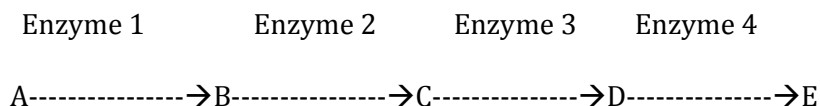


Big Idea 2: Chapter Questions

1. Most cells do not actively transport water, yet water is essential to life. How are cells able to control their water content?
2. Some critics of biological evolution claim that it violates the 2nd Law of Thermodynamics, since evolution involves simple life forms developing into more complex and more highly ordered organisms. Explain why this is not a valid argument against evolution.
3. Reaction 1 and Reaction 2 happen to have the same free-energy change $\Delta G = -36.4\text{kJ/mol}$ (-10kcal/mol). Reaction 1 is at equilibrium, but reaction 2 is far from equilibrium. Is either reaction capable of performing work? If so, which one? (Explain).
4. Based on what you have learned, explain why a high fever (above 105°F or 40°C) is often fatal.
5. In the following series, which enzyme(s) is/are most likely to have an allosteric site to which the end product E binds? Explain your selection.



6. Briefly describe the interaction between the following substances and the phospholipid bi-layer before they are transported into the cytoplasmic space: O_2 , N_2 , Glycerol, Glucose, and Na^+ .
7. The idea that speaking directly to ones plants enables them to grow is nothing new. However, some people incorrectly believe that this is due to the plant “feeling” nurtured. Using your knowledge, explain why plants will grow better in an environment where someone is regularly speaking to them in very close quarters.
8. The first step that cells take in glycolysis (the beginning of the cellular respiration of glucose) is to convert glucose into glucose-6-phosphate. This phosphorylation requires an energy input, and therefore will not occur spontaneously. Explain how the presence of an ATP molecule and H_2O can assist in the process.

9. What happens when cellular respiration decomposes glucose and other organic fuels? Why does the metabolic pathway yield energy?
10. In the presence of a metabolic poison that specifically and completely inhibits the function of the mitochondrial ATP synthase, what would you expect to occur across the mitochondrial membrane? Explain.
11. The final electron acceptor of the electron transport chain that functions in oxidative phosphorylation is oxygen. What properties of oxygen make it an excellent electron acceptor? What would happen if there was an inadequate supply of oxygen to the cell? Explain.
12. Going from ATP \rightarrow ADP yields ΔG -7.3 kcal/mol and ATP \rightarrow AMP yields ΔG -10.9kcal/mol. Knowing that there is a greater energy yield by breaking down ATP \rightarrow AMP why is it much more common to see the breakdown of ATP \rightarrow ADP as a source for energy? Name and describe the process by which ATP is broken down into ADP or AMP.
13. In prokaryotes the photosystem is part of the membrane system, just like the transport proteins. Explain how the interaction of sunlight and photosystem eventually allow for the production of ATP?
14. While the use of ATP as an energy source is vital for many biological functions it is inefficient at actually storing energy. Through evolution organisms have developed other means of storing excess energy for later use, describe why ATP is a poor at energy storage and detail what methods organisms have evolved in order to better store energy.
15. In response to a signal, how might a cell regulate activities in the cytoplasm or transcription in the nucleus?
16. All animals require the same basic things (like air, water, and food). Using a dog and a worm as examples detail the similarities in any two of their systems.
17. The predator-prey relationship is an intricate and necessary function for both involved species. Understanding how this relationship works is key to ecologists. Some questions to answer: Why are the predators usually fewer in numbers than their prey? What are two ways in which predation is beneficial to the prey species? What are two strategies/methods adopted by a predator species to help it hunt more successfully. Name two strategies/methods that help a prey species to escape its predator.
18. Climate and other abiotic factors are important determinants of the biospheres distribution of organisms. Detail how the biosphere is an “environmental mosaic” in which several abiotic factors affect the distribution and abundance of organisms.

19. An Rh-positive baby is born to an Rh-negative mother. After the delivery the mother is passively immunized with antibodies to the Rh factor. Two years later she gives birth to another healthy Rh-positive baby. How did the antibodies administered after the first birth protect the second baby? Should the mother be given antibodies to the Rh factor again? Why or why not?
20. A group of students was asked by their teacher to identify areas to help decrease the amount of pollutants in the Newark Bay. Since many students in the area were already doing clean-up of the shoreline the teacher asked them to think further and develop a new strategy that will help to remediate the water on a microscopic scale. The students decided that it would be best to plant oyster beds in several areas throughout the Newark Bay and concentrate on the areas closest to the Passaic River. The students recognize the Passaic River as a main source of chemical pollutants that contribute to the overall pollution of the Bay and eventually the Hudson River, and further developed a hypothesis that the oysters would act as a filter. Oysters remove nutrients, algae, plankton, and pollutants from the water column, which contributes to cleaner, clearer water. Outside of the hypothetical result, in what other ways can the oyster beds affect the biotic and abiotic of their surroundings? Explain.
21. Eventually the project in the above question was to be shut down by the Department of Environmental Protection, due to unforeseen consequences in fish, miles downstream. Propose an explanation of what these consequences might have been and what, if any, measures the students can take to prevent the problem from re-occurring.
22. Homeostatic mechanisms reflect both common ancestry and divergence due to adaptations in different environments. In terms of water regulation all organisms have developed numerous methods for water retention and expulsion. Detail some adaptations that organisms in hot, dry climates (ex. cactus, scorpion, camel) have employed in order to maintain the amount of water necessary for life. What adaptations do aquatic organisms (ex. marine fish, paramecium) employ to maintain both the volume of water as well as the proper salinity?
23. How did the discovery that bacteria are able to communicate with each other change our general perception of many single, simple organisms inhabiting our world.
24. How does photoperiodism synchronize a plants response to changes of the season?
25. Black bears were once not considered true or "deep" hibernators. Recent discoveries about the metabolic changes that allow black bears to remain dormant

for months without eating, drinking, urinating, or defecating, most biologists have redefined mammalian hibernation as "specialized, seasonal reduction in metabolism concurrent with scarce food and cold weather". Given this new definition, would black bears be considered hibernators? Explain.

26. Pollination usually involves pollen from flowers of other plants of the same species fertilizing the ovules which leads to the formation of the seed ultimately. In self-pollination the flower has a structure that allows the stamens and the stigma to contact each other and thereby the flower is pollinated. Self-pollination is found to occur in some species like sunflower, soybeans, peas, peanuts, etc. These plants use self-pollination only as a last resort, if cross pollination has not occurred. What are the advantages and disadvantages to this method? Explain.

Answers

1. Most cells are able to control their water content through simple diffusion, in the specialized case of water we refer to this as osmosis. During osmosis the water molecules are able to diffuse freely across the membrane down their concentration gradient.
2. While the notion of increasing order is suggested in individual development, the 2nd law applies to the entire Universe and other isolated systems. A single living organism is not a closed system; it is constantly exchanging energy with its environment and the entropy decreases due to the evolution of complex life forms is more than off-set by the increases in entropy of the rest of the environment.
3. Reaction 2 is capable of work. The state of equilibrium for reaction 1 hinders any ability to perform. The fact that reaction 2 is not in equilibrium lends itself to tend towards such a state and therefore ability to do work.
4. A sustained fever, where internal temperatures are above 105°F, can be potentially fatal because the intense heat that is designed to destroy foreign pathogens, begin to degrade and destroy the enzymes necessary to perform many chemical processes within the body. The destruction of these enzymes and the ensuing lack of integral enzymatic processes can eventually result in the death of the organism.
5. Enzyme 1. The product of the last reaction in a metabolic pathway inhibits the enzyme that catalyses the first reaction during negative feedback. Although it can inhibit any other enzyme in the pathway, it is most efficient to do so as early in the reaction as possible.
6. The gases are able to move across the membrane along their concentration gradient without any extended interaction with the lipid bi-layer. Ions are transported across the membrane when the transport proteins bind to ions of water-soluble substances. This causes a change in the shape and shunts the solute across the membrane.
7. The excess production of CO₂ as a byproduct of talking can influence the growth of a plant; however the length of time 'talking' to the plant needs to be of great duration and in a closed environment in order to produce measurable results. (There is also some data that suggests that the frequency with which humans speak creates vibrations in some plants that may turn on some genes responsible for light response.) Finally, the idea of 'nurturing' a plant through talk is false mainly because regardless of what is said the production of CO₂ is relatively similar.
8. Converting glucose into glucose-6 phosphate requires an energy input as well as a P_i, therefore there is a need for an H₂O and an ATP molecule to assist this conversion. The hydrolysis of ATP yields the energy necessary for the reaction to proceed as well as the requisite inorganic phosphate. (ATP + H₂O \rightleftharpoons ADP + inorganic phosphate (P_i)).

9. Student should discuss the transfer of electrons during the chemical reaction. The relocation of electrons releases the energy stored in food molecules, and this energy is used to synthesize ATP.
10. There would be an increase in the pH across the mitochondrial membrane.
11. Without the electronegative oxygen to pull electrons down the transport chain, oxidative phosphorylation ceases. However, fermentation provides a mechanism by which some cells oxidize organic fuel and generate ATP without the help of oxygen.
12. The process of creating a molecule of ATP, in terms of the phosphate groups, is much like compressing a spring. Wherein the addition of PO_4^{3-} requires increasing amounts of energy, and therefore much more energy is stored between each successive group. Since there is more energy required to add the third phosphate group than was required to add the second, there is a greater amount of energy stored between phosphates 2 and 3. So, even though there is a greater net yield of energy from $\text{ATP} \rightarrow \text{AMP}$ than from $\text{ATP} \rightarrow \text{ADP}$ the resulting energy gain is much less desirable than using hydrolysis to break down another molecule of $\text{ATP} \rightarrow \text{ADP}$.
13. When photons, from sunlight, excite an electron to be transferred within the photosystem this creates the motive force, which allows environmental hydrogen ions to move into the membrane. Eventually, there is an excess of H^+ ions on the inside of the cell. This creates a membrane potential, where the excess H^+ ions flow from higher concentration within the cell back to the environment turning the ATP synthase and allowing for the phosphorylation of ATP.
14. ATP cannot be used for storage of energy because it is highly reactive causing it to break down too quickly. So ATP producing organisms can only survive when sunlight is available, or if they flood their environment with ATP. Organisms looking for a more stable way to store energy were able to take advantage of the production of glucose. This enabled them to store excess energy for later use when sunlight was not present but energy was required.
15. Signaling pathways regulate enzyme activity (like the enzymes that break down glucose) and cytoskeleton rearrangement in the cytoplasm. Other pathways regulate genes: they do this by activating transcription factors, proteins that turn on specific genes.
16. Answers will vary, but should include the use of at least two different systems and a detail of how the structures are similar due to their relative function.
17. The amount of offspring for a given prey must always be greater than the respective amount of predators. This can be accomplished through more frequent births, shorter gestation periods, etc. If the number of prey were to decrease so would the number of predators (as they require a food source). This is a key limiting factor for consumption of prey. If the relationship were to be unbalanced heavily in the predators favor the result would be extinction of the prey and (depending on the food web of the predator) the predator

- alike. Predation is most beneficial to the prey species in that it allows only those most fit to survive. Predators will select and be most successful at hunting weaker, slower, sickened prey and therefore these inferior genes are removed from the prey gene pool. Group hunts and separating the young/weak from the group. Traveling in packs allows the majority of prey to stay alive and continue the species among other things.
18. Answers will vary. Temperature, water quality and availability, light intensity, wind, soil characteristics, and even less predictable disturbances, such as fire. Global climates and seasonality are established by the input of solar energy and the earth's rotation around the sun. Latitudinal variation in temperature and precipitation account for the geographical distribution of major ecosystems. Oceans and lake moderate the climate in coastal localities, and mountains influence temperature and rainfall. When the conditions exist that are most suitable for particular organisms they are found in these particular areas.
 19. Since it takes a period of time to develop the antibodies for the Rh factor the first child will not be affected, however had the mother not been given the antibodies the subsequent pregnancy could have lead to a variety of issues, such as jaundice or anemia, at the time of birth. Given the situation, if the mother decides she will get pregnant again the another round of Rh factor antibodies may be necessary.
 20. While the hypothetical results indicate the positive contribution with the addition of the oyster beds to the Newark Bay, there exist some other potential affects to the biotic and abiotic environment. Clearly the addition of Oysters into the Bay would produce an immediate food supply for the surrounding organisms that consume them naturally. While an abundance of resources for these fish may have potential survival and reproductive benefits, the consumption of filter feeders can lead to higher than normal amounts of harmful toxins in the tissues. These fish then travel to areas where they can either be consumed by larger fish or caught for recreational or commercial use. The problem when they are consumed in larger fish is referred to as biomagnification, where the concentration of toxins accumulates in the tissues of organisms in greater amounts. These fish, when consumed are harmful to humans as well of other organisms in the waterways.
 21. In order to prevent the oysters from being readily available for consumption or drifting downstream the students must make efforts to contain the oysters in a restrictive environment that still allows for filtering of the waterway. The students need to determine the size of the organisms feeding on them and construct a container that restricts as many predators as possible.
 22. Desert Organisms Can:

Store Water - Water can be stored by animals in fatty deposits in their tails and other tissues. Water can be stored in the roots, stems, and/or leaves of plants (plants that do this are called succulents).

Conserve Water - Minimize loss of water out of the skin (cutaneous loss), from urine and feces (excretory loss), and from "breathing" (respiratory loss) through various means.

Tolerate Dehydration - Many of the desert plants like the cactus and animals can tolerate great losses of water out of their bodies without dying.

Dissipate Heat - If heat reduction isn't enough, then it is time to get rid of body heat by evaporation (costs water though), long appendages (legs, ears, etc.), or small "bodies" (e.g., whole body, leaves, etc.) that radiate heat.

Tolerate Hyperthermia - Some plants and animals can survive body temperatures that would be dangerous to humans (temperatures over 104 degrees F!).

23. Instead of language, bacteria use signaling molecules, which are released into the environment. As well as releasing the signaling molecules, bacteria are also able to measure the number (concentration) of the molecules within a population. Nowadays we use the term 'Quorum Sensing' (QS) to describe the phenomenon whereby the accumulation of signaling molecules enable a single cell to sense the number of bacteria (cell density). In the natural environment, there are many different bacteria living together, which use various classes of signaling molecules. As they employ different languages they cannot necessarily talk to all other bacteria. Today, several quorum-sensing systems are intensively studied in various organisms such as marine bacteria and several pathogenic bacteria.
24. Certain developmental processes, including flowering in many plant species, require a certain photoperiod, the relative lengths of night and day. For example, a critical night length sets a minimum (in short day plants) and maximum (in long day plants) number of hours of darkness required for flowering.
25. Answers will vary.
26. This is due to the fact that self-pollination leads to the plants that grow from the seeds produced having genes similar to the parent plant. And it is essential that the progeny not be like the parent for the development of the species. Self-pollination is helpful in a few cases where there are only a few plants in the geographical area or if the number of pollinators is very small.