.23, pp. 944–950; Membrane structure and function, pp. 146-147)

A solution with a high concentration of solutes relative to one with a lower concentration of solutes is hypertonic. A solution with a lower concentration of solutes is hypotonic. On a concentration gradient, water has the lowest solubility and a concentrated salt solution has the highest solubility. A concentrated salt solution is the most hypertonic and water is the most hypotonic. Of the responses above, coffee has less solubility than the concentration salt solution. Individuals who drank coffee will produce more urine than those who drank the salt solution. The salt solution is a hypertonic relative to the body, therefore causing retention of fluids.

23. A protein is usually tagged for degradation by proteasome activity by which of the following proteins?
- A. Caspase
  - B. Kinase
  - C. Protease
  - D. Ubiquinone
  - E. Ubiquitin

Answer: E (The organization and control of eukaryotic genomes, fig. 19.12, pp. 368)

A proteasome is an enormous protein complex that chops up unneeded proteins in the cell. The proteins attacked by the proteasome are tagged with short chains of ubiquitin.



24. Which of the following statements is true of territorial behavior?
- A. Intruders win the majority of confrontations
  - B. Intruders are most likely to escalate a battle
  - C. "Owners" defend mainly against male intruders
  - D. "Owners" defend mainly against conspecifics
  - E. Contests are seldom "ritualized"

Answer: D (Behavioral biology, pp. 1137–1140)

A territory is usually fixed in location. Its size varies with the species, as do the function and amount of available resources. Territories are established and defended through agonistic behavior. An individual that has gained a territory is often difficult to dislodge. A territory is worth more to an owner than to an intruder because the owner is already familiar with it. The owner is usually more likely to escalate a battle than is an intruder. The owner mainly defends its territory against intruders of its own species (conspecifics).

25. You extract RNA from liver cells and then carry out an agarose gel electrophoresis of the liver RNA. The RNA fragments are then transferred to an RNA-binding membrane (nitrocellulose or nylon) using capillary action. Next, you hybridize a probe for gene X to the RNA on the membrane. Which of the following statements regarding your experiment is true?
- A. You are trying to determine how many copies of Gene X are in liver cells
  - B. You are trying to determine if the Gene X protein is present in liver cells
  - C. You are trying to determine if Gene X is expressed in liver cells
  - D. You are trying to determine the chromosomal location of Gene X
  - E. You are trying to determine whether Gene X has a mutant sequence

Answer: C (DNA technology and genomics, pp. 383–385)

Explanation? tlh

26. A toxin exists that inhibits the enzyme succinate dehydrogenase. If this were used in an experiment to stop respiration, how many net NADH and ATP molecules would be generated from each pyruvate molecule during pyruvate oxidation and the citric acid cycle up to that stage?
- A. 3, 1
  - B. 3, 2
  - C. 4, 1
  - D. 4, 2
  - E. 6, 2

Answer: A (Cellular respiration: harvesting chemical energy, fig. 9.8, fig. 9.9, fig. 9.11 and fig. 9.12, pp. 160–170)

2 NADH (from Glycolysis) + 2 NADH (upon conversion of 2 pyruvate to 2 Acetyl Co A) + 4 NADH (from conversion of 2 Acetyl Co A in the Krebs cycle up to succinate dehydrogenase) = 8 NADH; 8 NADH are produced from a molecule of glucose up to that point, and 4 ATP (or ATP equivalents, GTP) are produced in the Krebs cycle.

27. Which of the following characteristics is an adaptation of temperate climatic zone plants?
- A. Leaves with drip tips
  - B. Sunken stomata
  - C. Succulent leaves
  - D. Dormant buds
  - E. Very shallow roots

Answer: D (Plant structure and growth, pp. 721–724)

This material is not in Campbell. tlh



28. Which of the following statements is acceptable?
- A. A short day plant will flower if it has over a half day of darkness interrupted by a short flash of light
  - B. A long night plant will flower if it has over a half day of darkness interrupted by a short flash of light
  - C. A long day plant will flower if it has over a half day of darkness interrupted by a short flash of light
  - D. A long day plant will flower if it has over a half day of uninterrupted darkness A
  - E. A short day plant will flower if day length is less than 16 hours.

Answer: C (Plant responses to internal and external signals, fig. 39.22, pp. 821-822)

A short-day (long-night) plant flowers when night exceeds a critical dark period. A flash of light interrupting the dark period prevents flowering. A long-day (short-night) plant will flower only if the night is shorter than a critical dark period. The night can be artificially shortened with a flash of light.

29. Which of the following is NOT a second messenger?
- A. Calcium ion
  - B. Magnesium ion
  - C. Diacyl glycerol
  - D. Inositol trisphosphate (IP3)
  - E. Cyclic AMP

Answer: B (Cell communication, pp. 206–209)

Many signaling pathways involve small, non-protein, water-soluble molecules or ions called second messengers (the extracellular signal molecule that binds to the membrane receptor is a pathway's "first messenger."). Since second messengers are both small and water-soluble, they can readily speed throughout the cell by diffusion. Examples of second messengers are cyclic AMP, calcium ions, inositol triphosphate (IP3), and diacyl glycerol (DAG).

30. The reduction phase of the Calvin cycle is equivalent to which of the following processes in reverse?
- A. Electron transport chain
  - B. Krebs cycle
  - C. Light reactions of photosynthesis
  - D. Energy investment phase of glycolysis
  - E. Energy payoff phase of glycolysis

Answer: E (Cellular respiration: harvesting chemical energy, fig. 9.8, fig. 9.9 and fig. 9.11, pp. 160–168)

The Calvin cycle is a metabolic pathway similar to the Krebs cycle in that a starting material is regenerated after molecules enter and leave the cycle. Glycolysis consists of ten steps that can be divided into two phases, an energy investment phase and an energy payoff phase. In the energy investment phase, the cell uses ATP to phosphorylate the fuel molecule glucose. In the energy payoff phase, ATP is produced by the substrate-level phosphorylation and NAD<sup>+</sup> is reduced to NADH.

31. Which of the choices below correctly ranks [from least to greatest] the contribution of the various ecosystems as to their "Average Net Primary Production per unit area (kcal/m<sup>2</sup>/yr)"?
- A. Open ocean, tropical rainforest, savanna, temperate forest
  - B. Tropical rain forest, open ocean, savanna, temperate forest
  - C. Open ocean, savanna, temperate forest, tropical rain forest
  - D. Savanna, tropical rainforest, temperate forest, open ocean
  - E. Open ocean, tropical rainforest, temperate forest, open ocean

Answer: C (Ecosystems, fig. 54.3, pp. 1201)

32. In most terrestrial mammalian species, parental investment is greater for female parents than for male parents. This is because:
- A. females often court and mate with multiple males.
  - B. females often choose poor quality mates.
  - C. females are often injured in fighting for mates.
  - D. males are typically polyandrous.
  - E. females are typically 'K-selected', whereas males are more often 'r-selected'.

Answer: E (Population ecology, pp. 1163)

Female mammals have a low potential reproductive capacity relative to male mammals. They are "K" selected and have relatively few offspring due to parental investment and offspring security. Male mammals, however, have a far greater potential reproductive capacity. They are "r" selected and maximize their number of offspring.

33. Which of the following is part of the egg-producing structure in plants?
- A. The megagametophyte of angiosperms
  - B. The plasmodesmata of angiosperms
  - C. The microgametophyte in gymnosperms
  - D. The antheridium of mosses
  - E. The sori of ferns

Answer: A (Plant reproduction and biotechnology, fig. 38.1 and fig. 38.4, pp. 783-788)

A megagametophyte is a female gametophyte that arises from a megaspore of a heterosporous plant.

34. A booster dose of a vaccination helps to:
- A. increase the blood antibody level by increasing the number of effector cells.
  - B. increase the blood antibody level by decreasing the number of T-suppressor cells.
  - C. increase the MHC recognition sites by increasing effector cells.
  - D. maintain a high monocyte count.
  - E. decrease the number of monocytes.

Answer: A (The body's defenses, pp. 904-906, 916)

A primary response is the first time the body is exposed to an antigen. Ten to 17 days are required from the initial exposure to an antigen for selected lymphocytes to generate the maximum effector cell response. [Memory cells are long-lived cells bearing receptors specific for the same antigen. Effector cells are short-lived cells that combat the same antigen.] If an individual is exposed to the same antigen at a later time, the response is faster (only 2 to 7 days), of greater magnitude, and more prolonged. A vaccinated person who encounters a pathogen will therefore have the same quick, secondary response based on memory cells as a person who has had the disease.

35. In mice, one gene regulates color. Homozygous recessive organisms are white, homozygous dominant organisms are black, and some organisms exhibit incomplete dominance (gray fur). A gray male and a gray female produce an offspring of unknown gender. What is the probability that the mouse will NOT be born with white fur?
- A.  $\frac{1}{4}$
  - B.  $\frac{1}{3}$
  - C.  $\frac{3}{4}$
  - D. 1
  - E.  $\frac{1}{2}$

Answer: C (Mendel and the gene idea, fig. 14.5 and fig. 14.6, pp. 249-252)

An organism having a pair of identical alleles for a characteristic is homozygous for the gene controlling that character. If the two alleles differ, then one, the dominant allele, is fully expressed in the organism's appearance. A recessive allele in a heterozygote with complete dominance has no noticeable effect on the

organism's appearance. Incomplete dominance exists when a hybrid or heterozygote has an appearance different from the phenotype of the two homozygous parental varieties.

36. The most phytoplankton in a lake would be found in which zone?
- A. Aphotic zone
  - B. Benthic zone
  - C. Limnetic zone
  - D. Oligotrophic zone
  - E. Profundal zone

Answer: C (An introduction to ecology and the biosphere, fig. 50.18, pp. 1107)

In a lake, the zone that is well lit with open surface waters far from shore is called the limnetic zone. It is occupied by a variety of phytoplankton consisting of algae and cyanobacteria. These organisms photosynthesize and reproduce at a high rate during the spring and summer.

37. Hemoglobin, an iron-containing protein in erythrocytes, binds oxygen molecules. Myoglobin, a protein in muscle cells, is used for oxygen storage. What can be deduced about the relative oxygen affinities of hemoglobin and myoglobin?
- A. Myoglobin has greater oxygen affinity than hemoglobin
  - B. Hemoglobin has greater oxygen affinity than myoglobin
  - C. Both have roughly the same oxygen affinity
  - D. Neither has a significant oxygen affinity
  - E. The two cannot be compared as one is associated with binding the other with storage

Answer: A (Circulation and gas exchange, pp. 896–897)

A high concentration of an oxygen-storing protein, myoglobin is stored in muscles. Erythrocytes lack nuclei, which leaves more space in the tiny cells for hemoglobin, the iron-containing protein that transports oxygen. Oxygen transported in erythrocytes is preferentially bonded to myoglobin when blood presses through muscle tissue because of its higher affinity for oxygen.

\*Figure 'Comparison of oxygen affinity curve for hemoglobin vs. myoglobin' can be found at:  
[http://www.gravitywaves.com/chemistry/CHE%20450/07\\_MyoglobinHemoglobin.htm](http://www.gravitywaves.com/chemistry/CHE%20450/07_MyoglobinHemoglobin.htm).

38. In an experiment, a plant is grown at a particular level of light and in a certain concentration of CO<sub>2</sub>. With CO<sub>2</sub> constant and light intensity gradually increasing to a preset level, oxygen production increases up to a point and then levels off. If light is increased beyond the preset level, no further increase in oxygen production is noted. In a second experiment, the same increasing regimen of light is used, but a higher level of CO<sub>2</sub> is supplied. O<sub>2</sub> production in the second experiment continues to increase beyond the point where it leveled off in the first experiment. From these observations, one might conclude:
- A. light is the only limiting factor.
  - B. CO<sub>2</sub> concentration is the only limiting factor.
  - C. both light and CO<sub>2</sub> concentration are limiting factors throughout the time course of the reaction.
  - D. light is limiting up to a point and then CO<sub>2</sub> becomes a limiting factor.
  - E. neither light nor CO<sub>2</sub> concentration are limiting.

Answer: D (Plant nutrition, pp. 767–770)

39. Plant systematists have found that monocots were not the first flowering plants to evolve. This would suggest that:
- A. they must be more complex than previously thought.
  - B. they were misplaced in their lineage.
  - C. evolution does not always proceed from simple to complex.
  - D. they do not represent a true clade.
  - E. they evolved from a different ancestral group than other flowering plants did.

Answer: C (The evolution of seed plants, fig. 30.4 and fig. 30.11, pp. 606–607)

All angiosperms are placed in a single phylum, Anthophyta. A division into different angiosperm lineages is currently under debate. Until the late 1990s, most plant taxonomists divided the angiosperms into two main classes, monocots and dicots, which differ in several anatomical and morphological details.

Comparisons of DNA, however, reveal that not all plants having the dicot-type of anatomy fall into a single monophyletic group. Ernst Mayr has labeled several phylogenetic principles as false, including the 'simple is always ancestral to complex' principle. For more information on phylogenetic principles under debate, please visit <http://geowords.com/histbooknetscape/e18.htm>.

40. In a certain population of 100 deer, 34 births and 25 deaths were recorded in one year. Assuming no immigration or emigration occurred, what is  $r$  for that population?
- A. 0.09
  - B. 0.25
  - C. 0.34
  - D. 0.66
  - E. 0.90

Answer: A (Population ecology, table 52.1 and table 52.2, pp. 1154–1156)

41. A patient is suffering from kidney failure. Which of the following symptoms will most likely be present in this patient?
- A. A collapse of blood glucose level
  - B. An accumulation of uric acid in the blood
  - C. A higher salt concentration in the blood
  - D. A swelling of the liver
  - E. An excretion of vital amino acids

Answer: C (Regulating the internal environment, fig. 44.21 and fig. 44.22, pp. 944–946, 952)

Filtration in the kidneys occurs as blood pressure forces fluid from the blood in the glomerulus into the lumen of the Bowman's capsule. Filtration in the Bowman's capsule is nonselective for small molecules. The filtrate contains salts; glucose; vitamins; nitrogenous wastes, such as urea; and other small molecules. The descending limb of the loop of Henle is permeable to water but not to salt; water moves by osmosis into the hyperosmotic interstitial fluid. Salt diffuses out of the concentrated filtrate as it moves through the salt-permeable ascending limb of the loop of Henle. If the kidneys fail, the salt will not diffuse out of ascending limb of the loop of Henle.

42. An investigator found 150 different diatom species in one mile of a stream. None of the species comprised more than 5% of the total population. In a second observation twenty-five miles downstream, there were only 20 different diatom species, with 2 species representing 80% of the total population. What is the best explanation of these two observations?
- A. The stream is bigger at mile 25
  - B. The nature of the stream bottom changed
  - C. The stream velocity changed
  - D. Organic wastes high in nitrates and phosphates entered the stream somewhere between the two sampling stations
  - E. There must have been something wrong with the sampling methods

Answer: D (Population ecology, pp. 1151–1171)

A common observation of organically polluted water is a decrease in species diversity with an increase in population size in one or several species. This is a consequence of these species having a greater tolerance for the pollutant.

43. Which of the following statements is an **acceptable** statement about growth in plants?
- A. Only primary growth is localized in meristems.
  - B. Only stems have secondary growth.
  - C. Only secondary growth produces reproductive structures.
  - D. Monocots have only primary growth and dicots have only secondary growth.
  - E. Some plants lack secondary growth.

Answer: E (Plant Structure, Growth, and Development, pp. 720 – 728)

Meristems give rise to both primary and secondary growth. The lateral meristems (cambium) produce either secondary xylem and phloem or phelloderm and cork. Secondary growth in a woody plant occurs in both stem and root with little or no secondary growth in leaves. Reproductive structures such as flowers have their origin from the L-2 layer of the apical meristem, thus originate from primary tissue. While monocots generally do not produce a vascular cambium thus have no secondary vascular tissue, they may produce anomalous secondary growth. Most monocots and some dicots have only primary growth.

44. ATP is an important molecule in metabolism because it:
- A. is readily obtained from an organism's environment.
  - B. is extremely stable.
  - C. contains valuable nutrients.
  - D. has high-energy phosphate bonds.
  - E. has phosphate bonds that are very easily formed but not easily broken.

Answer: D (An introduction to metabolism, pp. 94–95)

The bonds between the phosphate groups of ATP's tail can be broken by hydrolysis. Because hydrolysis releases energy, the phosphate bonds of ATP are sometimes referred to as high-energy phosphate bonds.

45. Crossing over contributes to the genetic variation of a species by exchanging chromosomal segments between nonsister chromatids of homologous chromosomes. In the production of which type of cell does the crossing over occur?
- A. Chondrocytes
  - B. Gametes
  - C. Leukocytes
  - D. Osteoblasts
  - E. Sporophytes

Answer: B (The chromosomal basis of inheritance, pp. 274–275)

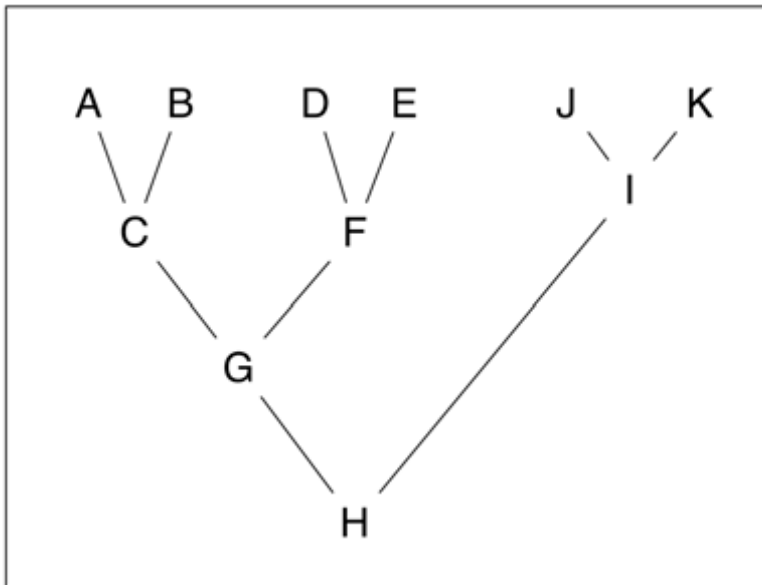
Homologous chromosomes are paired during prophase of meiosis I in the gamete cells. During crossover, nonsister chromatids may break at corresponding points and switch fragments.

46. In a population of 15 **AA**, 25 **Aa**, and 10 **aa** individuals, the frequency of the **a** allele is:
- A. 0.20.
  - B. 0.30.
  - C. 0.45.
  - D. 0.50.
  - E. 0.55.

Answer: C (The evolution of populations, fig. 23.3, pp. 448–449)

The Hardy-Weinberg equation calculates frequencies of alleles in a gene pool. Hardy-Weinberg equation is  $p^2 + 2pq + q^2 = 1$ .

47. Use the cladogram below to answer the following question. Which group(s) represent(s) a monophyletic taxon?



- A. A and B
- B. A, B, D, and E
- C. D, E, F, and G
- D. H, I, J, and K
- E. A, B, C, D, E, F, and G

Answer: E (Phylogeny and systematics, fig. 25.9, pp. 494–495)

A monophyletic group, or a clade, is made up of ancestral species and all of the descendant species.

48. A ribozyme is a(an):
- A. precursor form of an rRNA molecule
  - B. enzyme involved in the synthesis of RNA molecules.
  - C. protein that digests RNA molecules.
  - D. ribose molecule linked to an enzyme.
  - E. RNA molecule that functions as an enzyme.

Answer: E (From gene to protein, pp. 311–312)

Ribozymes are RNA molecules that function as enzymes.

49. When an ant in a colony dies, the live ants will throw the dead ant out of the anthill. If a live ant from the colony, Ant X, is sprayed with a chemical characteristic of dead ants, the live ants will repeatedly throw Ant X out of the anthill, until the chemical on Ant X wears off. What is the best behavioral explanation of ant colony?
- A. The ants are exhibiting a negative taxis triggered by the chemical
  - B. The other ants can learn only through trial and error
  - C. The ants exhibit a learned behavior
  - D. The live ants continue the behavior until they have been habituated
  - E. The chemical acts as a sign stimulus for a fixed action pattern

Answer: E (Behavioral biology, pp. 1124–1125)

A fixed action pattern (FAP) is a sequence of behavioral acts that is essentially unchangeable and usually carried to completion once initiated. It is triggered by an external sensory stimulus known as a sign stimulus.

50. Vascular plants share all of the following characteristics EXCEPT:

- A. alternation of generations.
- B. development of seeds.**
- C. dominance of the sporophyte.
- D. lignin in cell walls.
- E. xylem and phloem.

Answer: B (Plant diversity I: How plants colonized land, pp. 589)

Vascular plants include ferns and related plants (pteridophytes), gymnosperms and flowering plants (angiosperms). All possess to some degree food-transporting phloem tissue and water-conducting xylem tissue, and lignified cells. All have an alternation of gametophyte and sporophyte generations with a dominant sporophyte generation that becomes independent of the gametophyte, but they do not all produce seeds.