Massachusetts
Tests for Educator Licensure® (MTEL®)

Biology (13)

PRACTICE TEST APPENDIX:
Multiple-Choice Question Analyses

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MULTIPLE-CHOICE QUESTION ANALYSES

1. Formulating a testable hypothesis is particularly important when:

   A. determining cause and effect relationships between observable phenomena.

   B. interpreting a model that can be used to describe the workings of a natural system.

   C. explaining the interactions of all natural phenomena in terms of a few basic laws.

   D. describing as many characteristics as possible of living and nonliving things.

Correct Response: A. In science, a testable hypothesis proposes an explanation for a phenomenon or event. It must be measurable, and data must be collected through experimentation or observation. Formulating a testable hypothesis is important because it serves as a basis for making predictions that can be used to determine cause and effect relationships. In an experiment, a variable is manipulated according to the hypothesis (the cause). Data are collected to determine whether the results predicted by the hypothesis have been observed (the effect). The results can provide information for further experimentation. Interpreting a model (**B**), explaining interactions (**C**), and describing characteristics (**D**) involve scientific reasoning using existing information or data and do not require the use of a testable hypothesis.

2. Which of the following best describes the importance of having a control group in an experiment?

   A. insuring reproducibility of the results

   B. facilitating the peer review process

   C. reducing potential bias by the observer

   D. isolating the effect of a single variable

Correct Response: D. Best practice for a well-designed experiment is to include a test group for which the factor being tested (i.e., the independent variable) is not applied. In all other aspects, the conditions for the control group are identical to the groups to which the independent variable is applied. The results from the control group provide baseline data that allow researchers to determine whether the application of a single independent variable has an effect. Ensuring the reproducibility of the results (**A**) is best accomplished by keeping detailed records of the set-up and of the actual conditions of the experiment. This allows for the experiment to be faithfully replicated in order to determine whether the results are reproducible and real rather than a statistical anomaly. Although peer reviewers will most likely look for the inclusion of a control group when they evaluate the experiment, inclusion of a control group does not facilitate the peer review process (**B**). Potential bias may be reduced (**C**) by practices such as double-blind experiments in which both the participants and the observers are unaware whether they received the actual treatment or a placebo. However, reduction of potential bias is not the primary reason for the inclusion of a control group.

3. A scientist planning to survey the characteristics of individuals in a particular plant population is careful to choose methods that guarantee random selection of the individuals to be measured. This randomization will:

   A. reduce potential bias in the results.

   B. increase the statistical significance of the results.

   C. ensure reproducibility of the results.

   D. provide a sufficient number of samples in the results.

Correct Response: A. Randomization will ensure that all members of the population will have an equal likelihood of being included in the study. This will reduce potential bias resulting from known tendencies, such as the overrepresentation of larger or more conspicuous individuals in the study, as well as from the effects of important variables that may be unknown to the researcher. An underlying bias can make the level of statistical significance irrelevant (**B**), and truly random sampling clearly won't guarantee reproducible results (**C**). A larger sample size may increase reproducibility of the results, but is independent of the randomness of the sampling procedure (**D**).

4. A student is doing an experiment to determine how change in acidity affects enzyme activity. The time it takes for a disk soaked with catalase at different acidities to rise to the top of a vial containing 1% hydrogen peroxide will be measured. If the student presents the findings in a line graph, which of the following conditions will be represented on the *x*-axis of the graph?

   A. pH values

   B. catalase concentrations

   C. disk rise times

   D. percent hydrogen peroxide

Correct Response: A. In this experiment, the change in acidity (the variable that will be manipulated) is the independent variable. In line graphs, the independent variable values are on the *x*-axis. Catalase concentration (**B**) and percent hydrogen peroxide (**D**) are constants in this experiment; they do not change. As such, they do not get plotted along either axis on a line graph. The disk rise times (**C**) are the dependent variable. Changes in the rise time depend on changes in the independent variable, such as acidity in this experiment. In a line graph, the dependent variable is plotted on the *y*-axis.

5. **Use the table below to answer the question that follows.**

Trial number	1	2	3	4	5	6	7
Temperature (°C)	25	26	29	29	20	24	22

The data table shows the average sample temperature during each of seven experimental trials. If *x* represents the mode, *y* represents the median, and *z* represents the mean, which of the following expressions is true?

A. $z = y < x$

B. $x < z < y$

C. $z = x < y$

D. $x < y < z$

Correct Response: A. Statistically speaking, the mode represents the most frequent value within a range of values, the median is the middle value within a range of values, and the mean is the mathematical average of a set of values. For the data provided above, the mode (*x*) is 29°C, the median (*y*) is 25°C, and the mean (*z*) is 25°C, implying that $z = y < x$. The mode is the most frequent value in the data set, and in this case is also the greatest of the three values. However, the mode (*x*) is not the greatest value in expressions $x < z < y$ (**B**), $z = x < y$ (**C**), and $x < y < z$ (**D**).

6. A group of 14 students is monitoring the acidity level in a nearby stream over a period of two weeks. At the same time every day, a student will take one of four available digital pH meters to measure the pH of the stream, and record the result in a laboratory notebook. Which of the following factors represents a systematic error associated with the design of the experiment?

   A. the rounding of the pH readings in the digital displays

   B. the measurements being made by different students

   C. the use by the students of four different pH meters

   D. the sampling being done at the same time every day

Correct Response: C. The pH meters may not be equally accurate. This can introduce errors in measurement associated with which meter is used by the students. It would be preferable for the students to use the same pH meter, or at least calibrate all four of the existing meters to some standard. The rounding errors (**A**) are essentially random, not systematic, in nature. Students should use the same protocol when making the measurements (**B**), which should reduce the associated error in measurement. Sampling at the same time every day should minimize daily fluctuations in the data (**D**).

7. A study is being conducted to determine whether there is a causal link between a recently built chemical factory and the health of people in the surrounding area. Which of the following types of information would most strongly suggest that there is a causal relationship?

   A. visible air pollution in nearby neighborhoods

   B. historical links between chemical manufacturing and human health issues

   C. opinions of people living near the chemical plant

   D. increases in the number of patients being treated for asthma in nearby medical facilities

Correct Response: D. Asthma is a lung disease that causes airways to constrict, leading to difficulty in breathing. Asthma attacks can be triggered by chemicals, dust, and/or air pollution. An increase in the number of patients being treated for asthma in medical facilities near the chemical factory would suggest a causal relationship, especially if the increase in asthma patients coincides with activity from the chemical factory. Although visible air pollution near the factory (**A**) suggests that the factory may be affecting the local environment, this observation does not provide evidence about how people's health has been affected. Historical links between chemical manufacturing and human health issues (**B**) signal that health issues are a potential risk but do not provide direct evidence that health issues are occurring around this specific chemical factory. Although opinions (**C**) may be based on observations, opinions themselves are subjective and not the best source of information on which to determine a causal relationship.

8. A laboratory investigation requires students to dispense 5 mL of a 1 molar sodium chloride solution. Which of the following pieces of laboratory glassware should the students use to achieve the most precise measurement?

   A. 5 mL graduated beaker

   B. 10 mL graduated cylinder

   C. 15 mL graduated conical flask

   D. 20 mL graduated test tube

Correct Response: B. While all the glassware listed can be used to measure liquids, the 10 mL graduated cylinder would be the best choice for this application. This is because the measurement markings of the graduated cylinder are more accurate than those of the beaker (**A**) and conical flask (**C**). Also, compared to the graduated test tube (**D**), the volume of the graduated cylinder is much closer to the volume of solution to be dispensed. Selecting glassware with a volume close to the desired volume increases the precision of the measurement.

9. An excess of a chemical measured out for use in a laboratory experiment should be:

   A. returned to the original stock.

   B. reported on a Material Safety Data Sheet form.

   C. disposed of according to state guidelines.

   D. labeled and set aside for use in the future.

Correct Response: C. Excess chemicals need to be disposed of properly according to state, federal, and science safety guidelines. Chemicals not disposed of properly may be hazardous to the people in the laboratory and the environment. If the chemical is returned to the original stock (**A**), it has the potential of contaminating the entire stock. The Material Safety Data Sheet (**B**) provides information about the chemical, including the proper method of storage and disposal, but it is not a reporting form. Setting a chemical substance aside (**D**), even if properly labeled, is not an appropriate method of dealing with the excess chemical since it can become contaminated with other substances used in the laboratory or can react with the air while exposed.

10. A teacher is planning to lead a class of students on a field trip to a local park in Massachusetts where they will collect representatives of different types of insects. Before leaving for the park, it would be most important that the teacher ensure that the first-aid box contains an emergency kit for treating:

    A. allergic reactions to bee stings.

    B. exposure to poison ivy.

    C. spread of venom from a snake bite.

    D. infection from a mosquito bite.

Correct Response: A. A person who is allergic to bee stings may go into anaphylactic shock when stung. Bite and sting first-aid kits are available that contain an epi-pen that can reverse severe low blood pressure, wheezing, severe skin itching, hives, and other symptoms of an allergic reaction. Preventing contact with poison ivy (**B**) and infection from mosquito bites (**D**) involve taking precautions such as wearing appropriate clothing and using repellents effective against ticks and/or mosquitoes rather than using any treatments typically found in a first-aid kit. There are only two types of venomous snakes indigenous to Massachusetts, and they are both very rare, so the likelihood of needing to prevent the spread of venom from a snake bite (**C**) is low.

11. Which of the following factors was primarily responsible for the initial increase in O_2 in the earth's atmosphere?

    A. the escape of gases from volcanoes

    B. the emergence of multicellular organisms

    C. the photosynthesis of cyanobacteria

    D. the condensation of water into oceans

Correct Response: C. Cyanobacteria are capable of photosynthesis and release oxygen gas as a by-product of the photosynthetic process. Fossil evidence indicates the presence of cyanobacteria during the early stages of the earth, so they had the potential to be responsible for the increase of atmospheric oxygen. Gases escaping from volcanoes (**A**) are sulfur-based, so volcanoes did not contribute to the initial increase in oxygen. Multicellular organisms (**B**) emerged later than cyanobacteria. In addition, many multicellular organisms, such as animals, do not release oxygen to the atmosphere. The condensation of water **(D**) is part of the water cycle; it does not produce oxygen during the process of changing physical states.

12. Scientists have developed plants that contain genes from microbes to help them kill insects. Some people are concerned that transgenic agricultural crops might transfer genes to other species. Which of the following is the basis for this concern?

    A. Plant genes have promoter sequences that are similar to those of microbes.

    B. Transgenic plants may be unusually susceptible to native diseases.

    C. Most microbes are known to exchange DNA through conjugation.

    D. Transgenic DNA is designed to be incorporated into new genomes.

Correct Response: D. One advantage of generating transgenic plants with desirable traits is that the desirable traits will be passed from one generation to the next. For this to occur, the genes must be incorporated into the germline cells of the transgenic plants. Thus, the ability to be incorporated into new genomes is deliberately designed into the vectors used to transfer the genes to the target plants. Some people are concerned that under the right conditions this vector design could allow the genes to be unintentionally incorporated into other organisms. There are structural differences between eukaryotic and prokaryotic gene promoters (**A**). There is no evidence to date that transgenic crops are unusually susceptible to native plant diseases (**B**). Some microbes can exchange DNA through conjugation (**C**), but successful conjugation between microbes and eukaryotic cells is relatively infrequent under natural conditions.

13. A story in a newspaper reports that post-surgical patients who received a type of alternative therapy involving light touching of the body report less severe pain than those who did not receive the therapy. The story concludes that this therapy should be adopted in all hospitals. Which information would be most useful to a reader in assessing the validity of this conclusion?

    A. the percentage of patients in all hospitals who report that they have experienced severe pain after undergoing surgery

    B. the estimated cost to hospitals of providing the alternative therapy to all of their postsurgical patients

    C. the percentage of patients reporting reduced pain after receiving other widely used treatments such as traditional massage or talking with staff

    D. the level of pain reported by post-surgical patients before and after they received the alternative therapy

Correct Response: C. If hospitals are to adopt the alternative therapy to reduce post-surgical pain, the most useful method to assess the usefulness of this treatment would be to know whether the alternative therapy is at least as effective as more traditional methods of pain reduction. Having information about the percentage of patients reporting reduced pain after receiving other forms of treatment would allow this assessment to be made. Information about the percentage of patients in all hospitals who experienced severe pain after surgery (**A**), the cost of the alternative therapy (**B**), and the level of pain reported pre- and post-alternative therapy (**D**) would not be helpful in determining if the alternative therapy was as effective in reducing pain as other treatment methods and, therefore, whether the therapy should be used in all hospitals.

14. The ability of plants to transport water and dissolved nutrients against the force of gravity is directly attributable to the:

    A. cohesion of water molecules.

    B. breaking of hydrogen bonds in liquid water.

    C. temperature-induced changes in water density.

    D. high specific heat of liquid water.

Correct Response: A. Water molecules (H_20) are polar and form hydrogen bonds between oxygen and hydrogen atoms on neighboring water molecules. This tendency of water molecules to "stick" to one another allows them to pull one another up through the roots and stem as water evaporates from the leaves of the plant. If the hydrogen bonds between water molecules are broken (**B**), water loses its cohesion and thus its ability to draw water molecules up through the plant. Water transport in plants does not involve temperature-induced changes in water density (**C**) or the high specific heat of liquid water (**D**).

15. A solution with a pH of 3 is how many times more acidic than a solution with a pH of 6?

    A. 2x

    B. 10x

    C. 1000x

    D. 2000x

Correct Response: C. The pH of a solution is measured using a logarithmic scale. A logarithm is an exponent. This means that each whole number value on the pH scale is 10 times more acidic than the next greater whole number value. Since a pH of 6 is greater than a pH of 3 by 3 whole number values, a pH of 3 is 1000x ($10 \times 10 \times 10 = 10^3$) more acidic than a pH of 6. (**A**) incorrectly assumes that the relationship is multiplicative instead of logarithmic ($2 \times 3 = 6$). (**B**) represents the difference in acidity between two consecutive whole number values on the pH scale. (**D**) represents a combination of a multiplicative and logarithmic relationship between whole number values on the pH scale ($2 \times 10 \times 10 \times 10$).

16. The immense diversity of biological molecules results most directly from the:

    A. reactivity of oxygen.

    B. mass of phosphorus.

    C. availability of nitrogen.

    D. structure of carbon.

Correct Response: D. Each carbon atom is able to form four covalent bonds. This allows carbon to form molecules with diverse characteristics that include the ability to form carbon chains of differing lengths, double and triple bonds, and bonds with a variety of different functional groups. Although oxygen (**A**) is able to react with a large variety of different molecules, in most cases each oxygen atom can form only two covalent bonds. The size of phosphorus (**B**) contributes to its ability to form more covalent bonds than nitrogen (**C**) or even carbon. However, the structure of phosphorus and nitrogen do not allow the formation of the variety of chains or bonds and functional groups demonstrated by carbon-based molecules.

17. Biologically important properties of water such as its cohesion, high specific heat, anomalous phase densities, and role as a solvent can be attributed primarily to the:

    A. tendency of water molecules to form double bonds.

    B. hydrogen bonds that form between water molecules.

    C. relatively low molecular weight of water compared to other liquids.

    D. ability of water to dissociate into hydrogen and hydroxide ions.

Correct Response: B. The fact that water forms hydrogen bonds with other water molecules means that water molecules are attracted to one another (cohesive). Water can also absorb a large amount of heat while going through a phase change because an initial input of heat is required to break hydrogen bonds between water molecules before a phase change can occur. Ice is less dense than liquid water because the hydrogen bonds force water molecules into a more rigid, less dense structure as water cools. Water can form hydrogen bonds with other molecules as well, contributing to water's role as a solvent. Water does not tend to form double bonds (**A**). The relatively low molecular weight of water (**C**) and water's ability to dissociate (**D**) do not contribute significantly to the collective set of properties listed.

18. Saturated fats are best distinguished from unsaturated fats by the fact that saturated fats:

    A. are more likely to be solid at room temperature.

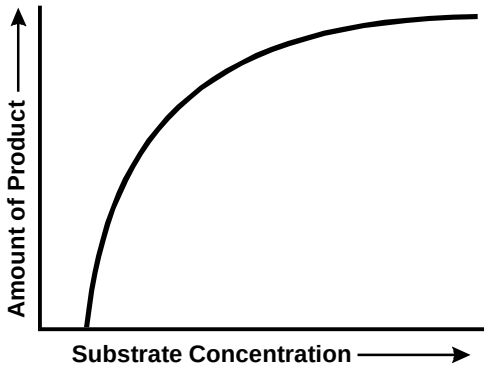
    B. contain more cholesterol.

    C. are more common in plants than in animals.

    D. contain more double bonds.

Correct Response: A. Saturated fats have carbon chains that contain the maximum number of hydrogen atoms and only single bonds between adjacent carbon atoms. This results in carbon chains that are relatively linear and able to pack closely together. These properties tend to make saturated fats solid at room temperature. Although cholesterol (**B**) is also a lipid, it has a molecular structure that is distinct from saturated and unsaturated fats. Saturated fats are more common in animals, not plants (**C**). Unsaturated fats, rather than saturated fats, contain more double bonds (**D**). These double bonds make unsaturated fats more rigid, less able to pack tightly together, and more likely to be liquid at room temperature.

19. **Use the graph below to answer the question that follows.**



The graph shows the relationship between the amount of product of a reaction and the substrate concentration for a reaction that is catalyzed by an enzyme. Which of the following is the best explanation for the flattening of the curve at higher concentrations of the substrate?

A. There is a competitive inhibitor present.

B. The enzyme is being denatured.

C. The substrate has been used up.

D. The active site of the enzyme is saturated.

Correct Response: D. The flattening of the curve occurs when essentially all enzyme active sites are occupied at a given moment. At this point, the substrate concentration is so great that as soon as products are released from an enzyme molecule, new substrates bind to its active site. A competitive inhibitor (**A**) would reduce the amount of product formed at low substrate concentrations, resulting in a curve with a more gradual increase or slope. If the enzyme had been denatured (**B**), the amount of product would decrease. The graph does not depict a situation in which the substrate has been used up (**C**), since the *x*-axis shows only a continuously increasing substrate concentration.

20. The end of the general belief in the spontaneous generation of life led to the widespread acceptance of which of the following scientific concepts?

    A. cell theory

    B. endosymbiosis

    C. natural selection

    D. uniformitarianism

Correct Response: A. Growing evidence against the idea that life derives spontaneously from nonliving materials coincided with increasing evidence in favor of the cell theory. Cell theory describes the properties of cells and asserts that cells are the basic unit of life as well as the basic unit of reproduction. Endosymbiosis (**B**) is a more recent theory that specifies that several key organelles of eukaryotes originated as a symbiosis between separate single-celled organisms. Natural selection (**C**) is the concept that the differential survival and reproduction of individual organisms is the result of differences in phenotype, while uniformitarianism (**D**) is a theory that states that changes in Earth's crust during geological history have resulted from the action of continuous and uniform processes.

21. Which of the following enables plant cells to achieve enough structural rigidity to support the overall plant?

    A. the stacking of thylakoids within the chloroplasts

    B. the osmotic pressure within the central vacuole

    C. the facilitated diffusion of proteins across the plasma membrane

    D. the matrix of polysaccharides in the cytoskeleton

Correct Response: B. As the central vacuole of a plant cell fills with water, the total osmotic pressure within the cell increases. The cell begins to expand until it meets resistance from the rigid cell wall. It is the pressure of the cell pushing against the cell wall that provides the overall structural rigidity in a plant. Thylakoids (**A**) are flattened sacs that divide the interior of the chloroplast into chambers and do not supply structural rigidity. Facilitated diffusion (**C**) uses specialized proteins to move large molecules or charged particles (ions) across the cell membrane. These molecules are not part of the plant cell's structure. The cytoskeleton (**D**) consists of different proteins making up filaments and tubules, which do provide some support within the cell but do not contribute to the overall rigidity of a plant to the extent that osmotic pressure within the central vacuole does.

22. Rough endoplasmic reticulum is particularly well developed in cells that:

    A. secrete proteins or glycoproteins.

    B. detoxify drugs or poisons.

    C. support chemiosmosis.

    D. hydrolyze macromolecules.

Correct Response: A. The rough endoplasmic reticulum is the portion of the endoplasmic reticulum to which ribosomes are attached. Together, the endoplasmic reticulum and the ribosomes produce membrane proteins and proteins that are to be secreted from the cell. Additionally, carbohydrate chains are frequently attached to proteins in the rough endoplasmic reticulum to produce glycoproteins. For these reasons, the rough endoplasmic reticulum is well developed in cells that produce large quantities of secreted and/or glycoproteins. The detoxification of drugs or poisons (**B**) occurs in the smooth endoplasmic reticulum. The movement of charged particles (ions) across the cell membrane is called chemiosmosis (**C**), and the rough endoplasmic reticulum does not have a direct role in this. The hydrolysis of macromolecules (**D**) frequently occurs in lysosomes and by proteasomes in the cytoplasm.

23. Which of the following structures are typically found in both plant and animal cells?

    A. cell walls

    B. Golgi apparatus

    C. lysosomes

    D. central vacuoles

Correct Response: B. The Golgi apparatus is an organelle that helps sort, modify, and transport membrane components and secreted proteins that were made in the endoplasmic reticulum. This function is required in all eukaryotic cells, including both plant and animal cells. Cell walls (**A**) and central vacuoles (**D**) are found in plant but not animal cells. Animal cells contain lysosomes, which perform hydrolytic functions for the cell (**C**). These same functions are performed by vacuoles in plant cells.

24. Which of the following characteristics allows a virus to propagate itself without killing its host cell?

    A. nature of the protein coat on the virus

    B. absence of restriction enzymes in the cell

    C. existence of a provirus stage in its life cycle

    D. RNA as the viral genetic material

Correct Response: C. Some viruses are able to integrate a DNA copy of their genome into the host cell's DNA. This integrated viral DNA is called a provirus and becomes a permanent part of the host cell's genome. The provirus is a latent form of the virus that does not kill the host cell. It gets propagated each time the host cell copies and passes its DNA to daughter cells. The nature of the viral protein coat (**A**) does not play a role in the propagation of the virus except in finding a compatible host. Restriction enzymes destroy foreign DNA within a cell, so the absence of restriction enzymes (**B**) may actually increase the viruses' ability to infect and destroy a host cell. The use of RNA as the viral genetic material (**D**) does not play a role in the prevention of the death of the host cell. It only carries the genetic material for the virus.

25. Which of the following processes is most likely to cause an increase in the level of lactic acid within a cell?

    A. hydrolysis

    B. respiration

    C. glycolysis

    D. fermentation

Correct Response: D. Fermentation is a process cells use to deal with the products of glycolysis in the absence of oxygen. During glycolysis, NAD^+ is reduced to NADH in order to produce ATP and pyruvate. The cell needs to regenerate NAD^+ so that glycolysis can continue. Under anaerobic conditions, fermentation occurs. Pyruvate is reduced to lactic acid, and NADH is oxidized to regenerate NAD^+. Hydrolysis (**A**) is a general term that refers to reactions in which water is used to split a larger molecule. These reactions generally do not produce lactic acid. Glycolysis (**C**) itself does not produce lactic acid. Rather, under aerobic conditions, the NADH and pyruvate generated during glycolysis are shuttled into the mitochondria, which uses them to produce more ATP via the process of cellular respiration (**B**). Lactic acid is not a byproduct of cellular respiration.

26. The Calvin cycle is the process by which:

    A. carbon dioxide is fixed and converted into carbohydrates.

    B. hydrogen ions are generated and used to make NADPH.

    C. electrons become excited and are used to produce ATP.

    D. oxygen is removed from water molecules and released as a gas.

Correct Response: A. During photosynthesis, the Calvin cycle uses ATP and NADPH to incorporate carbon dioxide gas into carbohydrates. The production of NADPH (**B**) and ATP (**C**) and the release of oxygen gas (**D**) are all events that occur during the light reactions of photosynthesis, rather than during the Calvin cycle.

27. The mechanism by which ATP provides energy for the metabolic processes of a cell involves the:

    A. generation of heat by hydrolysis of a phosphate group.

    B. transfer of a phosphate group to other molecules.

    C. lowering of the activation energy required for phosphorylation.

    D. absorption of light by pigments during phosphorylation.

Correct Response: B. During many metabolic reactions, enzymes facilitate the transfer of a phosphate group from adenosine triphosphate, or ATP, to one of the reactant molecules. Bonds with phosphate groups tend to contain a lot of chemical potential energy, which has now been transferred to the reactant in the metabolic process and can be used to drive the metabolic reaction forward. Although hydrolysis of a phosphate group will release heat (**A**), this heat is dissipated and its energy is unavailable to drive a metabolic reaction forward. Lowering the activation energy is often required for phosphorylation (**C**), but this process is generally facilitated by enzymes. Absorption of light by chlorophyll does help provide the energy needed to generate ATP during photosynthesis. However, absorption of light by pigments (**D**) is not a general mechanism used by the cell to drive metabolic reactions.

28. Which of the following situations best demonstrates phagocytosis?

    A. A bacterium is surrounded by a plasma membrane, engulfed, and enclosed by a vacuole.

    B. An antigen binds to a specific receptor on the surface of a plasma membrane, which invaginates around the antigen.

    C. A food particle is surrounded by a plasma membrane, engulfed, and diffuses through the lipid bilayer.

    D. An antibody within the cell is enclosed in a vesicle that fuses with the plasma membrane and releases the antibody from the cell.

Correct Response: A. Phagocytosis is the type of endocytosis that facilitates bringing large particles such as bacteria into the cell. Endocytosis is used when the particles are too large to enter through the plasma membrane. During phagocytosis, the plasma membrane surrounds the particle, enclosing it in a vacuole so that it can be engulfed by the cell. Although a cell is able to deactivate an antigen, such as a pathogen, when it binds to a specific receptor (**B**) on the membrane, phagocytosis is not necessary for this process to occur. Phagocytosis occurs when particles, including food, are too large to diffuse through the plasma membrane, which is composed of a lipid bilayer (**C**). Instead the cell surrounds the particle with its membrane and forms a vacuole around the particle to allow digestion. The process of antibody-containing vesicles fusing with the plasma membrane to release the antibodies from the cell (**D**) is an example of exocytosis, rather than phagocytosis.

29. Unlike mitosis, binary fission:

    A. occurs in prokaryotic cells.

    B. requires formation of a spindle.

    C. increases genetic variability.

    D. results in identical daughter cells.

Correct Response: A. Mitosis is a process used by eukaryotic cells to generate new cells. It involves disassembling the nucleus in the parent cell and reassembling a new nucleus in each daughter cell. Prokaryotic cells (bacteria) do not contain a nucleus and use an alternate method for reproduction called binary fission. A spindle (**B**) is a structure used during mitosis to separate sister chromatids to opposite sides of the dividing cell. Unrepaired mutations during DNA replication can generate some genetic variability (**C**), but these mutations can occur in both mitosis and binary fission. Both mitosis and binary fission typically result in identical daughter cells (**D**), so this is not a difference between the two processes.

30. One application of gene therapy is the delivery of *p53* genes to cells. These genes cause cells that malfunction to undergo programmed death. This method would be most effective at:

    A. preventing cancer from being inherited.

    B. treating polygenic disorders related to cancer.

    C. inhibiting the development of cancerous tumors.

    D. improving the response of healthy cells to chemotherapy.

Correct Response: C. The p53 gene regulates cell growth and proliferation by preventing unrestricted cell division. When the p53 gene is deactivated, malfunctioning cells may continue to have unregulated growth and may eventually form tumors. Therapy using the p53 gene targets these malfunctioning cells for apoptosis, or programmed death, thus inhibiting the development of cancerous tumors. Although a predisposition for cancer may be inherited (**A**), the goal of p53 therapy is to provide a treatment for the malfunctioning cells, not to prevent the inheritance of cancer. The primary function of p53 is to regulate cell growth and proliferation; as such, it is unlikely to have a significant effect in treating polygenic disorders related to cancer (**B**), nor would it be likely to improve the response of healthy cells to chemotherapy (**D**).

31. A germinating fern spore will develop into:

    A. a rhizoid.

    B. a gametophyte.

    C. an archegonium.

    D. a sporophyte.

Correct Response: B. Spores are part of the haploid phase of the fern life cycle. When fern spores germinate, they undergo mitosis to produce a haploid gametophyte, the function of which is to produce gametes. When a male gamete fertilizes a female gamete a fern can transition to the diploid phase of its life cycle. A rhizoid (**A**) is a filamentous structure primarily produced on the underside of a moss thallus, and functions in anchoring the plant or conducting water. The archegonium (**C**) is the sex organ within the gametophyte that produces oocytes. The sporophyte (**D**) is the multicellular diploid phase of the fern.

32. The double fertilization that is unique to the reproduction of angiosperms has which of the following consequences?

    A. Polyploidy and hybridization are more common in plants than in animals.

    B. Two pollen grains are necessary to fertilize each ovum.

    C. Zygotes form during both the gametophyte and sporophyte generations.

    D. Food storage tissue in seeds is triploid.

Correct Response: D. During angiosperm fertilization, each pollen grain divides and forms two sperm cells. One sperm cell fertilizes the ovum (egg) to produce the zygote. The other sperm cell combines with the two polar nuclei within the embryo sac and forms a triploid cell. This triploid cell develops into the food storage tissue (endosperm) of the seed. Polyploidy (having several complete sets of chromosomes) and hybridization (the combination of nuclei from different species of organisms) (**A**) occur more frequently in plants but are not the result of double fertilization. Only one sperm cell derived from a single grain of pollen is required to fertilize each ovum (**B**). Zygotes form during the sporophyte stage (**C**) of the angiosperm life cycle.

33. An important difference in how aquatic autotrophs and land plants carry out photosynthesis is that only land plants:

    A. receive carbon dioxide through specialized structures.

    B. have chlorophyll *a*, which allows them to absorb red and blue light.

    C. produce NADPH during the light reactions.

    D. use a chemiosmotic mechanism for producing ATP.

Correct Response: A. Land plants take in carbon dioxide from the atmosphere through pores in their leaves called stomata. Such pores are necessary because the leaves of land plants are coated in a waxy covering called the cuticle. The cuticle prevents water loss but also limits gasses from diffusing directly into the leaves. Aquatic autotrophs such as algae lack a cuticle. This allows aquatic autotrophs to obtain dissolved carbon dioxide from the water primarily by diffusion, so stomata are not needed. Aquatic plants and land plants both contain chlorophyll *a* (**B**), produce NADPH during the light reactions (**C**), and use a chemiosmotic mechanism for producing ATP (**D**).

34. Closure of stomata immediately affects a plant's:

    A. root pressure.

    B. transport of glucose.

    C. rate of water loss.

    D. frost resistance.

Correct Response: C. Stomata are openings found primarily on the underside of a plant's leaves and on its stem. When the stomata close, water vapor in the plant cannot escape, thus reducing the rate of water loss. Pressure in the root (**A**) affects the amount of nutrients, including water, absorbed by the root from the environment, but root pressure is not affected immediately with the closure of the stomata. Transportation of nutrients (**B**) throughout the plant uses special tissues; the closing of the stomata, however, does not affect the immediate movement of nutrients. A plant increases its frost resistance (**D**) by changing the colloidal consistency of its protoplasm (or in the case of woody plants, its sap), but the closing of the stomata does not trigger or affect the frost resistance of the plant.

35. Bean leaves growing under constant environmental conditions in a laboratory raise and lower their leaves on a 26-hour cycle. This is an example of a:

    A. phototropism.

    B. circadian rhythm.

    C. day-neutral behavior.

    D. photoperiodic response.

Correct Response: B. Circadian rhythms are periodic biological responses that occur on an approximately 24-hour cycle. Circadian rhythms are independent of external stimuli and would thus continue to occur under constant environmental conditions. Phototropism (**A**) is a directional response in which plants grow toward a light source. A day-neutral behavior (**C**) is independent of the relative amount of light and dark hours received by a plant. However, day-neutral behaviors do not occur on a 24-hour cycle. A photoperiodic response (**D**) depends on the ratio of light-to-dark hours a plant receives and would not occur under constant environmental conditions.

36. Which of the following describes the triple response of seedlings that allows them to push up through the soil to the surface?

    A. phototropism; ethylene emission; programmed cell deaths

    B. slowing of stem elongation; thickening of stem; horizontal growth of stem

    C. changes in turgor pressure; phytochromes; blue-light receptors

    D. variation in auxin concentrations; production of growth inhibitors; abscission layers

Correct Response: B. The triple response occurs when the sprouting seedling encounters an obstacle such as a rock on its way to breaking through the soil's surface. The seedling then produces ethylene, which causes stem elongation to slow, the stem to thicken to be stronger and the stem to have horizontal growth to find an easier path to the surface. Once the path is found the seedling continues to move upward. Although ethylene does play a role in the triple response, phototropism and programmed cell deaths (**A**) do not affect the triple response. Changes in turgor pressure, phytochromes, and blue-light receptors (**C**) do not affect the triple responses of the seedling because the seedling has not yet broken through the soil. Auxin concentration, the production of growth inhibitors and the abscission layers (**D**) may occur in a plant, but they do not play a role in the triple response of a seedling that is still underground.

37. Lichens obtain their carbon from the:

    A. photosynthesis of green algae or cyanobacteria.

    B. absorption of decomposing organic material.

    C. accumulation of wind-borne particulate matter.

    D. assimilation of solutes dissolved in precipitation.

Correct Response: A. Lichens are a mutually beneficial association between fungi and photobionts (either algae or cyanobacteria). The photobiont provides carbon for the lichen through photosynthesis. In the case of cyanobacteria. Absorption of decomposing organic material (**B**), the accumulation of wind-borne particulate matter (**C**), and the assimilation of solutes dissolved in precipitation (**D**) are not significant means by which lichens obtain carbon.

38. After two prokaryotes undergo conjugation:

    A. one cell resides inside the other as an endosymbiont.

    B. each cell divides and produces two daughter cells.

    C. the genome of one cell is altered by the process.

    D. both cells remain attached to each other and begin to form a colony.

Correct Response: C. To provide a means for genetic variation, prokaryotes undergo conjugation, which is the direct transfer of genetic material from one cell into another. This changes the genetic composition of the cell that receives the transferred DNA. Endosymbiosis (**A**) occurs when one cell resides in another for mutual survival. Prokaryotic cells divide and produce daughter cells through the process of binary fission (**B**). Although cells undergoing conjugation are connected while the transfer of genetic material from one cell to the other occurs, they separate once the transfer is complete (**D**).

39. Roundworms are among the most primitive organisms that have a

    A. nerve net.

    B. digestive tract.

    C. respiratory organ.

    D. circulatory system.

Correct Answer: B. Roundworms are some of the most primitive organisms to have an actual digestive track consisting of a mouth and anus connected by a digestive tube. More-primitive organisms, such as hydra and jellyfish, have a network of interconnected neurons called a nerve net (**A**). Roundworms lack both respiratory organs (**C**) and a structured circulatory system (**D**).

40. Hydrostatic skeletons are characteristic of which of the following groups of animals?

    A. jellyfish

    B. sponges

    C. insects

    D. annelids

Correct Response: D. A hydrostatic skeleton consists of layers of muscles and a pressurized fluid-filled compartment that assist in the movement of soft-bodied animals. The muscles stretch and then contract, and movement is dependent on the pressure of the fluid. Annelids, such as earthworms, have a hydrostatic skeleton. Myriapods, such as jellyfish, (**A**) and insects (**C**), have exoskeletons with muscles attached internally that allow for movement. Sponges (**B**) have spiny spicules for structural support, but they lack muscles and do not have a hydrostatic skeleton.

41. Among unicellular organisms, the distinguishing feature of the protozoa is their:

    A. movement through fluids using cilia or flagella.

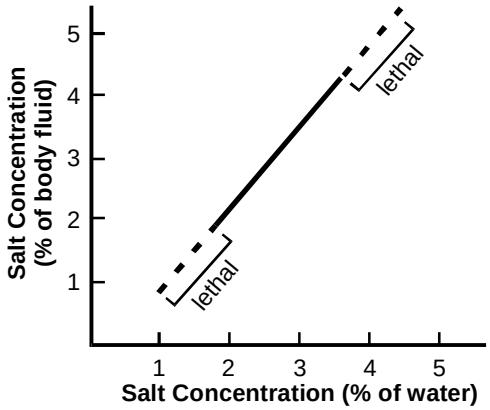
    B. consumption of other microbes for nutrients and energy.

    C. ability to aggregate in response to chemical signals.

    D. reproduction by binary fission rather than by spores.

Correct Response: B. Unicellular organisms are diverse and can be classified in many ways. One way is by their primary method of obtaining nutrients and energy. Protozoa are heterotrophic and consume other microbes, algae are autotropic, and fungus-like organisms are heterotrophs that absorb nutrients from dead and decaying organisms. Although there are examples of unicellular algae and fungus-like organisms that consume other microbes in specific situations, this is not their primary method of obtaining nutrients. Movement through fluids using cilia or flagella (**A**), the ability to aggregate in response to chemical signals (**C**), and reproduction by binary fission (**D**) are not unique to protozoa.

42. **Use the graph below to answer the question that follows.**



The graph above shows the change in salt concentration in the cells of a spider crab as the salt concentration of the surrounding water changes. The data suggest that with respect to salt concentration the spider crab is:

A. regulating its internal environment.

B. using a positive feedback mechanism to maintain homeostasis.

C. conforming to the external environment.

D. using a negative feedback mechanism to maintain homeostasis.

Correct Response: C. The data in the graph indicate that the salt concentration in the cells of the spider crab is the same as that in its environment. As the salt concentration in the environment goes up, the salt concentration in the spider crab cells increases by the same amount. Because the data show that the salt concentration in the spider crab cells varies with the salt concentration of the environment, they demonstrate that the salt crab is unable to regulate its internal environment (**A**). Nor is it able to maintain homeostasis, the ability to maintain a stable internal environment, by either a positive (**B**) or negative (**D**) feedback mechanism.

43. In birds which of the following characteristics is most likely to be correlated with a monogamous mating relationship?

    A. male and female sexual dimorphism

    B. cryptic coloration

    C. young that require constant feeding

    D. seasonal migration

Correct Response: C. A monogamous mating relationship in birds is when a male and female bird form a pair bond for one or more nesting seasons and work together to raise their young. One situation in which this relationship is advantageous is when the young require constant feeding. Male and female sexual dimorphism (**A**) is when certain traits, such as coloration, are inherited in a male- or female-specific pattern within a species. Cryptic coloration (**B**) helps an organism blend in with its environment and is an advantage for hiding from predators. An example of seasonal migration (**D**) is birds following a seasonal pattern in moving from one region to another in order to obtain necessary resources, such as food or nesting locations. None of these characteristics are specifically tied to monogamous mating relationships in birds.

44. Which of the following characteristics of vertebrates is a necessary consequence of being bilaterally symmetrical?

    A. a true body cavity

    B. an endoderm layer

    C. an interior skeleton

    D. a right and a left side

Correct Response: D. Bilateral symmetry indicates that the organism can be divided down a central axis, each side being a mirror image of the other, with right and left sides. Vertebrates are coelomates, having a true body cavity (**A**), but this is not a consequence of being bilaterally symmetrical. Vertebrates have an endodermal layer (**B**), but so do echinoderms, which are not bilaterally symmetrical as adults. Some bilateral organisms, such as flatworms, do not have an interior skeleton (**C**).

45. One reason that birds are better able than mammals to function at high altitudes is that unlike mammals, birds:

    A. rely on negative pressure breathing rather than on positive pressure breathing.

    B. exchange air in the lungs completely with every breath.

    C. maintain a lower partial pressure of oxygen in the lungs than do mammals.

    D. have oxygen-carrying proteins in addition to hemoglobin.

Correct Response: B. The structure of lungs in birds is different from that of mammals. In birds, air flows in one direction through parabronchioles, where gas exchange with capillaries occurs. Each breath completely exchanges air in the lungs. This is more efficient than the mammalian lung structure, in which air flow is bidirectional and gas exchange occurs in alveoli. Birds and mammals both use negative-pressure breathing (**A**) in which air is drawn into the body by the expansion of the rib cage. Although birds at high altitudes would likely have a lower PO_2 in their lungs than animals at lower altitudes (**C**), this would tend to make oxygen exchange with the blood more difficult and is a challenge birds must overcome. Hemoglobin is responsible for transporting oxygen in birds as well as in mammals (**D**), although the hemoglobin produced by high-altitude birds may have a greater affinity for oxygen.

46. Panting by mammals is part of a feedback response that cools the body by:

    A. hyperventilating the lungs.

    B. dilating capillaries in the mouth and throat.

    C. triggering a countercurrent heat exchange.

    D. increasing evaporative heat loss.

Correct Response: D. Panting that is observed in some mammals and birds is a feedback response when the internal body temperature rises. Panting increases the evaporation of moisture from the nasal passages, mouth, and throat. Evaporation causes some internal body heat to be lost as it evaporates moisture from the tissues, thus reducing the internal body temperature. Hyperventilation of the lungs (**A**) is a rapid increase in the volume of air entering the lungs and is a symptom of a more serious condition than overheating. Dilating the capillaries in the mouth and throat (**B**) is not caused by panting, although it can bring heat up to the surface of the mouth and throat. Panting does not trigger a countercurrent heat exchange (**C**), in which heat moves from one area to another, even though it enables moisture in the oral cavities to evaporate.

47. A veterinarian finds that a cat has a lesion on its hypothalamus. This injury would most directly affect the cat's ability to:

    A. coordinate muscle movements.

    B. regulate its body temperature.

    C. perceive visual stimuli.

    D. control its breathing.

Correct Response: B. The hypothalamus is a section of the brain that produces hormones that help regulate bodily functions, such as body temperature, thirst, and hunger. The skeletal muscles that produce coordinated movements (**A**) and the perception of visual stimuli (**C**) are controlled by the somatic nervous system, not the hypothalamus. Breathing is controlled (**D**) by the autonomic nervous system, not the hypothalamus**.**

48. Which of the following is a function performed by the liver?

    A. regulation of blood flow to the stomach during digestion

    B. generation of new red and white blood cells

    C. removal of wastes and toxins from the blood

    D. control of peristalsis in the digestive tract

Correct Response: C. Among other functions, the liver helps control blood composition. It does this both by regulating the amount of sugar, fats, and proteins in the blood and by removing wastes and toxins, such as ammonia. Blood flow to the stomach (**A**) is largely regulated by hormones. Generation of all new red blood cells and most white blood cells occurs in the bone marrow (**B**). Control of peristalsis in the digestive tract is a function of the nervous system (**D**).

49. Which of the following best describes the function of bile salts in the process of digestion?

    A. bonding to the surface of amino acids to allow them to be actively pumped against the concentration gradient by epithelial cells

    B. lowering stomach pH to produce the acid environment necessary for the proper functioning of enzymes and the destruction of pathogens

    C. coating fat droplets and preventing them from coalescing to expose more surface of the droplets to the action of hydrolytic enzymes

    D. cleaving bonds of amino acids to break long polypeptide chains into smaller segments that can be more easily absorbed

Correct Response: C. The bile produced by the liver and stored in the gall bladder helps emulsify lipids (fats) in the duodenum. Bile salts are hydrophilic on one side and hydrophobic on the other side, and they tend to aggregate around droplets of lipids. The hydrophobic side is positioned toward the fat, and the hydrophilic side faces outward. The hydrophilic side prevents fat droplets coated with bile from re-aggregating into larger fat particles and exposes the fat's surface to enzymes. Bile salts emulsify fats and do not bond with amino acids in order to move them against the concentration gradient (**A**). Bile salts are secreted into the duodenum, which is part of the intestinal tract and is not part of the stomach (**B**). Bile salts adhere to lipids rather than to amino acids (**D**); it is pepsin that begins the process of breaking down protein in the stomach.

50. Which of the following is the primary cause of most peptic ulcers in humans?

    A. bacterial infection

    B. frequent ingestion of spicy foods

    C. viral eruption

    D. regular use of antacids

Correct Response: A. Peptic ulcers are lesions that form in the lining of the stomach. The most common cause of peptic ulcers is the bacterium *Helicobacter pylori*. Although excess alcohol consumption and frequent use of some pain medications can also increase the likelihood of ulcers, spicy food (**B**), viral eruption (**C**), and use of antacids, which help neutralize gastric acid, (**D**) do not contribute significantly to ulcer formation.

51. Which of the following best describes an important role of the lymphatic system in circulation?

    A. returning fluid and blood proteins lost by capillaries back to the veins

    B. transporting carbon dioxide released from cells to the bloodstream

    C. maintaining electrolyte balance of body fluids within tolerance limits

    D. removing toxins from the blood before they damage the heart

Correct Response: A. As blood circulates through the capillaries, it loses a significant volume of fluid to the surrounding tissues. Vessels of the lymph system collect the lost fluid and return it to the blood stream. Without this important function of the lymphatic system, blood volume would most likely drop to the extent that circulation could no longer occur. Carbon dioxide released from cells (**B**) diffuses through the interstitial fluid that bathes the cells and enters the capillaries, also by diffusion. The kidneys, not the lymphatic system, are the primary organs that maintain the electrolyte balance of body fluids (**C**). The liver, not the lymphatic system, has a number of functions that include the detoxification of potentially harmful chemicals from the bloodstream (**D**).

52. Which of the following best describes the role of clonal selection in the development of acquired immunity to a pathogen?

    A. Leukocytes that are stimulated as a result of increased body temperature during an infection differentiate from their precursor stem cells more rapidly.

    B. Lymphocytes that possess receptors that can bind to the pathogen's antigens rapidly divide to produce many cells capable of recognizing and attacking the pathogen.

    C. Natural killer cells that produce antibodies capable of attacking the pathogen are stimulated to produce more antibodies than cells that do not produce such antibodies.

    D. Phagocytes that ingest many pathogens over a short period of time grow and divide more rapidly than those that have not ingested many pathogens.

Correct Response: B. Acquired immunity is a specific immune response that is generated after exposure to specific antigens. Each lymphocyte contains receptors that recognize a single antigen. When that specific antigen binds to a receptor on a lymphocyte, the lymphocyte divides to produce many cells capable of recognizing and attacking the pathogen source of the antigen. After the initial stimulation of a lymphocyte, the body can respond more rapidly upon exposure to the same pathogen. Immune responses as a result of increased body temperature (**A**) and natural killer cells (**C**) are part of the non-specific immune response, rather than acquired immunity. Although certain phagocytes help trigger clonal selection by presenting antigens to lymphocytes, phagocytes (**D**) are themselves part of the non-specific immune response, in that they recognize and destroy pathogens indiscriminately.

53. Evidence suggests that fever is a mechanism of homeostasis that can help fight infection by:

    A. reducing the permeability of plasma membranes to pathogens.

    B. increasing the concentration of oxygen in the blood.

    C. lowering blood pressure and heart rate.

    D. enhancing production and mobility of leukocytes.

Correct Response: D. When fighting an infection, the body's temperature increases, creating an environment that is hostile to pathogens. This increase in temperature is called a fever. The body begins to produce white blood cells—leukocytes—to detect and destroy the microorganisms that are causing the infection. Increased temperatures, such as a fever, increase rather than reduce the permeability of the plasma membrane (**A**). A fever decreases the concentration of oxygen in the blood (**B**) because it reduces the oxygen's ability to bind to hemoglobin. A fever increases blood pressure and heart rate rather than lowering them (**C**).

54. Which of the following best describes an aneurysm and its effect on circulation?

    A. An aneurysm is a blood clot that may stick in an artery and restrict blood flow.

    B. An aneurysm is a deposit of plaque on the wall of an artery that may impede or block blood flow.

    C. An aneurysm is an abnormal connection between an artery and a vein that can lead to decreased oxygen delivery to tissues.

    D. An aneurysm is a weak spot in the wall of an artery that may rupture and cause a major hemorrhage into surrounding tissues.

Correct Response: D. Aneurysms are bulges or widenings in a blood vessel caused by a weakness in the blood vessel wall. Because of this structural weakness, aneurysms are prone to rupturing and causing blood to hemorrhage into surrounding tissues. If such ruptures occur in the brain, it can lead to a stroke. A blood clot that forms in a blood vessel (**A**) is a thrombus. Deposits of plaque on the walls of arteries (**B**) are found in atherosclerosis and are known as atheromas. An abnormal connection between an artery and a vein (**C**) is an arteriovenous fistula and can lead to decreased oxygen delivery to surrounding tissues because capillaries in the region are bypassed.

55. Which of the following best describes the function of the cilia that are attached to the epithelial lining of the bronchi and bronchioles of the lungs?

    A. producing mucous and other secretions that trap pathogens

    B. insulating delicate lung tissue from exposure to cold inhaled air

    C. moving particulate contaminants upward to the pharynx

    D. trapping inhaled oxygen molecules for transfer to the blood

Correct Response: C. Cilia are hairlike extensions of the cell membrane of specialized cells that are found in the bronchi and bronchioles of the lungs. They have an upward sweeping motion that assists in moving dust and other particles that have entered the lungs back out into the environment. The lining of the lungs has specialized cells called goblet cells (**A**) that produce secretions to trap dust and other particles that have entered the trachea. The lungs hold air that is brought in, and the body warms the air as it enters the lungs (**B**). Oxygen moves from cells that line the lungs' alveoli into the blood by diffusion (**D**). None of these processes require the use of cilia.

56. Which of the following best describes the mechanism by which hemoglobin loads and unloads oxygen?

    A. Production of CO_2 during cellular respiration lowers blood pH, which decreases the affinity of hemoglobin for oxygen and facilitates the unloading of oxygen to cells.

    B. Oxygen molecules binding to one subunit of a hemoglobin molecule change its shape, and the other three subunits also change shape and accept oxygen more readily.

    C. Blood arriving at the lungs has a lower PO_2 pressure than the air inside the lungs, which favors the diffusion of oxygen into the blood from the lungs.

    D. Carbon dioxide in the blood as a result of increased cellular respiration causes the heart's pacemaker to speed up and increase the transport of oxygen to cells.

Correct Response: A. Loading and unloading of oxygen from hemoglobin is sensitive to the pH of the blood. As blood becomes more acidic due to the release of carbon dioxide as a byproduct of cellular respiration, the affinity of hemoglobin for oxygen decreases, and oxygen is released into the surrounding tissues. The affinity of hemoglobin for oxygen does increase after the initial oxygen molecule binds (**B**), but this mechanism does not control the loading or unloading of the initial oxygen molecule onto hemoglobin. Blood arriving at the lungs does have a lower PO_2 than the air inside the lungs (**C**), causing oxygen to diffuse into the blood from the lungs; however, this does not explain the mechanism by which hemoglobin loads and unloads oxygen. Although the heart rate does increase in response to increased levels of carbon dioxide in the blood (**D**), this does not describe the mechanism by which hemoglobin loads and unloads oxygen.

57. The sensation of thirst is produced by the brain primarily in response to signals from the body indicating:

    A. decreased heart rate and blood pressure.

    B. increased internal temperatures.

    C. decreased urinary output by the kidneys.

    D. increased osmolarity of the blood.

Correct Response: D. An increase in the concentration of dissolved chemicals present in the blood, or osmolarity, signals to the brain that the body needs more water to dilute the chemicals and return the body to homeostasis. A decrease in heart rate and blood pressure (**A**) generally causes light-headedness or dizziness rather than thirst. An increase in internal temperature (**B**) can be an indication of infection and will signal the production of leukocytes to destroy pathogens. However, this does not usually cause the sensation of thirst. The first indication of less water in the body is a decrease in urinary output by the kidneys (**C**), which are signaled to reabsorb the water instead of moving it to the urinary bladder. Only when reabsorption of water by the kidneys is unsuccessful at balancing the osmolarity of the blood, is the sensation of thirst produced.

58. Which of the following best describes a difference between the peripheral nervous system and the central nervous system?

    A. Axons within the peripheral nervous system are longer since they must stretch from cell bodies in the ganglia located along the spine to their destinations in the tissues.

    B. Nerve cells that are located within the peripheral nervous system have many more dendrites than those that are located within the central nervous system.

    C. Synapses within the peripheral nervous system are electrical rather than chemical and so do not require the use of neurotransmitters to transmit information.

    D. Impulses in the peripheral nervous system carry information from the body to the brain, while those in the central nervous system carry it from the brain to the body.

Correct Response: A. The central nervous system consists of the brain and spinal cord. The nerves of the peripheral nervous system originate in or near the central nervous system and extend to the different regions of the body. Because of this, the axons in the peripheral nervous system must be longer. Dendrites are the extensions of a nerve cell that receive signals from other nerve cells. The nerve cells within the peripheral nervous system do not have significantly more dendrites than those located in the central nervous system (**B**). Synapses in the central and the peripheral nervous system both use neurotransmitters to transmit chemical signals (**C**). Impulses in the peripheral nervous system flow both to and from the central nervous system (**D**).

59. In invertebrates, the speed at which an action potential travels along an axon is directly proportional to the axon's diameter. However, vertebrate axons have narrow diameters, but can still conduct action potentials at very high speeds. This is true because vertebrate axons:

    A. contain higher concentrations of water that increase the conductivity.

    B. possess a lipid-rich myelin sheath that functions as electrical insulation.

    C. operate at higher body temperatures that reduce electrical resistance.

    D. generate action potentials that use sodium rather than calcium to generate electrical impulses.

Correct Response: B. The myelin sheath is a protective covering, composed of proteins and lipids, that surrounds an axon. It speeds up the transmission of electrical impulses by allowing a current to flow only along certain segments of the axon that are exposed to extracellular space. Although water (**A**) helps in electrical conductivity, it is the myelin sheath that increases the speed of electrical impulses along axons. The temperature of the body cannot be said to significantly affect electrical resistance along vertebrate axons (**C**), since the body temperatures of cold-blooded and warm-blooded vertebrates vary widely. All organisms use sodium to propagate action potentials along axons (**D**).

60. Which of the following best describes the role played by the hormone oxytocin in human reproduction?

    A. inducing and regulating uterine contractions during the various stages of labor

    B. stimulating the growth of follicles in the ovary and maturation of the oocytes

    C. inducing and regulating the disintegration of the uterine lining during menstruation

    D. stimulating the development of the endometrium in preparation for pregnancy

Correct Response: A. Oxytocin is a hormone made in the hypothalamus and stored in the posterior pituitary gland. This hormone is responsible for inducing contractions during labor. Follicle stimulating hormone is responsible for stimulating the growth of follicles and the maturation of oocytes (**B**). Estrogen and progesterone stimulate the development of the endometrium and maintain it in preparation for pregnancy (**D**). If the oocyte is not fertilized, the levels of estrogen and progesterone drop off, which induces the disintegration of the uterine lining (**C**).

61. The "fight or flight" response to a stress is initiated when nerve impulses stimulate the:

    A. thyroid to produce the hormones triiodothyronine and thyroxine.

    B. posterior pituitary to release the tropic hormone adrenocorticotrophic hormone.

    C. adrenal medulla to secrete the catecholamines, epinephrine and norepinephrine.

    D. parathyroid glands to release the glucocorticoid hormone cortisol.

Correct Response: C. The "fight or flight" response to a stressor begins when the adrenal glands are stimulated to secrete the catecholamines, epinephrine and norepinephrine. These hormones stimulate the necessary physical responses to either fight the perceived harm or to run away from it for the purpose of survival. The hormones triiodothyronine and thyroxine produced by the thyroid (**A**) are used for regulating metabolism and are not involved directly in the "fight or flight" response. The pituitary gland releases adrenocorticotrophic hormone (**B**), which causes the release of other hormones to help deal with stress and low blood sugar, but it does not cause the "fight or flight" response. The hormone cortisol released by the parathyroid (**D**) is produced to deal with long-term stress by maintaining homeostasis; it does not cause the "fight or flight" response.

62. Which of the following is a major difference between cartilage and other types of connective tissues?

    A. The extracellular matrix in cartilage lacks collagen.

    B. Cartilage does not contain blood vessels.

    C. The primary mineral in cartilage is phosphorus rather than calcium.

    D. Cartilage cells do not possess nuclei.

Correct Response: B. Connective tissues join and/or support other tissues within the body and include such tissues as adipose tissue, bone, and cartilage. Cartilage is unique among connective tissue in that it does not contain blood vessels. Collagen (**A**) is an important structural component of cartilage. Unlike bone, cartilage is not a significant reservoir of either phosphorus or calcium (**C**). Chondrocytes, or cartilage cells, contain nuclei (**D**).

63. In the human skeleton, which of the following has a pivot joint?

    A. shoulder

    B. knee

    C. elbow

    D. finger

Correct Response: C. A pivot joint is a type of synovial joint that includes two or more bones that are covered with slippery cartilage at each end. They have a cylindrical bone that rotates inside another bone, which forms a ring around it. With the elbow, the radius rotates around the ulna when the hand is turned inward or outward. The shoulder joint has a ball and socket joint (**A**) that has the most range of motion around its axis. The knee has a hinge joint (**B**) that allows movement in one direction or one plane, and the wrist has gliding joints (**D**) in which one bone glides over another for a limited range of motion.

64. Which of the following best describes how muscle fibers contract?

    A. Actin filaments shorten during the early phase of contraction, and myosin filaments shorten during the later phase of contraction.

    B. Actin and myosin filaments slide past each other without changing their length.

    C. Actin and myosin filaments wind tightly around each other during contraction, which shortens their lengths.

    D. Actin filaments shorten during contraction, while myosin fibers stretch.

Correct Response: B. During muscle contraction, actin and myosin filaments slide past one another, remaining the same length as they create movement. The actin and myosin filaments do not shorten (**A**) or wind around one another and shorten (**C**), nor does one shorten and one lengthen (**D**) during a contraction. Instead, the actin and myosin remain the same length as they slide past one another during a contraction.

65. The stratum corneum tissue of human skin consists mainly of dead cells that are continuously sloughed off and replaced by new cells migrating from underlying layers. This characteristic of the stratum corneum is most directly related to the skin's ability to:

    A. maintain elasticity and tone in underlying muscle and connective tissue.

    B. provide a continuous supply of leukocytes as part of the innate immune response.

    C. replenish worn and damaged sensors of the peripheral nervous system.

    D. protect against injury and serve as a barrier against the entry of pathogens.

Correct Response: D. The stratum corneum is the outermost layer of skin and is part of the epidermis. The cells of the stratum corneum contain large quantities of keratin, a tough, fibrous protein that helps provide protective properties to the skin. Studies show that removal of the stratum corneum causes the skin to lose its ability to serve as a protective barrier. Collagen and elastic fibers within the skin's dermis provide strength and elasticity to skin (**A**). Eccrine sweat glands, also located in the dermis, release fluid that contains water and metabolic wastes (**B**). The release of sweat by eccrine sweat glands also helps dissipate heat (**C**).

66. In humans, the allele for red-green colorblindness is sex-linked and recessive. For a colorblind female, which of the following statements must be true?

    A. Her mother is colorblind.

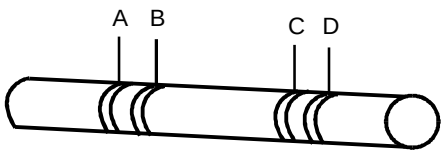
    B. Both parents carry the allele for colorblindness.

    C. Her father has normal vision.

    D. Her mother has normal vision, but is a carrier for colorblindness.

Correct Response: B. Since colorblindness is sex-linked and recessive, a female must receive two alleles for the trait to be expressed, one from the X-chromosome of the biological mother, and one from the X-chromosome of the biological father (**B**). A sex-linked trait is carried on the X-chromosome. Since a male has only one X-chromosome, and this father passed down the trait to his daughter, his X-chromosome must carry the trait; therefore, he is colorblind, so (**C**) cannot be true. A female has two X-chromosomes, of which only one is passed on to her child. Since the daughter received an X-chromosome that carried the trait from her mother, the mother could have been colorblind (**A**), or a heterozygote carrier (**D**), but it cannot be determined from the information given which genotype is true in this case.

67. **Use the diagram below to answer the question that follows.**



The diagram above shows a chromosome map of four genes relative to each other. Which pair of genes would have the highest recombination frequency?

A. B and A

B. A and C

C. B and C

D. A and D

Correct Response: D. Recombination of two genes occurs when a crossover event happens between homologous chromosomes in the region between the two genes. The probability of recombination increases as the distance between the genes increases, because there is a larger area of the chromosome in which a crossover event could occur. The diagram shows that genes A and D are farthest away from each other on this chromosome, so these two genes would have the highest recombination frequency. Gene pairs B and A (**A**), A and C (**B**), and B and C (**C**) are all closer to each other on the chromosome than gene pair A and D. Therefore each of these pairs would have a lower recombination frequency than gene pair A and D.

68. Polyploidy in an organism is most likely to result from a:

    A. frameshift mutation that deletes a termination codon.

    B. low level of helicase activity during DNA replication.

    C. reciprocal exchange of material between nonsister chromatids.

    D. chromosomal nondisjunction during meiosis.

Correct Response: D. When an organism is polyploid, the organism has more chromosomes than the normal number in a set for that species. This occurs during meiosis after the DNA has been replicated. It results from a failure of chromosomes to segregate into separate daughter cells. Frameshift mutations that delete a termination codon most frequently result in nonfunctional proteins as the result of the incorporation of extra amino acids (**A**). Helicase is an enzyme that separates the strands of DNA molecules. Low helicase activity potentially slows down DNA replication but would not result in polyploidy (**B**). During a reciprocal exchange of material between nonsister chromatids (**C**), DNA is neither lost nor gained, so this process does not result in polyploidy.

69. During which phase of meiosis is crossing over most likely to occur?

    A. prophase I

    B. prophase II

    C. metaphase I

    D. metaphase II

Correct Response: A. Crossing over is the exchange of genetic material between homologous chromosomes. During prophase I of meiosis, synapsis occurs in which homologous chromosomes come together to form pairs, overlapping at several places along their lengths. At this time genetic material can be exchanged between the homologous chromosomes. Although homologous chromosomes are still paired during metaphase I (**C**), crossing over occurs most frequently during prophase I. Since homologous chromosomes have been separated into different daughter cells at the end of meiosis I, crossing over cannot occur during either prophase II (**B**) or metaphase II (**D**).

70. In mice, black coat color allele (*B*) is dominant to brown coat color allele (*b*). However, a gene on a different chromosome determines whether or not color will be deposited in the coat at all. The dominant allele *C* represents color deposition while the recessive allele *c* represents lack of pigment. If two mice heterozygous for both genes are crossed, what is the probability that any one of their offspring will be brown?

A. $\frac{1}{16}$

B. $\frac{3}{16}$

C. $\frac{1}{4}$

D. $\frac{9}{16}$

Correct Response: B. Each parent has a BbCc genome. This type of problem is often represented using a Punnett square. There are 16 possible combinations for the offspring: BCBC, BCBc, BCbC, BCbc, BcBC, BcBc, BcbC, Bcbc, bCBC, bCBc, bCbC, bCbc, bcBC, bcBc, bcbC, and bcbc. In this dihybrid cross, only the genomes bCbC, bCbc, and bcbC, $\frac{3}{16}$ of the offspring, will inherit the two b alleles and at least one C allele needed to produce the brown coat phenotype. Approximately $\frac{1}{16}$ (**A**) of the offspring will have two b alleles, but still lack color because they also inherited two c alleles. The probability that an offspring could have no color is $\frac{1}{4}$, (**C**), and the probability that an offspring is black-coated is $\frac{9}{16}$ (**D)**.

71. Upon reaching a ribosome, a tRNA molecule will:

    A. match an anticodon to the complementary mRNA codon.

    B. attach an amino acid to the growing polypeptide chain.

    C. eliminate introns from the mRNA sequence.

    D. terminate the growing polypeptide chain.

Correct Response: A. The primary role of tRNA molecules is to bring the appropriate amino acids to the ribosome during translation. A tRNA molecule accomplishes this by matching its anticodon (a sequence of three nucleotides that designates the specific amino acid attached to the tRNA molecule) to the codon sequences in the mRNA molecule being translated. The anticodon sequence will pair only with the complementary mRNA codon, thus ensuring that the correct amino acid is added to the polypeptide chain. The amino acids that are delivered to the ribosome by tRNA molecules are attached to the growing polypeptide chain by the large ribosomal subunit (**B**). Introns (non-coding regions) are eliminated from the mRNA sequence (**C**) by a structure called a spliceosome before the mRNA leaves the nucleus. Termination of the growing polypeptide chain (**D**) occurs when the ribosomal complex reaches a termination codon, which signals a protein called a release factor to bind and release the polypeptide chain.

72. Which of the following best describes an operator in prokaryotic gene expression?

    A. It is a specific nucleotide sequence that indicates where DNA replication begins.

    B. It removes introns and facilitates the splicing of exons in genes.

    C. It is a transposable genetic element that activates an operon.

    D. It controls access of RNA polymerase to the genes in a transcription unit.

Correct Response: D. An operator is a DNA sequence to which a repressor can bind, blocking RNA polymerase from transcribing prokaryotic genes. The operator does not function as an origin of replication (**A**), nor is an operator able to remove introns, which are non-coding sections of RNA (**B**). This process is typically performed by a spliceosome. Transposable elements are segments of DNA that are capable of excising and reinserting themselves into new locations within the chromosome (**C**). They do not activate operons.

73. One consequence of the redundancy of the genetic code is that:

    A. somatic mutations do not affect the germ line.

    B. nucleotide base deletions may lead to frameshift mutations.

    C. some point mutations have no effect on phenotypic expression.

    D. missense mutations may result in translocations.

Correct Response: C. The genetic code is redundant in the sense that there are 64 possible codons and only 20 different amino acids. This means that many amino acids are coded for by multiple codons. When a point mutation occurs that changes a codon but does not change the amino acid that it codes for, there will be no change in phenotype because the amino acid that is incorporated into the protein will not change. Somatic mutations occur in body cells and will not affect the germline of the organisms, regardless of the redundancy of the genetic code (**A**). The redundancy of the genetic code will not prevent nucleotide base deletions from leading to frameshift mutations (**B**). A missense mutation is a nucleotide substitution that results in a new amino acid being incorporated into the encoded protein. A translocation is when DNA is exchanged between chromosomes. Missense mutations do not result in translocations (**D**) and neither are affected by the redundancy of the genetic code.

74. Which of the following techniques is used to increase the quantity of DNA in a sample to be analyzed?

    A. DNA sequencing

    B. polymerase chain reaction

    C. restriction fragment analysis

    D. DNA hybridization

Correct Response: B. To increase the quantity of DNA in a sample, a scientist would use the polymerase chain reaction technique, in which the polymerase enzyme replicates samples of DNA. DNA sequencing (**A**) provides information about the genome but does not increase the quantity of DNA in a sample. Restriction fragment analysis (**C**), which provides information about DNA that has been cut into smaller fragments, is not a technique that increases the quantity of DNA in a sample. Likewise, the quantity of a DNA sample is not increased using the technique of DNA hybridization (**D**), which is a process that combines two single strands of DNA molecules into one single double-strand molecule.

75. Researchers trying to date speciation events in the past for which fossils are not available sometimes rely on evidence that assumes the:

    A. occurrence of convergent evolution.

    B. validity of the Hardy-Weinberg equilibrium.

    C. existence of a molecular clock.

    D. applicability of the biological species concept.

Correct Response: C. Evidence suggests that at least for certain genes the rate of mutation is fairly constant among different species, thus providing a sort of molecular clock. This means that the amount of time that has elapsed since two species diverged can be approximated by examining the number of differences in the DNA and protein sequences of the two species. These estimates can be made using tissue from living organisms, rather than relying on fossil evidence. In convergent evolution (**A**), two species that are not closely related evolve similar traits as a result of living in similar environments. These similar structures may tend to obscure when the two species diverged in the absence of other types of evidence. The Hardy-Weinberg equilibrium (**B**) assumes a stable population in which natural selection, and hence evolution, is not occurring. Thus, it provides no information about speciation. The biological species concept (**D**) defines a species as organisms that are capable in interbreeding with each other. It provides criteria for whether two organisms belong to the same or different species but does not provide evidence about when speciation might have occurred.

76. Which of the following pairs is a result of convergent evolution?

    A. a turtle's egg and a frog's egg

    B. a bird's wing and a bat's wing

    C. a housefly's leg and a bee's leg

    D. a human hand and a monkey hand

Correct Response: B. Convergent evolution is the process followed by organisms that are not closely related but that independently evolved similar traits or structures as a result of having to adapt to similar environments or niches. Of these pairs, only the bird's wing and the bat's wing fit this description. Progressive evolution led to the amniotic turtle egg (**A**), which evolved as organisms evolved into land organisms and which prevents the embryo from drying out and is laid on land. The frog egg is anamniotic and needs to be laid in water to prevent the embryo from drying out. A housefly and a bee (**C**) are both arthropods that have characteristic jointed legs. Through progressive evolution, arthropods developed the characteristic jointed appendages. The type of evolution for the human hand and the monkey hand (**D**) is more divergent because humans and monkeys have a common ancestor and the hands of each have developed differently for different purposes.

77. The original source of variation in a genome is:

    A. independent assortment.

    B. recombination.

    C. crossing over.

    D. mutation.

Correct Response: D. All sources of genetic variation rely on an initial change or mutation to the genetic code and mutations can occur both in sexually and asexually reproducing organisms. Although independent assortment of homologous chromosomes (**A**) and recombination (**B**) of chromosomes resulting from crossing over events (**C**) during meiosis are sources of genetic variation in sexually reproducing organisms, they will not result in genetic variation if the genetic material is identical to begin with.

78. The existence of which of the following situations in a natural population would violate the assumptions of a Hardy-Weinberg equilibrium condition?

    A. variable environment conditions

    B. sexual selection

    C. high level of phenotypic diversity

    D. large population size

Correct Response: B. The Hardy-Weinberg equilibrium model states that the frequencies of alleles in the gene pool will remain unchanged in the absence of evolutionary factors. Stability in the gene pool depends on a number of factors, including the condition that all members of the population breed and that mating is random. If sexual selection occurs, the frequency of alleles in the gene pool changes. Variable environmental conditions (**A**) and a high level of phenotypic diversity (**C**) are not assumptions made in the Hardy-Weinberg equilibrium model. A large population size (**D**) is a requirement of the Hardy-Weinberg model, so this condition would support, rather than violate, the model.

79. A plant species that is widely distributed on a continent is separated into an eastern and a western population during an ice age. By the time the glaciers retreat, the two populations are morphologically distinct from each other. This is an example of the effect of:

    A. character displacement.

    B. punctuated equilibrium.

    C. adaptive radiation.

    D. geographical isolation.

Correct Response: D. Geographical isolation is when a physical barrier, such as a glacier, separates a population of organisms into multiple smaller populations and prevents gene flow between the smaller populations. The separated populations are subject to the selective pressures of their respective geographical locations and may evolve into distinct species through allopatric speciation. In character displacement (**A**) the differences among similar species are accentuated when they live in overlapping geographical regions. Competition for resources favors the selection of the traits in each species that allow each species to take advantage of different niches, resulting in reduced competition for resources. Punctuated equilibrium (**B**) is a model of evolution that proposes that species remain relatively stable over long periods and that evolution tends to happen in spurts. In adaptive radiation (**C**), a particular lineage evolves into many different species within a relatively short period of time after a change to the environment alters available resources and niches.

80. Shifting from the five-kingdom taxonomic scheme to the three-domain scheme by biologists included the:

    A. splitting of the prokaryote kingdom into two prokaryote domains.

    B. merging of the prokaryote kingdom with the protista into a domain.

    C. separating of the autotroph kingdom into two different domains.

    D. grouping of unicellular organisms in different kingdoms into one domain.

Correct Response: A. In the five-kingdom taxonomic scheme, all prokaryotes were classified in a single kingdom called Monera. In the three-domain system, prokaryotes fall into separate domains (Bacteria and Archaea), and all eukaryotic organisms fall into the Eukarya domain. Protista are eukaryotes; as such they remain in a domain distinct from all prokaryotes (**B**). Autotrophs can be found in the Monera, Protista, and Plantae kingdoms in the five-kingdom scheme, so the shift did not separate a single autotroph kingdom into different domains (**C**). Unicellular organisms can be found in each of the three domains in the domain scheme, so the grouping of all unicellular organisms into one domain was not accomplished by the shift to the three-domain scheme (**D**).

81. The conclusion that fungi are more closely related to animals than to green plants is best supported by evidence based on analysis of:

    A. modes of nutrition.

    B. fossil records.

    C. molecular systematics.

    D. phenetic relationships.

Correct Response: C. Molecular systematics, or the use of molecular genetics to study evolutionary relationships, provides the best evidence that fungi are more closely related to animals than to green plants. It shows that fungi DNA and protein sequences are more similar to the protein and DNA sequences of animals than to those of plants. Although fungi and animals are both heterotrophs (**A**), molecular evidence provides more support for evolutionary relationships than do modes of nutrition. Fossil records (**B**) show that fungi developed soon after land plants, which might suggest that fungi are more closely related to plants. If only phenetic relationships (**D**), such as the morphology of the fungi, were studied, it would be difficult to determine that fungi and animals are more closely related than fungi and plants because the fungi morphology is so unlike that of animals.

82. If it is to have taxonomic value, the number of spots on a beetle's wing covers must be:

A. adaptive.

B. unique to the species.

C. used in a dichotomous key.

D. heritable.

Correct Response: D. In taxonomic comparisons, a phenotypic trait, or a trait that exhibits phylogenetic change in a particular group of organisms, is used to determine relatedness. For the trait observed in the beetle to be of taxonomic value, it needs to be present in each generation of beetles, implying that the trait must be heritable. When an observable trait is adaptive (**A**), it will help the beetle survive a changing environment, but a trait does not need to be adaptive in order for it to have taxonomic value. A trait unique to the beetle species (**B**) helps in identifying the species, but many shared traits, or combinations of traits, are useful identifying different species A dichotomous key (**C**) is a tool used to identify an organism's taxonomic, but many heritable traits are not used in creating a key.

83. In biological classification, which of the following taxonomic groups includes all the others?

A. family

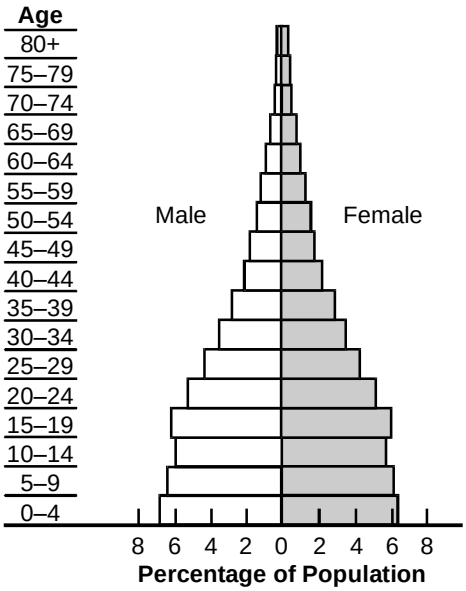
B. genus

C. order

D. phylum

Correct Response: D. The hierarchy of taxonomic groups, from most inclusive to least, is domain > kingdom > phylum > class > order > family > genus > species >. From this it follows that any two organisms in the same family are of necessity in the same phylum (**A**). The same is true of any two organisms in the same genus (**B**) or order (**C**).

84. **Use the diagram below to answer the question that follows.**



Based on the age structure table above, the human population that is represented will probably:

A. continue to grow rapidly.

B. increase slowly and steadily at a constant rate.

C. grow for another generation and then stabilize.

D. remain at its current size.

Correct Response: A. The diagram shows that the population has a very large percentage of young people and a very small percentage of people who are past child-bearing age. These are characteristics of a population that will continue to grow rapidly. A population that would grow at a low and steady rate (**B**) would have a fairly even distribution of people among all age groups, with somewhat smaller numbers of older people. With such a large percentage of children and of people of child-bearing age, it is very unlikely that this population would grow for another generation and then stabilize (**C**) or remain at its current size (**D**).

85. Which of the following is an example of a mutualistic relationship between two organisms?

A. hawks hunting mice during the day and owls hunting mice at night

B. ants obtaining food from aphids and protecting them from predators

C. ticks feeding on a moose's blood and dispersing at the same time

D. bees feeding on thistle nectar and siskins feeding on thistle seeds

Correct Response: B. In a mutualistic relationship, both organisms benefit from the relationship. Ants benefit by obtaining food from aphids, and aphids benefit from ants protecting them from predators. Hawks (**A**) and owls have a predator/prey relationship with mice, and they compete with each other for mice as a food source. Both hawks and owls benefit from mice, but mice do not benefit from hawks and owls. The relationship between a tick and a moose is a parasitic relationship. The tick benefits from feeding on the moose's blood (**C**), but the moose does not benefit from the tick. In fact, the moose can become weak and debilitated from the loss of blood. Bees and siskins feed on different parts of the thistle plant, so they do not compete for thistle as a resource, but neither do they benefit from each other (**D**).

86. Thermoclines are related to which of the following characteristics of ecosystems?

A. the ecotones that exist between grasslands and forests

B. the inverse correlation of temperature and elevation

C. the zonation of organisms in intertidal habitats

D. the vertical stratification of freshwater lakes

Correct Response: D. Large bodies of water can be separated into layers according to temperature. A mixed layer of relatively warm water is near the surface, a cold deep layer is at the bottom, and a transition layer called a thermocline separates the mixed and deep layers. Ecotones (**A**) are transition areas between ecological communities and often contain characteristics of both. Although an inverse relationship between temperature and elevation exists in the troposphere (**B**), this is not a thermocline. Zonation (**C**) is the distribution of organisms into specific geographical regions that occurs naturally based on the physical characteristics of the region. Zonation occurs in many habitats, including intertidal habitats. However, this phenomenon is distinct from thermoclines.

87. Which of the following conditions is a particular problem for organisms living in estuaries?

    A. availability of light

    B. leaching of nutrients

    C. erosion of substrate

    D. variation in salinity

Correct Response: D. Estuaries are areas where freshwater rivers and streams meet the salty water of oceans; therefore, the salinity in an estuary varies widely. Organisms that live in these areas have adaptations that allow them to cope with varying salinity within the general range that occurs annually. A problem arises when salinity is not within the general range for the area. If the salinity is too low, excess water enters an organism's cells, and it cannot be removed quickly enough for the organism to survive. If the salinity is too high, excess water is removed from the organism's cells, and the organism's survival is in jeopardy. While availability of light (**A**), leaching of nutrients (**B**), and erosion of substrate (**C**) are challenges for aquatic organisms, none of these are unique to estuaries.

88. Which of the following pairs of environmental factors together represents the primary determinant of the distribution of terrestrial biomes worldwide?

    A. mean temperature and precipitation

    B. elevation and mean precipitation

    C. mean temperature and soil type

    D. elevation and soil type

Correct Answer: A. Climate is largely responsible for determining the distribution of terrestrial biomes and is primarily determined by the mean temperature and precipitation in a region. For example, deserts and rain forests have similar mean temperatures but vary greatly in the amount of precipitation each receives. Although elevation is one factor that influences mean temperature (**B**), it does not solely contribute as much to biome distribution as mean temperature and precipitation do. Biomes can have distinct soil types (**C**). However, soil type is in part determined by the climate in a region, which is in turn determined by temperature and precipitation. Neither elevation nor soil type (**D**) have as much influence on biome distribution as mean temperature and precipitation do.

89. When existing species in a habitat alter environmental conditions in such a way that they inhibit their own reproduction in relation to other species, which of the following events is likely to occur?

    A. density independent selection

    B. habitat fragmentation

    C. boom and bust population cycles

    D. secondary succession

Correct Response: D. Existing species can sometimes alter environmental conditions, such as by changing the mineral composition of the soil. When these changes inhibit the species' ability to reproduce relative to other species, this opens the door for other species that are better suited to the new environment to grow and thrive. These new, better suited species begin to dominate the environment in a process called secondary succession. Density-independent selection (**A**) refers to factors such as natural disasters that affect a species regardless of the species' population size. Habitat fragmentation (**B**) affects a species by splitting its habitat into varying sizes, which might cause a change in the number of the species but it is not caused by the self-inhibition of reproduction. Boom and bust population cycles (**C**) occur as a result of the abiotic factors of space, nutrients, and water in an environment. When these factors are readily available, the population increases, but when they are depleted, the population decreases. This is not caused by a species inhibiting its own reproduction.

90. There is less biomass at higher trophic levels of an ecosystem because at the higher trophic levels:

    A. biodiversity is lower.

    B. less energy is available.

    C. decomposers are dominant.

    D. toxic compounds accumulate.

Correct Response: B. As energy flows from lower to higher trophic levels, only about 10% of it is transferred from one level to the next; the rest of the energy is lost to the environment. Energy is required to sustain biomass, so higher trophic levels contain less biomass because there is less available energy than at lower trophic levels. Biodiversity may be lower (**A**) at the higher trophic levels, but limited biodiversity is also likely a result of less available energy at these levels. Decomposers (**C**) can be found at all trophic levels as they clean up and return all dead organisms to organic matter; however, decomposers do not make up a large amount of the biomass. At higher trophic levels, toxic compounds (**D**) accumulate through biomagnification, but this does not significantly decrease the amount of biomass at the higher trophic levels.

91. Which of the following best explains why wildflowers on the forest floor in temperate deciduous forests often bloom between late March and early May in Massachusetts?

    A. Higher temperatures are more prevalent later in the summer.

    B. Pollinators are more available in early spring

    C. Light is a limiting factor later in the summer.

    D. Fewer insect herbivores are active in the early spring.

Correct Response: C. The production of flowers and seeds requires relatively large amounts of energy, and after the shrub and tree leaf canopy has developed in the summer, the amount of sunlight on the forest floor is greatly reduced. Thus there is a strong energetic advantage to reproduce before the leaf canopy develops. Temperatures are higher during the summer (**A**), but these do not provide the energy required for reproduction. Fewer pollinators are active during the spring (**B**), and although there are fewer insect herbivores in the spring **(D)**, this is not the primary reason for the frequency of early spring-blooming forest floor flowers.

92. The phosphorus cycle differs from the carbon and nitrogen cycles in that phosphorus is:

    A. in the same chemical form throughout its cycle.

    B. not produced as a result of human activities.

    C. not in a gas phase during any part of its cycle.

    D. rarely a limiting factor in ecosystems.

Correct Response: C. The phosphorus cycle is a biogeochemical cycle and differs from the other cycles in that phosphorus is a mineral that does not change into a gaseous state. In the phosphorus cycle, the phosphorus becomes part of a chemical compound (phosphate) and so does not stay in the same chemical form (**A**). Human activities contribute to the phosphorus cycle as well as to the carbon and nitrogen cycles. Both phosphorus and nitrogen can be released into the environment through use of fertilizers, and carbon is released into the atmosphere through the burning of fossil fuels (**B**). Organisms require phosphorus for growth and phosphorus can be a limiting factor (**D**) in some ecosystems when there is not enough present in the environment.

93. Which of the following statements about the carbon cycle is accurate?

    A. Decomposers and other heterotrophs absorb carbon dioxide from the atmosphere during respiration.

    B. Historically, calcium carbonate from dead organisms has been a primary reservoir of carbon stored in ocean sediments.

    C. The main source of carbon dioxide returning to the atmosphere is the respiration of terrestrial consumers from the higher trophic levels.

    D. More carbon dioxide is absorbed by an acre of living trees in a year than is released by an acre of trees burning during a fire.

Correct Response: B. Phytoplankton in the oceans remove carbon dioxide from the atmosphere during photosynthesis. Much of the carbon gets incorporated into the phytoplankton in the form of calcium carbonate. When the organisms die, their bodies sink to the ocean floor and become part of the ocean sediment, taking the calcium carbonate with them. All living organisms, including decomposers and other heterotrophs release carbon dioxide into the atmosphere during respiration, rather than absorb it (**A**). Consumers from the higher trophic levels represent such a small percentage of all organisms that their contribution of carbon dioxide is relatively small (**C**) and could not be considered a main source of carbon dioxide returning to the atmosphere. The amount of carbon dioxide released by an acre of burning trees represents many, not just one, years' worth of carbon dioxide absorbed during photosynthesis by those same trees (**D**).

94. The use of phosphate-free detergents has been very effective in cleaning up lakes and rivers. This is because in freshwater ecosystems phosphorus:

    A. presents osmoregulatory difficulties for zooplankton.

    B. lowers the pH as a result of increased carbon dioxide levels.

    C. accumulates in the brown fatty tissues of fish.

    D. is the limiting nutrient for algal growth.

Correct Response: D. One challenge facing freshwater ecosystems is the advent of harmful algal blooms, which can disrupt ecosystems. Algae require phosphorus and nitrogen to grow, and excess phosphorus in runoff is associated with more frequent blooms. For this reason, using phosphorus-free products, such as phosphate-free detergents, helps clean up freshwater ecosystems. Zooplankton (**A**) are a vital part of an aquatic ecosystem and can help keep algae populations in check, so disrupting their ability to osmoregulate would likely harm the ecosystem, rather than help it. Phosphorus increases the growth of algae and cyanobacteria (blue-green algae) in freshwater ecosystems. This will decrease, rather than increase, carbon dioxide levels because algae and cyanobacteria use carbon dioxide during photosynthesis. This tends to raise the pH of the water (**B**). Brown fatty tissues (**C**) are primarily found in mammals, not fish.

95. The productivity of fisheries over areas of regular oceanic upwellings is evidence that which of the following conditions is often limiting in open ocean ecosystems?

    A. nutrient availability

    B. light intensity

    C. salinity level

    D. water temperature

Correct Response: A. Oceanic upwellings bring many nutrients that have fallen to the ocean floor back up to the surface, providing an area where ocean life thrives. The fact that fisheries over areas of regular upwellings are more productive suggests that the availability of nutrients may be a limiting factor in an open-ocean system. Light intensity (**B**), salinity levels (**C**), and water temperatures (**D**) may vary throughout the ocean, including at the location of upwellings, so the productivity of fisheries over oceanic upwellings does not provide specific evidence that these factors are limiting.

96. The primary benefit of contour plowing on a farm is that it:

    A. increases organic matter and helps maintain soil structure.

    B. reduces the need for irrigation and cultivation.

    C. increases the angle and availability of incident light.

    D. reduces soil erosion due to water runoff.

Correct Response: D. In contour plowing, the soil is tilled following the contours of hills rather than down the slope. This reduces the amount of soil that is washed away during rain and also increases the amount of water the soil can absorb. Contour plowing by itself does not increase organic matter (**A**); it just prevents it from being washed away. Contour plowing is a method of cultivation (**B**), or preparing the soil for planting, so it does not reduce the need to cultivate. Following the existing contours of the land when plowing does not change the angle at which light would hit the crops (**C**).

97. Aquatic ecosystems tend to be dead zones near points at which nuclear power plants discharge water because of:

    A. high levels of acidity.

    B. elevated background radiation.

    C. decreased light penetration.

    D. low dissolved oxygen content.

Correct Response: D. Aquatic dead zones are regions of water in which the dissolved oxygen content is so low that it cannot support life. Warmer water holds less oxygen, and discharge from nuclear power plants can contribute to the formation of dead zones by raising the temperature of the local water systems. Increased levels of acidity (**A**) and decreased light penetration (**C**) are conditions created by dead zones, rather than causes. Background radiation (**B**) is the natural radiation that occurs in the environment, so any increased radiation in the region surrounding a nuclear power plant would not be considered background radiation.

98. The presence of increased levels of nitrogen oxides in the atmosphere is an environmental concern because this can result in:

    A. a decrease in soil fertility as minerals are leached away.

    B. a decrease in the populations of nitrogen-fixing bacteria.

    C. an increase in the rate of ozone depletion in the atmosphere.

    D. an increase in the eutrophication of aquatic ecosystems.

Correct Response: A. When dissolved in water, especially rain, nitrogen oxides produce an acid that will cause the minerals in the soil to leach away as they dissolve in the acid rain. This can lead to reduced soil fertility, creating an environmental concern. The populations of nitrogen-fixing bacteria (**B**), the rate of ozone depletion (**C**), and the eutrophication of aquatic ecosystems (**D**) are not affected by nitrogen oxides in the atmosphere or when dissolved in water in clouds or in precipitation as acid rain.

99. The draining of wetlands for development leads directly to increases in which of the following environmental problems?

    A. accumulation of pollutants

    B. flooding in adjacent habitats

    C. pressure on nearby landfills

    D. establishment of exotic species

Correct Response: B. Wetlands help absorb water that would otherwise directly enter downstream rivers and streams. Removal of wetlands along with their ability to store excess water has been shown to increase local flooding. Although human activity on the newly developed land may eventually lead to the excessive accumulation of nutrients in adjacent bodies of water (**A**) and increased pressure on nearby landfills (**C**), these potential environmental problems depend somewhat on how the land is used and are not the most direct consequence of draining wetlands. Removing the wetland habitat is likely to reduce biodiversity and is therefore unlikely to help establish exotic species in the area (**D**).

100. Which of the following practices is the best way to reduce the environmental consequences associated with logging forests in mountainous areas?

A. applying nitrogen and potash fertilizers after logging the site

B. closing the logged area to recreational uses until trees are reestablished

C. leaving some trees standing on the site when it is logged

D. cultivating the soil immediately after logging and planting tree seedlings

Correct Response: C. When logging occurs in a mountainous area and all the trees are removed, the soil is no longer held in place, and erosion begins to occur. If some trees are left standing, there will be less erosion in the area, and environmental consequences will be reduced. Applying fertilizers (**A**), closing the logged area (**B**), and planting tree seedlings (**D**) are not the best ways of reducing erosion in a clear-cut logged area.