

Discovering Design with Biology Answer Key and Tests

Answers to the Chapter 1 Review

1. a. Irreducible complexity – When a system is made up of several interacting components, each of which is necessary for the system to function, and none of which can be made by modifying an already-existing component.
- b. Metabolism – The sum of all chemical reactions occurring in an individual cell to sustain life
- c. Catabolism – The chemical reactions occurring in an individual cell that break down complex molecules into simple ones, releasing energy that the organism can use
- d. Anabolism – The chemical reactions that build complex molecules from simple ones, usually requiring the input of energy
- e. Homeostasis – The ability of an organism to maintain a constant internal environment
- f. Symbiosis – A long-term relationship between organisms of different species
- g. Asexual reproduction – A mode of reproduction in which the offspring comes from only one organism
- h. Sexual reproduction – A mode of reproduction which combines genetic information from a male individual and a female individual to produce offspring
- i. Differentiation – The process by which a cell becomes specialized to perform a specific set of tasks
- j. Taxonomy – The science of classifying things, such as organisms
- k. Prokaryotic cell – A cell without organelles
- l. Eukaryotic cell – A cell with organelles
- m. Energy – The ability to do work
- n. Producers – Organisms that can produce energy-rich molecules as their food source
- o. Consumers – Organisms that must eat other organisms for food
- p. Decomposers – Organisms that decompose dead organisms
- q. Natural selection – The process by which organisms better adapted to an environment will be more likely to survive and reproduce, passing those adaptations to their offspring
- r. Mutation – A change in an organism's DNA that alters the information contained in the DNA

2. Organization, metabolism, homeostasis, response to a stimulus, adaptation, reproduction and heredity, and growth and development. They can be in any order.
3. This is catabolism. Anabolism is the building of large molecules from small molecules.
4. It comes from the sun.
5. This is homeostasis, because it involves keeping the internal environment the same.
6. This is adaptation, because it is a long-term adjustment to conditions.
7. DNA. You can also say deoxyribonucleic acid.
8. Reproduction as well as growth and development. The cell had to reproduce, and then the products of that reproduction had to reproduce more to make all the cells in your body. This helped you develop and made you grow.
9. Atom, molecule, organelle, cell, tissue, organ, system of organs, organism, population, community, ecosystem, biome, biosphere. See Figure 1.7.
10. Domain, Kingdom, Phylum, Class, Order, Family, Genus, Species.
11. The two organisms from the same Genus will be more similar. The lower you go in the division of taxonomy, the more similar the organisms.
12. *Felis catus*, which is an example of binomial nomenclature.
13. The name must be italicized, and only the first word is capitalized.
14. That is called Baraminology.
15. No. Science cannot *prove* anything. It has developed a lot of evidence that indicates the earth orbits the sun, but proof is beyond the ability of science.
16. Observation, hypothesis, prediction, experimentation, analysis, conclusion. The hypothesis is based on observations. A prediction is made to test the hypothesis, and experimentation is used to determine whether or not the prediction is correct. The experiment must then be analyzed, and then a conclusion can be reached.
17. Producers, primary consumers, secondary consumers, tertiary consumers, decomposers. While decomposers do not appear in many food webs, they are the last to use the energy in an organism.
18. a. Plankton. The arrows indicate they are consumed but do not consume anything.

b. Primary consumer and tertiary consumer. When it eats plankton, it is eating a producer. When it eats squid, it is eating a secondary consumer.

c. Secondary consumer. It eats only one thing, and that is a primary consumer.

19. The mutation that makes fish faster swimmers is more likely to be found in many fish.

Natural selection “selects” traits that make an organism more likely to survive. Faster swimmers can get to the food faster and are more likely to get away from predators. That makes them more likely to survive. When metabolism (or any biological process) is more difficult, the organism is less survivable.

20. A and B have more similar DNA. When two organisms are able to sexually reproduce, their DNA must be similar.

21. Natural selection works to ensure the survival of existing forms. Those who believe evolution produced all that we see must assume it can also produce new forms, but that has not been confirmed by the data.

Test for Chapter 1

1. Define the following terms:

- | | | | |
|----------------|--------------------|---------------------|----------------------|
| a. Catabolism | c. Symbiosis | e. Prokaryotic cell | g. Natural selection |
| b. Homeostasis | d. Differentiation | f. Producers | h. Mutation |

2. What term includes both anabolism and catabolism?

3. Which two characteristics of life are missing from the following list?

metabolism, homeostasis, response to a stimulus, adaptation, reproduction and heredity

4. What does the molecule DNA do when it comes to reproduction and heredity?

5. Which level of organization is the largest: molecule, organism, ecosystem, cell, organ?

6. Which division of taxonomy has the most members? Which has the fewest?

7. In which division of taxonomy are the organisms the least similar: Genus, Order, Class, or Phylum?

8. The scientific name of the domestic horse is *Equus ferus*. To what Genus does it belong?

9. What is the purpose of Baraminology?

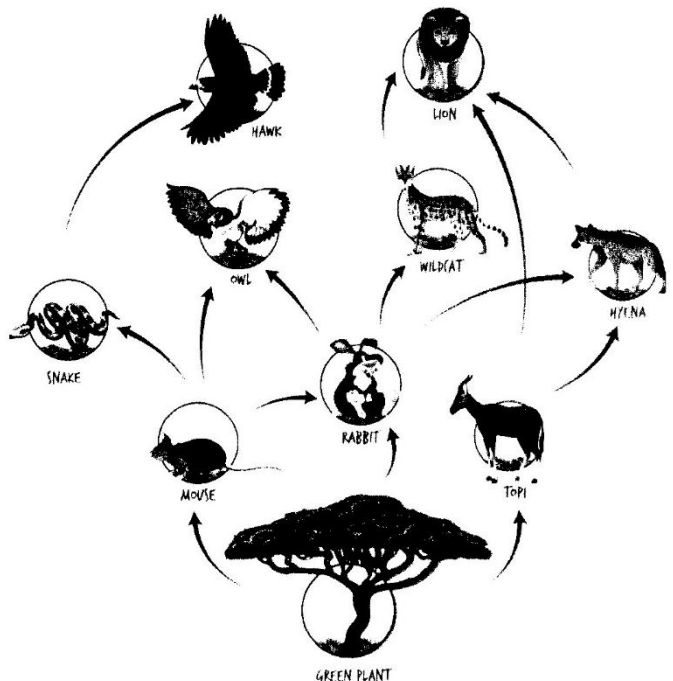
10. What do we call the organisms that break down dead organisms so that biological materials can be recycled?

11. For the food web shown on the right, what are the possible trophic levels of the lion?

12. List all the primary consumers shown in the food web on the right.

13. For the organisms shown in the food web on the right, which ones are dependent on the sun for their energy?

14. Why is the term natural selection often described with the phrase, "survival of the fittest"?



(End of the Test)

Answers to the Test for Chapter 1

1. (8 points, one for each definition)
 - a. Catabolism – The chemical reactions occurring in an individual cell that break down complex molecules into simple ones, releasing energy that the organism can use
 - b. Homeostasis – The ability of an organism to maintain a constant internal environment
 - c. Symbiosis – A long-term relationship between organisms of different species
 - d. Differentiation – The process by which a cell becomes specialized to perform a specific set of tasks
 - e. Prokaryotic cell – A cell without organelles
 - f. Producers – Organisms that can produce energy-rich molecules as their food source
 - g. Natural selection – The process by which organisms better adapted to an environment will be more likely to survive and reproduce, passing those adaptations to their offspring
 - h. Mutation – A change in an organism's DNA that alters the information contained in the DNA
2. (1 pt) Metabolism. Metabolism is the sum of all chemical reactions, which includes the ones that build up molecules (anabolism) and the ones that break them down (catabolism).
3. (2 pts, one for each) Organization, growth and development.
4. (1 pt) It transmits genetic information from parent to offspring. You can use any phrase that indicates the information in the parent or parents is given to the offspring through DNA.
5. (1 pt) Ecosystem. Since it includes many organisms and their environment, it is much bigger than an organism. Organisms are much bigger than molecules, cells, and organs, since an organism is made up of them.
6. (2 pts, one for each) Domain has the most, while species has the fewest. The higher you are on the list of divisions, the more members that division has.
7. (1 pt) Phylum. The higher you are on the list of divisions, the more members there are, so the least similar those members will be.
8. (1 pt, ½ if it is not capitalized) Equus.
9. (1 pt) It correlates the organisms we see today with those that were originally created. You can have "animals" or any indicator of living things, and you just need to make it clear that it is trying to find a relationship between what exists now and what was originally created.

10. (1 pt) Decomposers

11. (2 pts, one for each. Take off 1 for any other designations given) Tertiary consumer or secondary consumer. It is tertiary when it eats the wildcat or hyena. It is secondary when it eats the topi.

12. (1 pt, one-third for each. Take off one-third for all wrong answers) Mouse, rabbit, topi. Only the things that eat producers are primary consumers.

13. (1 pt, ½ if only the green plant is given) All of them. While the green plant uses the sun's energy directly, they all depend on the sun, since they all depend on the green plant, something that ate the green plant, or something that ate something that ate the green plant.

14. (1 pt) An organism that is more fit to survive is more likely to live long enough to pass on its traits to the next generation, while the less fit to survive are less likely to pass on their traits to the next generation. Your answer can be very different. It just needs to make it clear that natural selection "selects" the fitter creatures, so they are the ones that tend to survive.

Total points: 24

Answers to the Chapter 2 Review

1. a. Substance – A form of matter that has characteristic chemical properties
 - b. Atom – The smallest stable unit of all matter (physical material), which is comprised of protons, neutrons, and electrons
 - c. Element – A pure substance that is composed of a unique type of atom
 - d. Molecule – A group of atoms that form a unit with specific chemical properties. The atoms may be the same or they may be different, depending on the specific chemical involved
 - e. Compound – A substance that contains two or more atoms from different types of elements held together by chemical bonds
 - f. Hydrophilic – Having a tendency to be attracted to water
 - g. Hydrophobic – Having a tendency to repel water
 - h. Cohesive – A property in which the molecules of a substance are attracted to its own molecules
 - i. Adhesive – A property in which the molecules of a substance are attracted to other similar substances
 - j. Carbohydrate – A molecule composed of carbon, hydrogen, and oxygen in which there are twice as many hydrogen atoms as oxygen atoms
 - k. Lipid – A hydrophobic macromolecule that readily dissolves in nonpolar environments
 - l. Protein – A complex polypeptide that plays a role in the chemistry of an organism
 - m. Nucleic acids – The molecules involved in the making of proteins and the passage of traits from one generation to the next.
 - n. Replication – The process by which DNA is copied to produce two duplicate double helices
 - o. Transcription – The process by which DNA is used to produce messenger RNA
 - p. Translation – The process by which the information on mRNA is converted into a specific sequence of amino acids to form a protein
 - q. Gene – A sequence of nucleotide bases on DNA that codes for a macromolecule (such as a protein or RNA)
2. Protons and neutrons are found in the nucleus, while electrons are found outside.

3. This process forms an ionic bond. When atoms lose or gain electrons, they become charged and are called ions. The opposite charges cause the ions to stay close together.
4. CH₄. In chemical formulas, the subscripts tell you the number of each atom, but if there is only one atom, no subscript is used.
5. Covalent bonds are stronger than hydrogen bonds. Also, covalent bonds exist within a single molecule, while hydrogen bonds exist between two separate molecules.
6. Gasoline is nonpolar, which makes it hydrophobic. Water is polar, so it dissolves other polar things. Anything that dissolves in water is hydrophilic, and anything that doesn't is hydrophobic.
7. Water's adhesive attraction to wax paper is small compared to its adhesive attraction to a paper towel. Remember, adhesion measures how attracted water is to another substance. If the substance is nonpolar, water won't be attracted to it. However, water is very attracted to a paper towel, as Experiment 2.1 showed.
8. C₈H₁₆O₈. Carbohydrates have carbon atoms and twice as many H atoms as O atoms.
9. A disaccharide and water are formed. This is a dehydration reaction.
10. It is a polysaccharide. If you said "polymer," you are correct, but there are many biological polymers. It is best to be as specific as possible.
11. A triglyceride is formed. This is another dehydration reaction. Those fatty acids make an unsaturated fat.
12. C is the hydrophilic part, while A is the hydrophobic part. B and D are close to the hydrophilic part, but also near the start of the hydrophobic part, so they represent a transition between the two.
13. It is an amino acid.
14. It is called a dipeptide. Several such reactions lead to a polypeptide. The bond is a peptide bond. You could say "protein" instead of polypeptide, but there are some polypeptides that are not proteins.
15. It is the order in which the protein's amino acids link together.
16. They are not necessarily the same protein. Even if they have all the same amino acids, those amino acids must be linked together in exactly the same order if they are the same protein. In other words, they must have the same primary structure to be the same protein.
17. Gastric juice is an acid, water is neither, and ocean water is a base. The pH scale says 7 is neutral (neither acid nor base). Above 7 is basic, while below 7 is acidic.

18. An enzyme is a specific kind of protein. Its function is to enable chemical reactions to occur at a speed that permits life.

19. i. B. In DNA, the nucleotide bases are attached to the sugars inside the backbone.
ii. A. The 3' end is the one that has a sugar attached to nothing.
iii. E. The 5' end has a phosphate attached to nothing.
iv. C. The pentagon represents the sugar deoxyribose.
v. D. The group that is made of P's and O's is the phosphate group.

20. Hydrogen bonds hold the double helix together.

21. i. G – C – A – T – T – C. G's can only connect to C's, and vice versa. A's can only connect to T's, and vice versa.

ii. G – C – A – U – U – C. The same rules apply here, but U replaces T in RNA.

iii. It would be translated into two amino acids. Remember, it takes three nucleotide bases to code for an amino acid. Since there are six in the sequence, it can code for two.

22. This is transcription. Transcription involves building an mRNA based on the DNA sequence, and that requires the nucleotide bases in RNA to attach to the bases on DNA.

23. This is translation. Translation is when the sequence of mRNA gets translated into amino acids, and that happens at a ribosome.

24. It is from a living organism. If a sample has all right- or left-handed molecules, it was made by a living organism.

25. It must explain:

1. The appearance of the correct organic macromolecules
2. The polymerization of these macromolecules
3. How protocells (pre-cursors to cell) developed
4. The development of the first cell

So far, no chemical evolution mechanism can explain any of those steps.

Test for Chapter 2

1. Define the following terms:

- | | | | |
|-------------|-----------------|----------------|------------------|
| a. Atom | c. Hydrophobic | e. Protein | g. Transcription |
| b. Molecule | d. Carbohydrate | f. Replication | h. Gene |

2. In a molecule, two atoms share electrons. Does this produce an ionic bond or a covalent bond?

3. How many carbon atoms are in a molecule of alanine, $C_3H_7NO_2$?

4. Fill in the blank: When several monosaccharides undergo _____ reactions, the result is a polysaccharide.

5. What kind of molecule is formed when glycerol links to three fatty acid molecules?

6. What kind of lipid is hydrophobic on one end and hydrophilic on the other?

7. What two atoms are linked by a peptide bond?

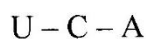
8. Fill in the blank: In the process of translation, amino acids are linked together in a specific order, forming the _____ structure of the protein.

9. In which organelle does transcription occur?

10. In the drawing of DNA on the right, the letter "A" points to cytosine.

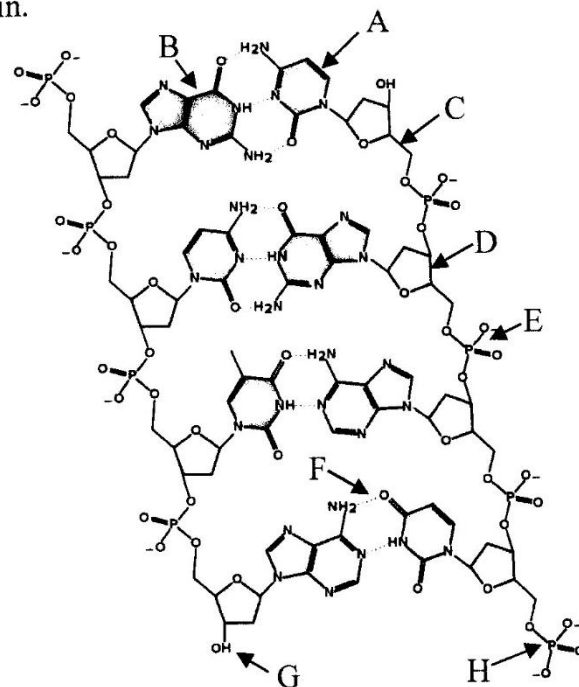
- Which letter points to a hydrogen bond?
- Which letter points to a 5' end?
- Which letter points to a sugar?
- What nucleotide base does B point to?

11. A small strand of mRNA has the following sequence:



- What was the sequence on the DNA that was transcribed?
- How many amino acids will this sequence be translated into?

12. Name two of the four steps that must be explained if life arose via chemical evolution.



(End of the Test)

The owner of this book is free to copy this page.

Answers to the Test for Chapter 2

1. (8 points, one for each definition)

- a. Atom – The smallest stable unit of all matter (physical material), which is comprised of protons, neutrons, and electrons
- b. Molecule – A group of atoms that form a unit with specific chemical properties. The atoms may be the same or they may be different, depending on the specific chemical involved
- c. Hydrophobic – Having a tendency to repel water
- d. Carbohydrate – A molecule composed of carbon, hydrogen, and oxygen in which there are twice as many hydrogen atoms as oxygen atoms
- e. Protein – A complex polypeptide that plays a role in the chemistry of an organism
- f. Replication – The process by which DNA is copied to produce two duplicate double helices
- g. Transcription – The process by which DNA is used to produce messenger RNA
- h. Gene – A sequence of nucleotide bases on DNA that codes for a macromolecule (such as a protein or RNA)

2. (1 pt) This is a covalent bond. An ionic bond is formed when one atom gives electrons to another atom. No sharing is involved.

3. (1 pt) There are three. The subscripts tell you how many of each atom, and “C” stands for “carbon.”

4. (1 pt) dehydration

5. (1 pt) A triglyceride is formed. Give ½ point for saying “lipid,” but there are other kinds of lipids, like steroids, waxes, etc.

6. (1 pt) A phospholipid

7. (1 pt, ½ for each atom) A carbon and a nitrogen atom are linked. The atoms can be in any order, and you can use C and N instead of their names. Remember, proteins are formed when amino acids link up. The link occurs between the N on the amine group and the C on the acid group, and it is called a peptide bond.

8. (1 pt) primary

9. (1 pt) It occurs in the nucleus. Remember that transcription involves using DNA to make mRNA. DNA is found in the nucleus, so transcription must occur there.

10. (4 pts, one for each)

- i. E, Hydrogen bonds link the nucleotide bases to hold the double helix together.
- ii. H, The 5' end is where a phosphate group is linked to nothing.
- iii. D, The pentagons represent deoxyribose, the sugar part of the backbone.
- iv. Guanine, since only guanine can link to cytosine, and you were told A is cytosine.

11. i. (2 pts) A – G – T. If you have “U” instead of “T,” take off 1 point. Take ½ off for every other wrong letter
- ii. (1 pt) It will be translated into one amino acid. It takes three nucleotide bases to code for one amino acid. There are three in the sequence.

12. (2 pts, one for each) The student only needs two of them, and they needn't be numbered. They also don't have to be worded exactly the same.

1. The appearance of the correct organic macromolecules
2. The polymerization of these macromolecules
3. How protocells (pre-cursors to cell) developed
4. The development of the first cell

Total points: 25

Answers to the Chapter 3 Review

1. a. Plasma membrane – A semipermeable membrane that surrounds all cells
- b. Ribosome – A two-part structure in all cells where proteins are synthesized
- c. Pathogen – An organism that causes disease
- d. Flagellum – A slender protein structure used by many cells to move around
- e. Diffusion – Movement of a solute from an area of high concentration to an area of low concentration
- f. Osmosis – Movement of a solvent across a semipermeable membrane from an area where the solute concentration is low to an area where the solute concentration is high
- g. Endocytosis – The process by which cells take in a substance by surrounding it with the plasma membrane and making a vesicle that holds the substance
- h. Exocytosis – The process by which a substance in a vesicle is released into the cell's environment by fusing with the plasma membrane
- i. Aerobes – Organisms that use oxygen in their cellular respiration
- j. Anaerobes – Organisms that do not use oxygen in their cellular respiration
- k. Endosymbiosis – The idea that eukaryotes arose as a result of one prokaryote engulfing others
2. (1) Cells are the basic unit of life. (2) All organisms are comprised of one or more cells. (3) Cells only arise from other cells.
3. A prokaryotic cell is generally smaller than a eukaryotic cell.
4. There are two layers of phospholipids. They are oriented so that their hydrophilic heads are pointed either into the cell or out to the surroundings. Their hydrophobic tails are pointed to each other.
5. The plasma membrane allows some substances to pass through and blocks other substances. This keeps the things that should be in the cell from leaving, and it allows the cell to take in substances that it needs from its environment. Also, it keeps harmful substances out.
6. The plasma membrane, cytoplasm, and ribosomes. All cells also have DNA, proteins, macromolecules, etc. But those are chemicals. The three listed in the answer are the *structures* that prokaryotic and eukaryotic cells have in common. Also, while a eukaryotic cell might have a flagellum (like prokaryotic cells have), most do not.

7. a. fimbriae, b. nucleoid, c. flagellum, d. ribosome, e. plasma membrane, f. cell wall, g. capsule, h. nucleus, i. nucleolus, j. centriole, k. mitochondrion, l. flagellum, m. endoplasmic reticulum, n. lysosome, o. Golgi. For b, you could say DNA, but you need to know that in prokaryotic cells, the DNA is in the nucleoid. For m, you can say rough endoplasmic reticulum, since that's what it is actually pointing at.
8. Structures c and l are used for movement, d is used to make proteins, h houses the DNA, k produces energy, n is for breaking down chemicals, and o is for packaging chemicals to be transported throughout the cell. Structure m is made of smooth ER, which is used for lipid production, and rough ER, which is used for protein production.
9. The cytoskeleton keeps the organelles in their place and aids in the transport of substances throughout the cell.
10. The chloroplast is where photosynthesis takes place. You can also say that it holds chlorophyll or some other pigment, but you need to know that both sets of photosynthesis reactions happen in the chloroplast.
11. DNA can also be found in chloroplasts and mitochondria.
12. Water will go through the membrane and into the solution of salt and water if it is semipermeable. If it allows all substances to pass through it, salt will go through the membrane and into the hypotonic solution. A hypotonic solution has a lower concentration of solute. If the membrane is semipermeable, only water can travel across it, so osmosis will make water travel into the membrane to dilute the saltwater solution it holds. If the membrane is fully permeable, salt can travel through it, so diffusion will make salt travel across the membrane to make the hypotonic solution more concentrated.
13. Cells use ATP for energy, breaking it down into ADP and P.
14. Chlorophyll captures energy from light. Photosynthesis uses up carbon dioxide and water, and it makes oxygen and glucose. There are a lot of chemicals involved in photosynthesis, but they are used and remade, so the only chemicals used up are carbon dioxide and water.
15. Glucose and oxygen are used up in aerobic respiration, while carbon dioxide and water are made. It is almost the opposite of photosynthesis.
16. ATP and NADPH are made and sent to the Calvin Cycle. Oxygen is made and released into the atmosphere.
17. Carbon dioxide is used up, while glucose is made. NADP⁺, ADP, and P are sent back to be used in the light-dependent reactions. Remember, the light-dependent reactions make energy, and it is sent to the Calvin Cycle in the form of ATP and NADPH. Those molecules are assembled from NADP⁺, ADP, and P, so once the energy is used, those components must go back so they can be made into more ATP and NADH.

18. A net of two ATPs are made in glycolysis. If there is no oxygen, the cell can do fermentation so that more glycolysis can happen. Two are used, but four are made, for a net gain of two.
19. It is acting as an anaerobe. Glycolysis is the only phase of cellular respiration that can happen when no oxygen is present.
20. The preparatory reaction, which makes no ATPs, the Krebs Cycle, which makes two ATPs, and the electron transport chain, which makes 32 ATPs. You can call the preparatory reaction the preparation step as well.
21. NADH and FADH₂ transport high-energy electrons to the electron transport chain. Remember, NADH and FADH₂ are called electron carriers.
22. The electron transport chain is occurring. The high-energy electrons are carried to the electron transport chain by NADH and FADH₂, and when their energy is used, the results are NAD⁺ and FAD.

Test for Chapter 3

1. Define the following terms:

- | | | | |
|--------------|----------------|---------------|------------------|
| a. Pathogen | c. Osmosis | e. Exocytosis | g. Anaerobes |
| b. Diffusion | d. Endocytosis | f. Aerobes | h. Endosymbiosis |

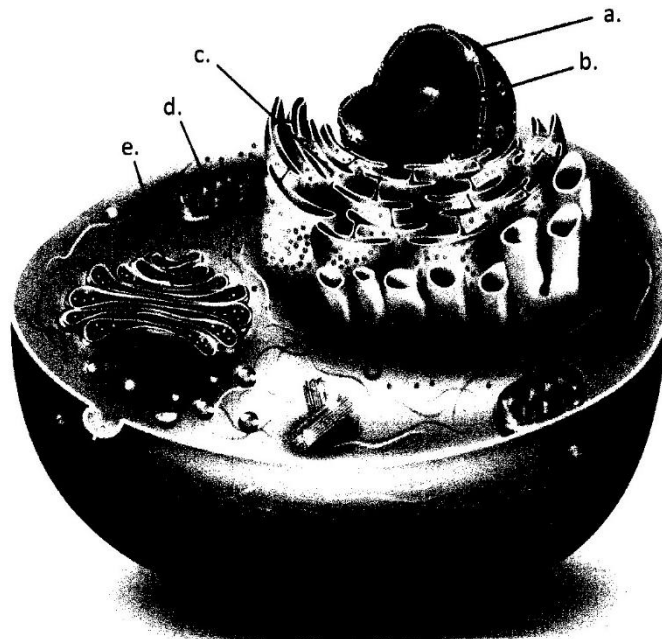
2. Identify the structures pointed out by the letters in the eukaryotic cell illustration shown on the right.

3. In which structures pointed out on the right can DNA be found?

4. If a cell requires a lot of energy, which of the structures on the right will the cell have many of?

5. Fill in the blank: When the cell needs to use energy, it breaks ATP down into _____ and P.

6. What are the dots on the structure labelled "c"? What do they do?



7. Water is traveling across a cell's plasma membrane, out of the cell and into the solution where it lives. Is it in an isotonic, hypertonic, or hypotonic solution?

8. In photosynthesis, NADP⁺ is being produced. Is this happening in the light-dependent reactions or the light-independent reactions?

9. In photosynthesis, oxygen is being made and released into the atmosphere. Is this happening in the light-dependent reactions or the light-independent reactions?

10. List the four main processes in aerobic respiration and how many net ATPs are produced in each.

11. A cell is performing fermentation after cellular respiration. Which of the four processes you listed above is the only one happening in the cell?

12. In cellular respiration, FAD is becoming FADH₂. Which of the four processes you listed above is happening?

(End of the Test)

Answers to the Test for Chapter 3

1. (8 points, one for each definition)

a. Pathogen – An organism that causes disease

b. Diffusion – Movement of a solute from an area of high concentration to an area of low concentration

c. Osmosis – Movement of a solvent across a semipermeable membrane from an area where the solute concentration is low to an area where the solute concentration is high

d. Endocytosis – The process by which cells take in a substance by surrounding it with the plasma membrane and making a vesicle that holds the substance

e. Exocytosis – The process by which a substance in a vesicle is released into the cell's environment by fusing with the plasma membrane

f. Aerobes – Organisms that use oxygen in their cellular respiration

g. Anaerobes – Organisms that do not use oxygen in their cellular respiration

h. Endosymbiosis – The idea that eukaryotes arose as a result of one prokaryote engulfing others

2. (5 pts, one for each) a. nucleus, b. nucleolus, c. endoplasmic reticulum, d. mitochondrion, e. Golgi. You can also be more specific and say rough endoplasmic reticulum for c.

3. (2 pts, one for each) a and d. You can also say nucleus and mitochondrion.

4. (1 pt) d. The mitochondria are where cellular respiration occurs. If the cell needs a lot of energy, it will have a lot of them.

5. (1 pt) ADP

6. (2 pts, one for the name, one for the function) Ribosomes, and they are used to make proteins.

7. (1 pt) Hypertonic. If water is leaving the cell, it must be going to where the solutes are more concentrated, and that means the solution is hypertonic.

8. (1 pt) The light-independent reactions. The light-dependent reactions make NADPH, which the light-independent reactions turn into NADP⁺ to use the energy.

9. (1 pt) The light-dependent reactions. The light-independent reactions make the other product, glucose.

10. (4 pts, $\frac{1}{2}$ for each process and $\frac{1}{2}$ for the correct number of net ATPs)

Glycolysis: 2

Preparatory reaction: 0 (You can call this the preparation step.)

Krebs Cycle: 2 (You can call this by any of the other names listed in the text.)

Electron Transport Chain: 32

11. (1 pt) Glycolysis. If it is doing fermentation, there is no oxygen, so the other three steps can't happen.

12. (1 pt) Krebs Cycle. Glycolysis makes NADH, not FADH₂. The electron transport chain uses FADH₂, so it can't make FADH₂. The preparation step doesn't produce energy or electrons, which is what FADH₂ carries. The Krebs cycle makes both NADH and FADH₂ to carry electrons to the electron transport chain.

Total points: 28

Answers to the Chapter 4 Review

1. a. Mitosis – The process by which a eukaryotic cell replicates into two identical daughter cells
 - b. Interphase – All phases of the cell cycle that do not include mitosis
 - c. Apoptosis – The death of a cell that occurs as a normal, controlled event in an organism
 - d. Budding – The formation of a new organism as an outgrowth of an existing organism
 - e. Cytokinesis – A division of the cytoplasm, which results in two cells where there was only one before
 - f. Chromosome – An organized package of DNA that is formed during cell division
 - g. Karyokinesis – The process by which genetic material is divided between two cells
 - h. Homologous Chromosomes – Chromosomes that carry the same genes, but one comes from one parent while the other comes from the other parent
 - i. Gamete – A mature haploid cell used in sexual reproduction
 - j. Zygote – A diploid cell that results from the union of two gametes
 - k. Hermaphrodite – An organism capable of producing male and female gametes
 - l. Artificial intelligence – The development of computer systems able to perform tasks that normally require human intelligence, such as visual perception, speech recognition, decision-making, and translation between languages
2. The cell cycle starts with the G₁ phase, where most of the life activities of the cell happen. Next comes the S phase, where a copy of the genome is made. That is followed by the G₂ phase, where the cell gets ready to reproduce. Finally, the mitosis phase is when the reproduction takes place. There are checkpoints between G₁ and S, between G₂ and mitosis, and in the middle of mitosis. All phases but mitosis belong to interphase. Your wording can be very different, but the basics of the phases, their order, and the checkpoints must all be there. Also, “synthesis” or “copying the DNA” can be used to describe the S phase.
3. Binary fission, budding, and mitosis. Bacterial use binary fission, yeast use budding, and eukaryotes use mitosis. Sexual reproduction and meiosis do not lead to genetically-identical cells.
4. Interphase, prophase, metaphase, anaphase, telophase.
5. a. metaphase, b. interphase, c. anaphase, d. telophase

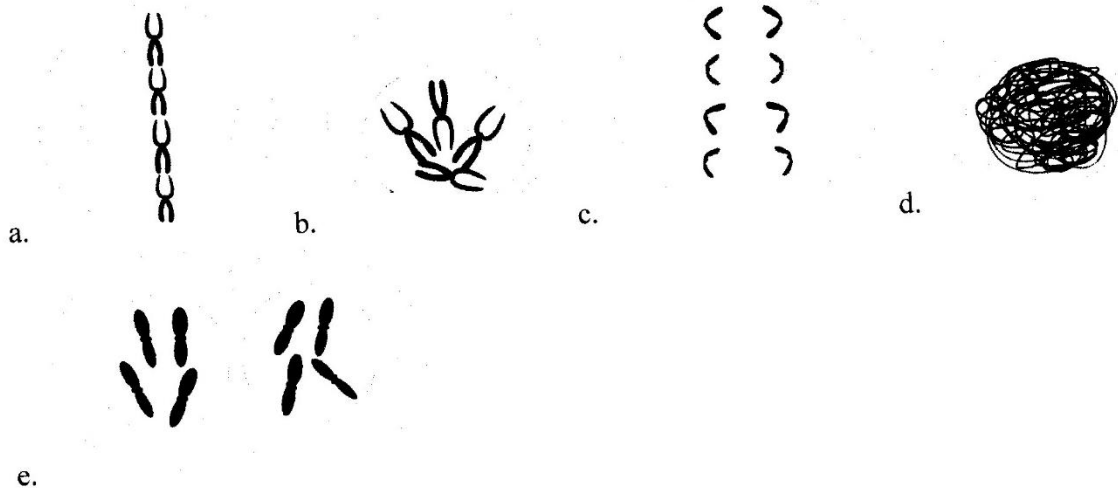
6. Prophase or metaphase. In interphase, chromosomes haven't formed yet. In anaphase, the sisters are being separated, so there are no more "X" shapes, only "V" shapes. In telophase, the sisters are completely separated, so the chromosomes look more like bars.
7. It would have 23 chromosomes if it had its haploid set. At the end of mitosis, there will be two daughter cells, each of which has 46 chromosomes. Remember, the chromosomes come in homologous pairs. During prophase, both chromosomes from each pair is present. Thus, if there are 46 chromosomes there must be 23 pairs. Mitosis starts with a diploid set and ends with two genetically-identical cells, each of which has a diploid set.
8. Telophase. In telophase, the cell starts to become two cells, which requires cytokinesis. It starts at the end of anaphase, but only telophase has it happening from the beginning.
9. It is a plant cell. Animal cells use a contractile ring, and bacterial cells don't do mitosis, so they don't have a telophase.
10. At the end of meiosis I, there will be two cells, each of which has 8 chromosomes attached to their sister chromatids. At the end of meiosis II, there will be four cells, each of which has 8 chromosomes that are not attached to their sister chromatids. Remember, meiosis I separates the homologs, and meiosis II separates the sisters.
11. After mitosis, there will be two cells, each of which has 28 chromosomes. After meiosis I and meiosis II, there will be four cells, each of which has 14 chromosomes. Mitosis starts with a diploid cell and ends with two genetically-identical diploid cells. Meiosis starts with a diploid cell and ends up making haploid cells, which each have half the number of chromosomes that the diploid cell has, since it has one chromosome from each pair.
12. Mitosis is used to make cells for replacement or growth. Meiosis makes gametes.
13. There will be four functional gametes. In spermatogenesis, all products of meiosis are functional.
14. There will be one functional gamete. In oogenesis, the function gamete gets most of the contents of the original cell. The other three are small and cannot be used for reproduction.
15. Eggs are much bigger than sperm. Remember, the egg has most of the cytoplasm, organelles, and all the maternal mRNA. Thus it is bigger.
16. The egg contains mRNA. The sperm has DNA, a centriole, mitochondria, and an acrosomal cap.
17. It must burrow through cells that protect the egg. That's what the acrosomal cap allows it to do. It must also bind to the receptor that ensures the egg is from the correct species. However, you don't have to include that.

Test for Chapter 4

1. Define the following terms:

- | | | | |
|---------------|----------------|---------------------------|------------------|
| a. Interphase | c. Cytokinesis | e. Homologous Chromosomes | g. Zygote |
| b. Apoptosis | d. Chromosome | f. Gamete | h. Hermaphrodite |

2. A cell is leaving the S phase. What phase of the cell cycle is beginning?
3. Is the cell described above in interphase?
4. A bacterium begins the process of binary fission. What will exist when the process is finished? Be as specific as possible.
5. A cell undergoing mitosis has passed its checkpoint. What is the next stage of mitosis that it will enter?
6. List the names of each stage of mitosis shown below, and indicate their proper order.



7. In which of the stage or stages shown above are the chromosomes *not* attached to their sister chromatids?
8. A contractile ring is formed during telophase. What kind of cell is undergoing mitosis?
9. What is the number of chromosomes in the haploid set of DNA for the cell whose mitosis is shown in problem #6?
10. A cell has its haploid set of chromosomes, and they are attached to their sister chromatids. It begins a process that produces two cells with their haploid set of chromosomes that are not attached to their sister chromatids. What happened: mitosis, meiosis I, meiosis II, budding, or binary fission?

The owner of this book is free to copy this page.

11. A cell with a total of 32 chromosomes ends up producing two cells with 16 chromosomes, each of which is attached to its sister chromatid. What happened: mitosis, meiosis I, meiosis II, budding, or binary fission?
12. Which contains more material: a sperm, an egg cell, a polar body?
13. Identify the processes that result in two genetically-identical cells: mitosis, meiosis I, meiosis II, budding, binary fission, sexual reproduction.

(End of the Test)

Answers to the Test for Chapter 4

1. (8 pts: one for each definition)

- a. Interphase – All phases of the cell cycle that do not include mitosis
- b. Apoptosis – The death of a cell that occurs as a normal, controlled event in an organism
- c. Cytokinesis – A division of the cytoplasm, which results in two cells where there was only one before
- d. Chromosome – An organized package of DNA that is formed during cell division
- e. Homologous Chromosomes – Chromosomes that carry the same genes, but one comes from one parent while the other comes from the other parent
- f. Gamete – A mature haploid cell used in sexual reproduction
- g. Zygote – A diploid cell that results from the union of two gametes
- h. Hermaphrodite – An organism capable of producing male and female gametes

2. (1 pt) The G₂ phase

3. (1 pt) Yes, it is in interphase. All parts of the cell cycle except mitosis are contained in interphase.

4. (1 pt: ½ for two cells, and ½ for genetically identical) Two genetically-identical bacteria. You can say “cells” instead of bacteria. You can also just say “Two identical bacteria.”

5. (1 pt) Anaphase is next. The checkpoint in mitosis is in metaphase. The next phase after that is anaphase.

6. (5 pts, ½ for each name, and ½ for each being in the proper order) a. metaphase, b. prophase, c. anaphase, d. interphase, e. telophase, and the proper order is d, b, a, c, e. You can use the names in the order instead of the letters, if you want.

7. (1 pt, ½ of a point for each) c and e. You can have the names instead of the letters. You can have d listed as well, although technically, there are no chromosomes in that phase.

8. (1 pt) It is an animal cell. In plants, a cell wall is built in between the new nuclei and a plasma membrane then constructed in telophase. There is no contractile ring. Bacterial cells don't use mitosis.

9. (1 pt) 2. Mitosis starts with a diploid cell, and the illustration shows four chromosomes in prophase. The haploid number of chromosomes is half that.

10. (1 pt) Meiosis II happened. Meiosis I splits up the homologs, but they are still attached to their sister chromatids. Meiosis II takes that cell and separates the sister chromatids.
11. (1 pt) Meiosis I happened. Meiosis I splits up the homologs, but they are still attached to their chromosomes. Meiosis II takes that cell and separates the sister chromatids.
12. (1 pt) An egg cell. The sperm has only a nucleus, a centriole, mitochondria, and an acrosomal cap. The polar bodies have very little in them, because most of the cytoplasm, organelles, and mRNA end up in the egg cell.
13. (1 pt: one-third for each) Mitosis, binary fission, budding. Both parts of meiosis produce cells that are very different, and sexual reproduction is the result of two gametes joining, making only one cell.

Total points: 24

Answers to the Chapter 5 Review

1. a. Alleles – Different forms of the same gene
- b. Dominant allele – The allele that determines the trait whenever it is present
- c. Recessive allele – The allele that determines the trait only when the dominant allele is not present
- d. Genotype – The genetic composition of the organism
- e. Homozygous – Both alleles for a gene are the same (either both dominant or both recessive)
- f. Heterozygous – One allele is dominant and one allele is recessive
- g. Phenotype – The physical traits determined by the genes
- h. Mutagen – An agent that causes a genetic mutation
- i. Monohybrid cross – The results of male and female mating with regard to a single trait
- j. Dihybrid cross – The results of male and female mating with regard to two traits
- k. Autosome – A chromosome that does not determine the sex of the individual
- l. Pedigree – The record of ancestors for an individual (or family) showing parent/offspring relationships across the generations, also called a family tree
- m. Law of Independent Assortment – Each allele for a trait moves into the gametes without influencing the other alleles for other traits
- n. Sex chromosomes – Two chromosome that determine the sex of an individual
- o. Sex-linked Disorder – A disorder caused by an allele that is found on a sex chromosome
- p. Law of Segregation – During gametogenesis, each gamete receives only one allele for every gene
2. a. The genotype is SS, and the phenotype is smooth peas. The dominant allele determines the letter, and it is capital, so “S” means the allele for smooth peas, while “s” would mean the allele for wrinkled peas. Homozygous means both alleles are the same. The phenotype is the trait expressed, and if even one dominant allele is present, that trait is the one expressed.
- b. The genotype is Ss, and the phenotype is smooth peas. Heterozygous means the alleles are different, and since there is still one dominant allele, that’s the trait which is expressed.

c. The genotype is ss , and the phenotype is wrinkled peas. Homozygous means both alleles are the same, and since there is no dominant allele, the recessive trait is expressed.

3. There is a 50% chance for a SS genotype and a 50% chance for a Ss genotype. 100% of the offspring will have smooth peas. Since the female is heterozygous, she is Ss . Half of her gametes will have the S allele, and the other half will have the s allele. The male is homozygous dominant, so his gametes will all have the S allele. That leads to the Punnett square on the right. Since there is only one possibility, you could just have one row in your Punnett square. Your answers will be the same. There are two boxes with SS , out of a possible four. That means the percent chance is $2/4 \times 100 = 50\%$. The other boxes are Ss , and there are also two of them, which means another 50% chance. However, all offspring have at least one dominant allele, so they will all express that trait.

		Possible gametes from the female	
		S	s
Possible gametes from the male	S	SS	Ss
	s	Ss	ss

4. 25% of the plants will produce yellow, smooth seeds, 25% will produce yellow, wrinkled seeds, 25% will produce green, smooth seeds, and 25% will produce green, wrinkled seeds. Since the female is heterozygous in both traits, she is $YySs$ (you could also say $SsYy$). That gives four possible gametes: YS , Ys , yS , and ys . The male expresses both recessive traits. The only way that can happen is for him to be $yyss$. That means all of his gametes will have a recessive trait in each allele (all will be ys). That means he gets only one row. You can give him as many rows as you like, however, as long as they are all ys , and the results will be the same. For the offspring, $YySs$ has one dominant allele from each trait, so it will produce yellow, smooth seeds. There is only one with that phenotype, so the chance is $1/4 \times 100 = 25\%$. The $Yyss$ has a dominant allele for color but two wrinkled alleles, so it makes yellow, wrinkled seeds with the same percent chance. The $yySs$ is recessive in color but has the dominant smooth allele, so it makes green, smooth seeds at the same percent chance. Finally, the $yyss$ is all recessive, so it makes green, wrinkled peas with a 25% chance.

		Possible gametes from the female			
		YS	Ys	yS	ys
Possible gametes from the male	ys	$YySs$	$Yyss$	$yySs$	$yyss$

5. a. Four express the phenotype. The shaded shapes are the ones with the phenotype.

b. The pattern is autosomal recessive. Males and females are equally affected, so this isn't linked to a sex chromosome. We know it's recessive because 3&4 don't express it, but one of their offspring does. That means they each carry an allele for it, but they do not express it, so it must be recessive.

c. Individuals 3, 4, and 6 are both Pp , while 7 is pp . Since 3 and 4 have a recessive allele that they each give to one of their male offspring, they must be heterozygous. Individual 7 can only express the phenotype if she has two recessive alleles. Individual 6 must have a recessive allele to give to two of her offspring, but she doesn't express it, so she must also be heterozygous.

6. Males can have the disorder, but females cannot. Only males have a Y-chromosome, so if the gene is on the Y-chromosome, only males can have that disorder.

7. Both males and females can have the disorder, but it will be more common in males. Both males and females have at least one X-chromosome, so they all have the gene. However, males have only one X-chromosome. Since the disorder is recessive, males need only one recessive allele to have the disorder, since they have only one X-chromosome. Females must have two recessive X-chromosomes to have the disorder, making it more rare for them.

8. 25% of the children will have A+ blood, 25% will have A- blood, 25% will have B+ blood, and 25% will have B- blood. Since the mother is type O, she must have two O alleles. However, she is heterozygous in Rh factor, so she is $OO+-$. All of her gametes will have an O allele, but half of them will have a + allele and half a -. That makes two possibilities. You could give her four columns, though, as long as $O+$ and $O-$ are the only possibilities. The male has type AB blood, so he has an A allele and a B allele. He is negative in Rh factor, however, so he has two - alleles. Thus, he is $AB--$. That means half his alleles will have the A allele, and half will have the B allele. They will all have the - allele, so there are only two possibilities, but once again, he can have four rows if you want. The $AO+-$ represents A+ blood, since it has a dominant allele for each trait. There is only one with that phenotype, so the chance is $1/4 \times 100 = 25\%$. The $AO--$ represents A- blood, since it has the dominant A allele but both recessive - alleles. Once again, there is a 25% chance for that. The $BO+-$ is B+, and there is a 25% chance of that. The $BO--$ is B-, and there is a 25% chance of that.

		Possible gametes from the female	
		$O+$	$O-$
Possible gametes from the male	$A-$	$AO+-$	$AO--$
	$B-$	$BO+-$	$BO--$

9. It means the trait is determined by more than one gene. This leads to more diversity. The more genes that contribute to the trait, the more variety there can be.

10. It does not, because genetics doesn't completely determine your traits. The environment plays a role as well.

11. They must be on the same chromosome and close together. If they are on different chromosomes, their alleles are sorted into gametes independently. If they are on the same chromosome but far from one another, crossing-over can cause them to be sorted into gametes differently. If they are on the same chromosome and close, however, crossing-over can't separate them.

12. Neither daughter cell will be normal (in fact, neither will survive) when nondisjunction happens in mitosis, but two daughter cells can be normal if it happens in meiosis. It must happen in meiosis II, as shown in Figure 5.14, and only half of them will be normal.

13. Translocation causes genes to move from one chromosome to another.

14. Duplication can produce copies of a gene so that the person has more.

15. They all allow an organism to get DNA from another organism. However, conjugation requires a living organism to give away a copy, transformation requires the DNA to be absorbed from the environment, and transduction requires a virus to deliver it. You can say “bacterium” instead of “organism,” since it mostly happens in bacteria. Also, you can include bacteria as something they have in common.
16. The protein is very different. Remember, a reading frameshift causes each codon after it to change. Thus, most of the amino acids coded for after the mutation will be different, which will lead to a much different protein.
17. That’s a nonsense mutation. It causes the translation process to end early, making the protein too short.
18. That’s a silent mutation. The mutation resulted in a different codon, but that codon was for the same amino acid, so the protein didn’t change.
19. Somatic cells have nothing to do with reproduction, while germ cells are the ones that are used to make gametes. It’s important because a mutation in the somatic cells will affect only the individual, while a mutation in the germ cells can affect future generations.
20. The information content went down, but the animal might be more fit to survive. Mutations tend to get rid of information, as John Sanford notes (p. 154). However, losing information might cause a gain in survival, such a streptomycin resistance in bacteria.

Test for Chapter 5

1. Define the following terms:

- | | | | |
|------------|-------------------|-----------------------|----------------------------------|
| a. Alleles | c. Dihybrid cross | e. Law of Segregation | g. Sex-linked Disorder |
| b. Mutagen | d. Autosome | f. Sex chromosomes | h. Law of Independent Assortment |

2. In certain species of mice, brown fur is dominant over white fur. If a mouse is heterozygous in the trait, what are its genotype and phenotype?

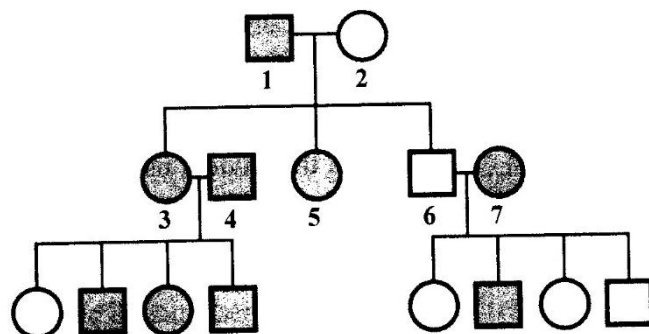
3. If a female mouse that is heterozygous in fur color mates with a male that is homozygous recessive in fur color, what are the possible phenotypes of the offspring, along with their percent chances of appearing?

4. In blood type, A and B are codominant, O is recessive. An additional trait for blood type, Rh factor, can be + or -, which + being dominant. If a mother who is Type A+ and heterozygous in each has children with a man who is Type B+ and is homozygous in type but heterozygous in Rh Factor, what are the possible blood types of the children, along with their percent chances?

5. The pedigree on the right tracks a genetic disorder. What pattern of inheritance does it follow?

6. For the pedigree on the right, what are the genotypes for individuals 3 and 6? (Use *P* and *p* to represent the alleles.)

7. Suppose a man has a phenotype that he gives to all his sons but none of his daughters. Most likely, on what chromosome is the gene for that trait found?



8. The genes for two traits are close to one another on the same chromosome. Will those traits be linked?

9. What kind of abnormality does nondisjunction cause?

10. A bacterium receives new DNA through transduction. Besides the bacteria and DNA, what else had to be involved to make this happen?

11. A gene codes for a protein with 1,347 amino acids. A point mutation causes that protein to have 718 amino acids. What kind of mutation was it?

12. For the mutation mentioned above to affect future generations, in what kind of cell would it need to happen?

(End of the Test)

Answers to the Test for Chapter 5

1. (8 pts: one for each definition)

- a. Alleles – Different forms of the same gene
- b. Mutagen – An agent that causes a genetic mutation
- c. Dihybrid cross – The results of male and female mating with regard to two traits
- d. Autosome – A chromosome that does not determine the sex of the individual
- e. Law of Segregation – During gametogenesis, each gamete receives only one allele for every gene
- f. Sex chromosomes – Two chromosome that determine the sex of an individual
- g. Sex-linked Disorder – A disorder caused by an allele that is found on a sex chromosome
- h. Law of Independent Assortment – Each allele for a trait moves into the gametes without influencing the other alleles for other traits

2. (2 pts, one for the genotype and one for the phenotype) The genotype is Bb , while the phenotype is brown fur. If the student used a different letter but still has one capital and one small, that's fine.

	Bb	bb
	Bb	bb

3. (2 pts, $\frac{1}{2}$ for each phenotype, and $\frac{1}{2}$ for each percent chance) The possible phenotypes are brown fur (50%) and white fur (50%). The female is heterozygous, so she is Bb . That means half her gametes get B , and the other half get b . The male is homozygous recessive, so he is bb . That means all gametes get b . As a result, the student can have only one row for the male. The light grey boxes have a dominant gene, so they get the dominant trait, and the percent is $2/4 \times 100 = 50\%$. The white boxes have only recessive alleles, so they have white fur, and that percent is also 50%.

4. (4 points, $\frac{1}{2}$ for each phenotype, and $\frac{1}{2}$ for each percent chance) 37.5% will have AB+ blood, 12.5% will have AB- blood, 37.5% will have B+ blood, and 12.5% will have B- blood. The

			$BO++$	$BO+-$
		$AB--$	$BO+-$	$BO--$

mother is heterozygous in both, so she is $AO+-$. That gives her four possible gametes, listed at the top of the Punnett square on the right. The male is homozygous in type but heterozygous in Rh factor, so he is $BB+-$. All of his gametes will have the B allele, but half

will have the + and half will have the -. That means he has two possibilities, but the student can have four rows, as long as two are B^+ and the other two are B^- . The AB^{++} and AB^{+-} boxes are AB blood, but they have at least one dominant Rh allele, so they are all AB^+ . There are three of them, so the percent chance is $3/8 \times 100 = 37.5\%$. The BO^{++} and BO^{+-} boxes are type B blood, since B is dominant over O, but they have at least one dominant Rh allele, so they are all B^+ . There are three of them, so the percent chance is $3/8 \times 100 = 37.5\%$. The AB^{--} box is AB^- , since it has two recessive Rh alleles, and that percent is $1/8 \times 100 = 12.5\%$. The BO^{--} box is B^- , since B is dominant over O, but both Rh alleles are recessive. That's also $1/8 \times 100 = 12.5\%$.

5. (2 pts, one for each word) Autosomal dominant. It is autosomal since it affects males and females equally. It appears a lot, which tends to mean it is dominant, but notice that 3&4 both have it, but they also have a child who doesn't have it. That means they must each carry an allele for not having it, but that allele is not expressed. This means not having it is recessive, which means having it is dominant.

6. (1 pt, $\frac{1}{2}$ for each) 3 is Pp , while 6 is pp . Since it is dominant, 6 must have two recessive alleles to not have the disorder. Since 3 and 4 have the disorder but have a child without the disorder, that means each of them must carry a recessive allele that is not expressed, so they must also have a dominant allele.

7. (1 pt) It is on the Y-chromosome. Only males get a Y-chromosome, and they get it from their father. Thus, if it is something on the Y-chromosome, it will be passed from any father who has it to all male children. However, none of the female children will get it, since they have no Y-chromosome.

8. (1 pt) Yes, those are the conditions required for two genes to be linked.

9. (1 pt) It causes a chromosomal abnormality, since the number of chromosomes in the daughter cells are not correct.

10. (1 pt) A virus must have been involved, since transduction requires a virus to infect one bacterium and then transfer it to another.

11. (1 pt) That was a nonsense mutation, which causes the translation process to stop prematurely.

12. (1 pt) A germ cell. If the student says gamete, take $\frac{1}{2}$ off. Gametes are the end result of meiosis. Germ cells start meiosis.

Total points: 25

Answers to the Chapter 6 Review

1. a. Biotechnology – The field that involves applying tools to the genome of an organism
 - b. Recombinant DNA – The resulting DNA when DNA from two (or more) organisms are combined
 - c. Genetic engineering – Modifying nucleic acids, either pieces of DNA or RNA, or entire genomes
 - d. Plasmid – A small, circular piece of DNA often found in bacteria
 - e. Transgenic – an organism that has genetic material from another type of organism
 - f. Cloning – Making a copy of a piece of DNA, a gene, a genome, or an entire individual
 - g. Reproductive cloning – Using adult cells from an adult individual to make a new individual
 - h. Therapeutic cloning – Using adult cells to produce various mature adult cells
 - i. Stem cell – An undifferentiated cell that can mature into many different types of cells
 - j. Gene therapy – Altering genes in order to treat or stop disease
 - k. Genomics – The field that studies sequences of nucleotides in DNA as well as their structure, function, and location
 - l. Proteomics – The study of proteins produced in an organism
2. It is a virus that attacks bacteria by injecting nucleic acids into them. You can say “DNA or RNA” instead of “nucleic acids.”
3. b. A palindrome must have both strands the same when read from the 5’ end to the 3’ end.
 4. It cuts DNA at a palindrome and can be called a restriction endonuclease.
5. a. III. The brightest band has the most segments in it.
 - b. II. The dimmest band has the lowest number of segments.
 - c. IV. The longest can’t travel far. Since they are negative, they travel away from the negative electrode and towards the positive. That means the closer to the negative electrode, the longer.
 - d. I. The smallest travel farthest. Since they are negative, they travel away from the negative electrode and towards the positive. That means the closer to the positive electrode, the smaller.

6. Denaturing, annealing, and extension. The strands need to be separated (denaturing), then primers must be added (annealing), and then matching strands are made (extension).
7. It will increase the sensitivity. Each cycle doubles the number of segments, so the more cycles, the more segments are made.
8. ACTC. The closer to the negative electrode, the longer. The Sanger method reads from the shortest chain to the longest.
9. DNA fingerprinting.
10. They are short tandem repeats, which are short repeats of a nucleotide sequence. The number of STRs varies from person-to-person, so a list of a person's STRS is unique to that person.
11. They cannot distinguish between people with identical DNA, such as identical twins or identical triplets.
12. Suspect 3 is the match, because all the bands are there in the proper place.
13. A plasmid is the vector.
14. Transgenic bacteria produce it.
15. Three are needed: the donor, which provides an adult cell nucleus, a female to contribute an egg cell from which the nucleus is removed, and a surrogate into which the embryo is implanted to develop. The donor animal is being cloned, as that's the animal from which the DNA is taken.
16. No, they will not, because they will not have the same environment, and environment affects traits as well. In fact, you can look online for pictures of CopyCat and the donor cat, named Rainbow. They look quite different.
17. Embryonic stem cells must be taken from an embryo, killing it. That's murder, which is unethical. Adult stem cells can be collected without permanently harming the person from which they are being taken.
18. It is an adult cell that has been de-differentiated so that it is like a stem cell. Ethically, it is like an adult stem cell, since no permanent harm comes to the donor.
19. In vivo gene therapy delivers modified DNA through a vector that is injected into the person. Ex vivo gene therapy delivers modified DNA through a vector that is given to cells that have been taken out of the body. You can also say that *in vivo* changes the DNA of cells while they are inside the person, while *ex vivo* changes the DNA of cells that are outside the person and then put back into the person.

20. a. Functional genomics, since it is interested in the function of a DNA sequence.
- b. Proteonomics, which studies the proteins produced by the DNA rather than the DNA itself.
- c. Comparative genomics, since DNA is being compared.
21. It determines where in the DNA the changes will be made. It is attached to the *Cas9* enzyme.
22. It can also edit genes that are already there.
23. Making transgenic people involves adding genes that were not part of God's original design.
This is a problem since we are made in the image of God. Adding genes from other organisms would change that.

Test for Chapter 6

1. Define the following terms:

- | | | | |
|--------------------|-------------------------|------------------------|-----------------|
| a. Recombinant DNA | c. Transgenic | e. Therapeutic cloning | g. Gene therapy |
| b. Plasmid | d. Reproductive cloning | f. Stem cell | h. Proteomics |

2. What does it mean for a segment of DNA to be a palindrome?

3. A strand of DNA is exposed to a restriction endonuclease. What happens to it?

4. An electrophoresis gel has many bands. What affects the brightness of the bands? Near which electrode are the longer segments of DNA found?

5. What does it mean to denature DNA?

6. The nucleotide sequence determined using the Sanger Method is *ACTTGC*. Draw what the gel for this sequence would look like, labeling positive and negative electrodes.

7. What two kinds of profiling that you learned about in this chapter can be used to identify a person based on his or her DNA?

8. How are plasmids used in making transgenic bacteria?

9. In the process of cloning an animal, an egg cell is taken from an adult version of the animal. What two things happen to that egg cell after it is taken?

10. Of the three animals required for cloning, which animal will have the same DNA as the clone?

11. A scientist harvests a mature skin cell and modifies it to become a stem cell. What kind of stem cell is it?

12. In order to use a stem cell, you must kill an individual. What kind of stem cell is being used?

13. If a scientist uses CRISPR to make a transgenic organism, what did he or she do?

14. In CRISPR, what is the *Cas9* enzyme bound to so that the genome gets changed in the correct place?

(End of the Test)

Answers to the Test for Chapter 6

1. (8 pts: one for each definition)

- a. Recombinant DNA – The resulting DNA when DNA from two (or more) organisms are combined
- b. Plasmid – A small, circular piece of DNA often found in bacteria
- c. Transgenic – an organism that has genetic material from another type of organism
- d. Reproductive cloning – Using adult cells from an adult individual to make a new individual
- e. Therapeutic cloning – Using adult cells to produce various mature adult cells
- f. Stem cell – An undifferentiated cell that can mature into many different types of cells
- g. Gene therapy – Altering genes in order to treat or stop disease
- h. Proteomics – The study of proteins produced in an organism

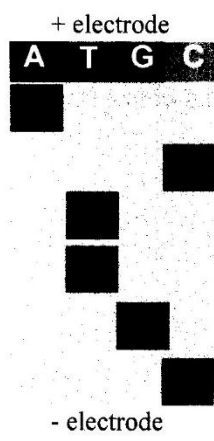
2. (1 pt) It means that the sequence is the same on both strands, as long as you read from the 5' end to the 3' end. You can also just say, proper or corresponding ends instead of 5' and 3'.

3. (1 pt) It gets cut into pieces. You can also say it gets shorter.

4. (2 pts – one for the brightness, one for the electrode) The number of DNA segments affects the brightness of the bands, while the longer segments are found near the negative electrode. The DNA backbone is negative, so the closer to the negative electrode, the less the DNA could travel. Long segments can't travel as well as short ones.

5. (1 pt) It means to separate the two strands. DNA is a double helix, and denaturing separates the two parts of the helix.

6. (2 pts: one-third for the correct placement of each box.)



The Sanger method adds the nucleotides in order, so that the first nucleotide shows up on the shortest segment, the last on the longest segment, and the rest in order in between. Since the segments near the positive electrode are the shortest, you read it from the positive electrode down. The student can have the electrodes reversed, but if so, the boxes must be reversed as well.

7. (2 pts: one for each) DNA fingerprinting and STR profiling. You can say restriction fragment length polymorphism or RFLP instead of DNA fingerprinting.
8. (1 pt) They are used as vectors. You can go into more detail, discussing how the plasmid is cut and the new gene added to it, but that is just a description of the fact that it is a vector.
9. (2 pts: one for each) The nucleus of the egg cell is removed and the nucleus from the donor cell is put in its place.
10. (1 pt) The donor animal. You can also just say the animal from which the adult cell was taken, or the animal whose cell had the inserted nucleus.
11. (1 pt) It is an induced pluripotent stem cell. You can also say iPSC. It is not an adult stem cell. Since it is a mature skin cell, it has already differentiated. Thus, it must be de-differentiated.
12. (1 pt) It is an embryonic stem cell. Only embryonic stem cells kill the donor.
13. (1 pt) He or she used CRISPR to insert a gene from a different organism. CRISPR can be used to edit or insert, depending on what you want to do.
14. (1 pt) It is bound to a guide RNA.

Total points: 25

Answers to the Chapter 7 Review

1. a. Microscopy – The use and development of special lenses and lens systems to view objects that cannot be seen with the naked eye
 - b. Culturing – Providing conditions that enable growth of microbes (or any type of cell, tissue, or organ)
 - c. Broth culture – A liquid culture that contains the nutrients the microbe needs (The organisms can live anywhere in the culture, but they often settle toward the bottom.)
 - d. Agar culture – A solid culture that contains the nutrients the microbe needs (The organisms live on or near the surface of the culture.)
 - e. Extremophiles – Organisms that live in especially harsh conditions, such as very high temperature water, very acidic solutions, high concentrations of salt, etc.
 - f. Endospore – A tough structure that protects a dormant bacterium and allows it to become freely living once the external conditions become suitable for life
 - g. Normal flora – The microbes that live on or inside a healthy human body
 - h. Obligate aerobes – Organisms that must have oxygen in order to survive
 - i. Obligate anaerobes – Organisms that cannot survive for long in the presence of oxygen
 - j. Facultative anaerobes – Organisms that can perform aerobic respiration but can switch to fermentation when little or no oxygen is present
 - k. Serology – The study of blood serum and immune responses
 - l. Strain – A subtype of organism within the species grouping, sometimes called a serotype
 - m. Nitrogen fixation – The conversion of atmospheric nitrogen into a nitrogen-containing molecule that organisms can use
 - n. Lytic cycle – Reproduction of viruses using the host cell's biomachinery, resulting in lysis of the host cell to release the virions
 - o. Lysogenic cycle – Viral nucleic acid is inserted into the host genome and replicates as the host replicates, sometimes called a temperate infection
2. You would use a TEM for the organelle and a light microscope for an entire eukaryotic cell. An STM's magnification is for looking at macromolecules, and an organelle is bigger than that. A TEM has magnifications that allow for you too examine organelles. Both of those have magnifications too large for an entire eukaryotic cell. That's what a light microscope does well.

3. Gram-negative bacteria will be red, while gram-positive bacteria will be purple.
4. It is called inoculation.
5. The presence of the chemical peptidoglycan is the main thing used to distinguish them. Archaea do not have it.
6. Halophiles live in very salty environments, thermophiles in hot environments, and acidophiles in acidic environments. Methanogens produce methane.
7. Bacteria mostly reproduce using binary fission.
8. *Lactobacillus acidophilus* are rod-shaped, *Agrococcus terreus* are spherical, and *Herbaspirillum huttiense* are spiral-shaped. The shape terms coccus, bacillus, and spirillum often appear in the name. If they do, they tell you the shape.
9. They produce a lot of oxygen through photosynthesis.
10. It got into the wrong place in the body. A lot of normal flora are fine when they are where they are supposed to be, but if they get in the wrong place, they become toxic. An example given in the book is skin flora that get under the skin because of a wound. Another possibility is that their population explodes, causing an imbalance. However, that is pretty rare.
11. Gammaproteobacteria are gram-negative, firmicutes are gram-positive, nonproteobacteria are gram-negative, and actinobacteria are gram-positive. All the proteobacteria and all the nonproteobacteria are gram-negative. The two main groups of gram-positive bacteria are firmicutes and actinobacteria.
12. Three types are needed. You don't have to know the types, but *Rhizobium* makes ammonia, *Nitrobacter* turns that into nitrite, and then *Nitrosomas* turns the nitrite into nitrate.
13. Prions, viruses, bacteria. Prions are molecules, viruses are made of at least two types of macromolecules, while bacteria are made of many, many different macromolecules.
14. Viruses are made of proteins and nucleic acids. The nucleic acids must get into the cell to cause an infection.
15. ssDNA is single-stranded DNA, dsDNA is double-stranded DNA, ss RNA is single-stranded RNA, and dsRNA is double-stranded RNA.
16. It initially entered the lysogenic cycle. The lysogenic cycle "hides" the viral infection until something causes it to go into the lytic cycle, which can take a long, long time.
17. No. Most are, but the book discusses one that allows plants to live where they otherwise couldn't live.

Test for Chapter 7

1. Define the following terms:

- | | | | |
|------------------|--------------------------|-------------|----------------------|
| a. Broth culture | c. Endospore | e. Serology | g. Nitrogen fixation |
| b. Extremophiles | d. Facultative anaerobes | f. Strain | h. Lytic cycle |

2. Which kind of microscope has the greatest magnification: TEM, STM, or a light microscope.

3. Fill in the blanks: When a Gram stain is applied, gram-positive bacteria are _____, while gram-negative bacteria are _____.

4. If a prokaryote is an extremophile, would you expect to find peptidoglycan in its cell wall?

5. What is a halophile?

6. Which type of Archaea is not named for the conditions under which it lives?

7. A bacterium is rod-shaped. What word would most likely be a part of its name?

8. Which member of domain Bacteria produces a significant amount of oxygen for the atmosphere?

9. What does it mean for a bacterium to be a part of the normal flora?

10. In what kind of environment must an obligate aerobe live?

11. If a bacterium is part of a group with "proteobacteria" in its name, is it gram-positive or gram-negative?

12. Gram-positive bacteria are split into what two groups?

13. In nitrogen fixation, which requires more than one type of bacterium: the production of ammonia or the production of nitrate?

14. You are examining a cell that has been infected by a virus. What macromolecule from the virus do you expect to find in it?

15. Explain the difference between the lytic cycle and the lysogenic cycle.

(End of the Test)

Answers to the Test for Chapter 7

1. (8 pts: one for each definition)

a. Broth culture – A liquid culture that contains the nutrients the microbe needs (The organisms can live anywhere in the culture, but they often settle toward the bottom.)

b. Extremophiles – Organisms that live in especially harsh conditions, such as very high temperature water, very acidic solutions, high concentrations of salt, etc.

c. Endospore – A tough structure that protects a dormant bacterium and allows it to become freely living once the external conditions become suitable for life

d. Facultative anaerobes – Organisms that can perform aerobic respiration but can switch to fermentation when little or no oxygen is present

e. Serology – The study of blood serum and immune responses

f. Strain – A subtype of organism within the species grouping, sometimes called a serotype

g. Nitrogen fixation – The conversion of atmospheric nitrogen into a nitrogen-containing molecule that organisms can use

h. Lytic cycle – Reproduction of viruses using the host cell's biomachinery, resulting in lysis of the host cell to release the virions

2. (1 pt) STM has the greatest magnification.

3. (2 pts – one for each) When a Gram stain is applied, gram-positive bacteria are purple, while gram-negative bacteria are red. (The student can have “blue” instead of “purple.”)

4. (1 pt) No. Most extremophiles are members of domain Archaea, and they do not have that chemical in their cell walls.

5. (1 pt) It is a prokaryote that lives in very salty environments. The student can say “bacterium,” but most extremophiles are archaea.

6. (1 pt) Methanogens. They produce methane.

7. (1 pt) Bacillus. Rod-shaped bacteria are called bacillus, and that often appears in the name.

8. (1 pt) Cyanobacteria.

9. (1 pt) It means it lives in a host normally and doesn't cause illness. The student can say that it has a symbiotic relationship or anything to indicate that it doesn't harm the host. The student can also say “person” or “animal” instead of “host.”

10. (1 pt) An environment with oxygen.
11. (1 pt) It is gram-negative.
12. (1 pt, ½ for each) Firmicutes and actinobacteria.
13. (1 pt) The production of nitrate. Ammonia is produced in one step, but that must be converted into nitrite, which then must be converted into nitrate. Three different bacteria are required.
14. (1 pt) You will find the nucleic acids in the cell. The proteins don't have to get into the cell, but the nucleic acids must.
15. (2 pts – one for the fact that cell death doesn't happen, one for what gets reproduced) In the lytic cycle, cells die, since the virus gets reproduced and causes lysis. In the lysogenic cycle, cells don't die. They reproduce normally, and the only the viral DNA is reproduced.

Total points: 24

Answers to the Chapter 8 Review

1. a. Supergroup - The classification category that is lower than domain and higher than kingdom
- b. Cytolysis – The bursting of a cell due to a rupture in its plasma membrane
- c. Plasmolysis – The shrinking of a cell's cytoplasm due to water loss
- d. Diatoms – Unicellular stramenopiles with a cell wall made of silica
- e. Dinoflagellates – Unicellular alveolates with a cell wall made of cellulose
- f. Pseudopod – An extension of cytoplasm used by some cells to move or feed
- g. Alternation of generations – Reproduction involving two phases (generations) where haploid spores grow into a gametophyte that produce gametes. The gametes combine to form a diploid sporophyte, which produces haploid spores to complete the cycle
- h. Plasmodium – An aggregate of diploid cells that have multiple nuclei
- i. Mycology – The study of fungi
- j. Fruiting body – The portion of a fungus (which is usually above the ground) that produces sexual spores
- k. Vegetative structures – Groups of cells that are involved in metabolic activity and growth
- l. Mold – Multicellular fungal structure that contain many hyphae that extend away from the mycelium
- m. Fleshy fungus – Multicellular fungal structure made of many hyphae that are compact and form a thallus (body)
- n. Saprotrophs – Organisms that obtain nutrition from dead and decaying organic matter
- o. Ascocarp – A bowl-shaped fruiting body that contains the sexual spores produced via meiosis
- p. Pasteurization – A heating process that reduces the level of microbes in a liquid to a safe level for consumption and storage
- q. Basidiocarp – The fruiting body of club fungi that appears as a mushroom
- r. Hallucinogen – A chemical that causes alteration in the perception of reality, making someone sense that what they are seeing or feeling is real when it is not

- s. Mutualism – Two or more organisms living together in a relationship where they all benefit
 - t. Parasitism – An organism living on or in another that serves as a host and harming the host
 - u. Commensalism – Two organisms living together in a relationship where one benefits and the host is neither helped nor harmed
 - v. Phylogenetics – The study of evolutionary relatedness among various groups of organisms
2. Protozoa, algae, and slime molds. The protozoa are animal-like, the algae are plant-like, and the slime molds are fungus-like. Protozoa belong to the zooplankton, while algae belong to the phytoplankton. Protozoa are animal-like because they move and must feed on other organisms. The algae are plant-like because they do photosynthesis. The slime molds are fungus-like because they form spore-releasing structures like fungi. The zooplankton can move, and the phytoplankton are photosynthetic.
 3. They have two flagella (one of which protrudes from the cell), chloroplasts, and an eyespot. They have other things (like a contractile vacuole), but these are the three things that identify them.
 4. It pumps water out of the cell. Osmosis draws water into the cell, which builds up the pressure inside the cell. To prevent that from bursting the cell, the contractile vacuole pumps water out of the cell when the pressure gets too high.
 5. The remains of diatoms can be used as a gentle abrasive, since their cell walls are like glass and break into shards when the diatoms die.
 6. The dinoflagellates live inside coral, and the relationship is an example of mutualism, because both organisms benefit.
 7. Genus *Plasmodium* is responsible for malaria.
 8. They have cilia, an oral groove, and two nuclei (a micronucleus and a macronucleus). Once again, they have other characteristics, but these three identify them.
 9. They have radial or bilateral symmetry, and large deposits of their remains can indicate the presence of oil.
 10. The gametophyte is haploid and produces gametes, while the sporophyte is diploid and produces spores. A zygote can only form if two gametes undergo fertilization.
 11. They form a spherical shape, and the circles inside are daughter colonies. When they are ready, the daughter colonies get released to form a new sphere.
 12. They form a spiral.

13. In a mature fungus, the hyphae are haploid, and it uses mitosis for asexual reproduction. It uses plasmogamy followed by karyogamy for sexual reproduction. The fruiting body is for sexual reproduction.
14. Chitin can be found in fungal cell walls, and it provides support and protection.
15. They must live inside the cells of another organism.
16. They produce spores that have flagella.
17. They produce zygospores.
18. They produce an ascocarp, but yeasts don't. Instead, the yeast produce spores that look like they came from an ascocarp.
19. They produce a basidiocarp.
20. If the sexual mode of reproduction in a fungus is unknown, a fungus might be put in that group.
21. In a lichen, a fungus supports and protects algae. It also gives some simple nutrients to the algae. The algae do photosynthesis, providing food and oxygen to the fungus.
22. In mycorrhizae, a fungus provides nutrients and protection to a plant's roots. It also loosens the soil to make it easier for the roots to grow. The roots give food from photosynthesis to the fungus.
23. a. Basidiomycota, b. Zygomycota, c. Ascomycota, d. Basidiomycota, e. Ascomycota
24. A phylogenetic tree is a reconstruction of the supposed evolutionary history of a group of organisms. When they are made from different groups of genes, they often disagree.

Test for Chapter 8

1. Define the following terms:

- | | | | |
|----------------|--------------------------|-------------------|------------------|
| a. Plasmolysis | c. Mycology | e. Fleshy fungus | g. Commensalism |
| b. Pseudopod | d. Vegetative structures | f. Pasteurization | h. Phylogenetics |

2. Match each type of organism on the left to a description on the right.

- | | |
|----------------------|---|
| a. <i>Euglena</i> | Made of many individuals that form a spherical shape |
| b. <i>Paramecium</i> | Unicellular organism with a cell wall made of silica |
| c. Radiolarian | Form a mutualistic relationship with coral |
| d. <i>Volvox</i> | Have two flagella, one of which protrudes from the cell |
| e. <i>Spirogyra</i> | Causes the disease malaria |
| f. Dinoflagellate | Uses cilia to move and has both a macronucleus and a micronucleus |
| g. Diatom | Has either radial or bilateral symmetry |
| h. <i>Plasmodium</i> | Has chloroplasts that form a spiral |

3. In alternation of generations, which form of the organism is haploid? Will it produce a reproductive cell that must be fertilized, or will it produce one that can immediately start to develop into the next generation?

4. A protist living in fresh water bursts open. What organelle wasn't working?

5. In what organisms studied in this chapter do you find chitin? Where is it in those organisms?

6. A fungus undergoes plasmogamy followed by karyogamy. What's next: a sporangium or a fruiting body?

7. A fungus makes spores that have flagella. To what group does it belong?

8. What kind of fruiting body is formed by a shelf fungus?

9. What unicellular sac fungus doesn't form an ascocarp?

10. A fungus and a root form a mutualistic relationship. What is it called?

(End of the Test)

Answers to the Test for Chapter 8

1. (8 points, one for each answer)

- a. Plasmolysis – The shrinking of a cell's cytoplasm due to water loss
- b. Pseudopod – An extension of cytoplasm used by some cells to move or feed
- c. Mycology – The study of fungi
- d. Vegetative structures – Groups of cells that are involved in metabolic activity and growth
- e. Fleshy fungus – Multicellular fungal structure made of many hyphae that are compact and form a thallus (body)
- f. Pasteurization – A heating process that reduces the level of microbes in a liquid to a safe level for consumption and storage
- g. Commensalism – Two organisms living together in a relationship where one benefits and the host is neither helped nor harmed
- h. Phylogenetics – The study of evolutionary relatedness among various groups of organisms

2. (8 points, one for each answer)

- a. Have two flagella, one of which protrudes from the cell
- b. Uses cilia to move and has both a macronucleus and a micronucleus
- c. Has either radial or bilateral symmetry
- d. Made of many individuals that form a spherical shape
- e. Has chloroplasts that form a spiral
- f. Form a mutualistic relationship with coral
- g. Unicellular organism with a cell wall made of silica
- h. Causes the disease malaria

3. (2 pts: one for each) The gametophyte is haploid, and its reproductive cells must be fertilized.

4. (1 pt) The contractile vacuole

5. (1 pt: ½ for each answer) It is found in the cell walls of fungi

6. (1 pt) A fruiting body. The fruiting body is formed after sexual reproduction, which is the result of plasmogamy followed by karyogamy.

7. (1 pt) Chytridiomycota

8. (1 pt) A basidiocarp. Shelf fungi are in Basidiomycota, and that's what they form for sexual reproduction.

9. (1 pt) Yeast

10. (1 pt) It is a mycorrhiza.

Total points: 25

Semester 1 Final Exam

1. Define the following terms:

- | | | | |
|---------------------------|------------------|---------------|-----------------|
| a. Irreducible complexity | e. Osmosis | i. Autosome | m. Normal flora |
| b. Homeostasis | f. Endosymbiosis | j. Genotype | n. Lytic cycle |
| c. Cohesive | g. Cytokinesis | k. Transgenic | o. Plasmolysis |
| d. Transcription | h. Gamete | l. Proteomics | p. Pseudopod |

2. An organism makes proteins from amino acids, is this catabolism or anabolism? What word includes both of those processes?

3. You randomly choose two organisms from the same family and compare them. You then randomly choose two organisms from the same phylum and compare them. In which case do you expect the organisms to be more similar?

4. An herbivore eats a plant. What is the trophic level of the plant? What is the trophic level of the herbivore?

5. What is the molecule that governs heredity?

6. Which is stronger: a covalent bond or a hydrogen bond?

7. Vegetable oil does not dissolve in water. Is it polar or nonpolar? Is it hydrophobic or hydrophilic?

8. A molecule is made of two monosaccharides bonded together. What would it be called?

9. A strand of DNA has the following sequence of nucleotide bases:

T – G – C – G – A – T

What is the sequence of nucleotide bases on the mRNA that would be made by transcription? How many amino acids would that mRNA be translated into?

10. State the three main parts of cell theory.

11. You are told that cell A is significantly larger than cell B. If that is the only information you have, which would you say is the eukaryotic cell?

12. What is the function of the mitochondrion in a cell?

13. Which stage of mitosis is missing from this list?

Prophase, Interphase, Anaphase, Telophase

14. A cell has 32 chromosomes during interphase:

- a. If it undergoes mitosis, how many cells will result and how many chromosomes will be in each?
- b. If it undergoes meiosis, how many cells will result and how many chromosomes will be in each?

15. Compare the number of functional gametes at the end of meiosis in males and females.
16. In pea plants, the seeds can be wrinkled or smooth. The allele that makes them smooth is dominant, while the allele that makes them wrinkled is recessive. A pea plant that is heterozygous for seed texture is crossed with a pea plant that makes wrinkled seeds. What are the possible genotypes of offspring and their percentages? What are the possible phenotypes and their percentages?
17. In addition to texture, pea plant seeds can also be yellow or green. The allele for yellow pea plants is dominant, while the allele for green seeds is recessive. What is the genotype for a plant that is heterozygous in both seed color and seed texture? What are the phenotypes?
18. Only males can get a certain sex-linked genetic disorder. On what chromosome is its allele carried?
19. For blood type, A and B are dominant over O, but they are codominant with each other. The Rh factor is controlled by a second gene, with + being dominant and - being recessive. An AB⁺ mother who is homozygous for Rh factor and a type O- father have children. What are the possible blood types and their percentages?
20. What do we call a molecule that cuts (digests) DNA and RNA into small pieces?
21. What do we call the product made when a differentiated cell is harvested from an adult and then turned into a stem cell?
22. What do we call the molecule attached to the Cas9 enzyme in CRISPR. It makes the Cas9 enzyme know where to cut the DNA.
23. Fill in the blank: PCR is done in three steps: denaturing, _____, and extension.
24. Of the three types of microscopes (light, TEM, STM), which has the highest magnification?
25. What bacterium is very important in maintaining the concentration of oxygen in the atmosphere?
26. When a Gram stain is applied, which bacteria have a reddish color?
27. Viruses are made of nucleic acids and what other type of macromolecule?
28. What do we call the vacuole that ensures that water doesn't cause too much pressure in a protist?
29. What are the three groups of protists?

(End of the Test)

Answers to the Semester 1 Final Exam

1. (16 points: One for each definition)

- a. Irreducible complexity – When a system is made up of several interacting components, each of which is necessary for the system to function, and none of which can be made by modifying an already-existing component.
 - b. Homeostasis – The ability of an organism to maintain a constant internal environment
 - c. Cohesive – A property in which the molecules of a substance are attracted to its own molecules
 - d. Transcription – The process by which DNA is used to produce messenger RNA
 - e. Osmosis – Movement of a solvent across a semipermeable membrane from an area where the solute concentration is low to an area where the solute concentration is high
 - f. Endosymbiosis – The idea that eukaryotes arose as a result of one prokaryote engulfing others
 - g. Cytokinesis – A division of the cytoplasm, which results in two cells where there was only one before
 - h. Gamete – A mature haploid cell used in sexual reproduction
 - i. Autosome – A chromosome that does not determine the sex of the individual
 - j. Genotype – The genetic composition of the organism
 - k. Transgenic – an organism that has genetic material from another type of organism
 - l. Proteomics – The study of proteins produced in an organism
 - m. Normal flora – The microbes that live on or inside a healthy human body
 - n. Lytic cycle – Reproduction of viruses using the host cell's biomachinery, resulting in lysis of the host cell to release the virions
 - o. Plasmolysis – The shrinking of a cell's cytoplasm due to water loss
 - p. Pseudopod – An extension of cytoplasm used by some cells to move or feed
2. (1 pt: ½ for each) This is anabolism, and the word that includes both is metabolism.
3. (1 pt) The organisms from the same family should be more similar.
4. (1 pt: ½ for each) The plant is a producer, and the herbivore is a primary consumer.
5. (1 pt) DNA

6. (1 pt) A covalent bond is stronger.
7. (1 pt: ½ for each) It is nonpolar and hydrophobic.
8. (1 pt) It is a disaccharide. Give ½ point if the student says carbohydrate. It's not the best answer, but it is true.
9. (2 pts: one for the sequence, one for the number of amino acids) The sequence is A – C – G – C – U – A. It would be translated into two amino acids. A and T bind together, as do C and G. Remember that U replaces T in RNA. It takes three to code for an amino acid, so six will code for two. If the student has T instead of U in the sequence and it's the only mistake, take off only ½ point.
10. (3 pts: one for each) (1) Cells are the basic unit of life. (2) All organisms are comprised of one or more cells. (3) Cells only arise from other cells
11. (1 pt) Cell A is the eukaryotic cell. Eukaryotic cells are usually bigger.
12. (1 pt) It produces most of the energy the cell uses.
13. (1 pt) metaphase
14. a. (1 pt: ½ for each) Two cells with 32 chromosomes. Mitosis makes two exact copies.
- b. (1 pt: ½ for each) Four cells with 16 chromosomes. Meiosis splits the homologous pairs and makes four cells.
15. (1 pt) There are more functional male gametes made in meiosis. All four male gametes are functional, but only one female gamete is.
16. (2 pts ½ for each percentage and genotype/phenotype)
50% of the plants will be Ss, and the other 50% will be ss.
50% will make smooth seeds, and 50% will make wrinkled seeds.
 Heterozygous means one of each allele, and if the other parent makes wrinkled seeds, it must be homozygous recessive.
- | | | |
|---|----|----|
| | S | s |
| s | Ss | ss |
| s | Ss | ss |
17. (2 pts: one for the genotype and ½ for each phenotype). The genotype is YySs, and the phenotypes are yellow, smooth seeds. The student can also say SsYy.
18. (1 pt) It must be carried on the Y chromosome, since that's the only chromosome males have but females do not.
19. (2 pts: ½ for each blood type and ½ for each percentage. Minus ½ for every wrong blood type.) The types are A+ (50%) and B+ (50%). Type AB must have one of each allele for type, and homozygous means both Rh alleles are +. Type O- must be recessive in all alleles.
- | | | |
|----|------|------|
| | A+ | B+ |
| O- | AO+- | BO+- |
20. (1 pt) It is a restriction enzyme. The student can also call it a restriction endonuclease.

56 Answer Key and Tests for Discovering Design With Biology

- 21. (1 pt) Induced pluripotent cell
- 22. (1 pt) Guide RNA
- 23. (1 pt) annealing
- 24. (1 pt) STM has the highest.
- 25. (1 pt) cyanobacterium – it does more photosynthesis than any other bacterium.
- 26. (1 pt) Gram negative bacteria
- 27. (1 pt) proteins
- 28. (1 pt) contractile vacuole
- 29. (1 pt: one-third for each type) Protozoa, algae, and slime molds.

Total points: 51

Answers to the Chapter 9 Review

1. a. Ectothermic organism – An organism that cannot control its internal body temperature
- b. Hermaphroditic – A situation in which a single individual can produce both male and female gametes
- c. Metamorphosis – A developmental stage where an immature organism goes through extensive changes in body plan to enter an adult stage
- d. Bilateral symmetry – Capable of being divided into two halves that are mirror images of each other
- e. Radial symmetry – Symmetry that arises from a central axis
- f. Open circulatory system – A system in which blood is not confined to blood vessels but is pumped into the body cavity to have direct contact with the organs
- g. External fertilization – Fertilization that occurs outside the parents' bodies
- h. Internal fertilization – Fertilization that occurs inside one of the parents' bodies
- i. Closed circulatory system – A system in which blood is confined to blood vessels
- j. Molting – The shedding and replacing of an old outer covering
- k. Compound eye – An eye that is made up of many small viewing units, each of which produces an image
- l. Simple eye – An eye that is made up of one lens which produces one image
- m. Pollinator – An animal that carries pollen from one plant to another to aid in fertilization
2. A vertebrate has an endoskeleton. If an invertebrate has one, it's an exoskeleton that is usually made of chitin.
3. Sponges feed by pulling water into themselves and filtering out the food. Their support structure contains the protein spongin.
4. Choanocytes are the cells that use their flagella to move the water into and out of a sponge and move the food into nearby cells. Amoebocytes move the food to cells in the sponge that are farther away. You can also call choanocytes "collar cells," but you still need to know what they do.
5. Cnidarians have an ectoderm, endoderm, and mesoglea.
6. Cnidarians have nematocysts on their tentacles.
7. It was in its medusa stage. The next stage is the polyp stage. See Figure 9.5.

8. The sea anemone protects the clownfish by preying on any fish that comes into it, while the clownfish cleans the sea anemone, provides nutrients to it, and chases predators away from it. This is a mutualistic symbiosis.
9. An incomplete digestive system has only one opening to the outside world, while a complete digestive has two. In an incomplete digestive system, food comes in the opening, and waste leaves the same opening. In a complete digestive system, food comes in one opening, while waste leaves the other opening.
10. Flatworms belong to phylum Platyhelminthes. We concentrated on genus *Planaria*, and members of that genus reproduce by regeneration. You can also say they tear themselves into two pieces and then regenerate.
11. A primary host is the host in which a parasite becomes an adult and reproduces. Intermediate hosts are used to develop into the form that can infect the primary host.
12. Proglottids are segments of a tapeworm that can produce offspring if separated from the worm.
13. Phylum Echinodermata contains those invertebrates, and their stomach can be extended outside their body in order to get food.
14. Phylum Mollusca contains those invertebrates.
15. Gastropods have antennae on their heads, and if they have a shell, it exists in only one part. Cephalopods have large heads and a foot that has the shape of a funnel, which serves as a siphon to move water. Bivalves make a shell that comes in two parts.
16. Phylum Nematoda contains the roundworms.
17. Phylum Annelida contains the segmented worms.
18. Phylum Arthropoda contains the most species.
19. a. mouth, b. brain, c. hearts, d. dorsal blood vessel, e. crop, f. gizzard, g. intestine, h. ventral nerve cord
20. Arthropods have a segmented body that contains a head, thorax, and abdomen. They also have jointed appendages attached to their body.
21. Arachnids have a cephalothorax and eight legs. They also have chelicerae and pedipalps.
22. Crustaceans have five pairs of legs attached to the thorax, one of which acts as claws. There are two antennae and two antennules on the head.
23. Insects have three pairs of legs attached to the thorax and two pairs of wings. In this case, you can think of the halteres as wings, even though they only give stability to flight.
24. Myriapods have many segments, each of which has legs attached to it.

25. The Cambrian Explosion describes the point in the fossil record where all the basic body plans for invertebrates appear in rock that supposedly represents only 11 million years of time. The fact that this time period is short is one problem, because it is unclear how all that diversity could be produced so quickly. Also, there are no intermediates linking these fossils to the “simpler” fossils.

Test for Chapter 9

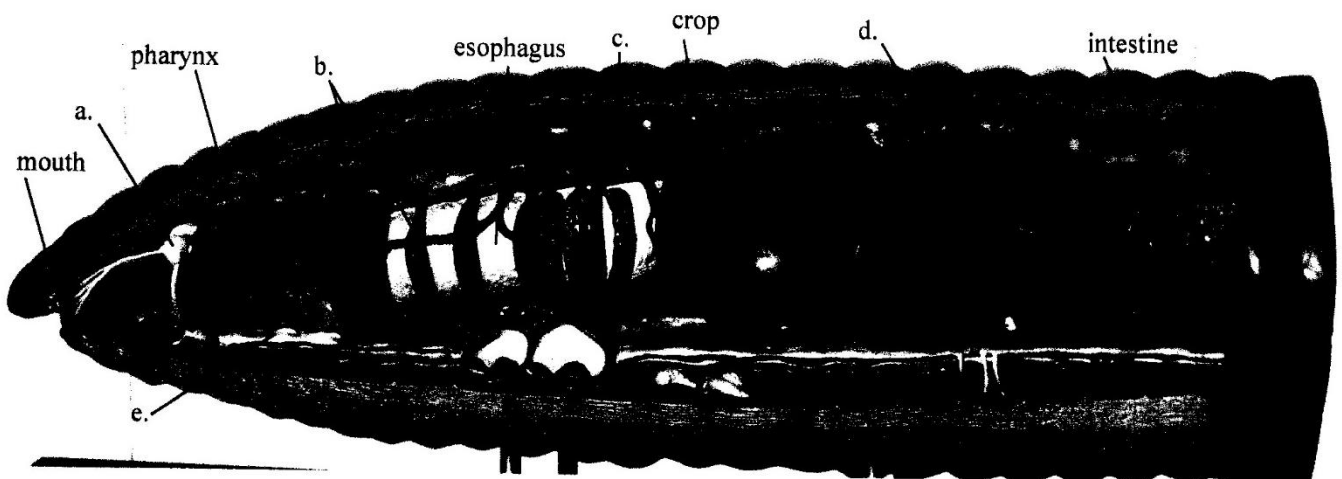
1. Define the following terms:

- | | | | |
|-------------------|----------------------------|---------------------------|-----------------|
| a. Hermaphroditic | c. Radial symmetry | e. External fertilization | g. Compound eye |
| b. Metamorphosis | d. Open circulatory system | f. Molting | h. Pollinator |

Match the classifications on the left to the descriptions on the right

- | | |
|-------------------------|--|
| 2. Phylum Mollusca | a. Segmented worms |
| 3. Phylum Porifera | b. Roundworms |
| 4. Phylum Echinodermata | c. Have three pairs of legs connected to a thorax |
| 5. Phylum Nematoda | d. Sponges |
| 6. Phylum Annelida | e. Segmented invertebrates with legs on each segment |
| 7. Phylum Cnidaria | f. Invertebrates with a strong foot, visceral mass, and a mantle |
| 8. Insects | g. Have eight legs attached to a cephalothorax |
| 9. Arachnids | h. Have spiny skin and tube feet |
| 10. Myriapods | i. Have nematocysts on their tentacles |

11. Identify the structures in the illustration below



12. In the mutualistic relationship between the clownfish and sea anemone, what does the sea anemone provide for the clownfish?

13. What are the two stages of life in a typical cnidarian? Which stage produces a planula?

(End of the Test)

Answers to the Test for Chapter 9

1. (8 pts: one for each definition)

- a. Hermaphroditic – A situation in which a single individual can produce both male and female gametes
- b. Metamorphosis – A developmental stage where an immature organism goes through extensive changes in body plan to enter an adult stage
- c. Radial symmetry – Symmetry that arises from a central axis
- d. Open circulatory system – A system in which blood is not confined to blood vessels but is pumped into the body cavity to have direct contact with the organs
- e. External fertilization – Fertilization that occurs outside the parents' bodies
- f. Molting – The shedding and replacing of an old outer covering
- g. Compound eye – An eye that is made up of many small viewing units, each of which produces an image
- h. Pollinator – An animal that carries pollen from one plant to another to aid in fertilization

2. (1 pt) f

3. (1 pt) d

4. (1 pt) h

5. (1 pt) b

6. (1 pt) a

7. (1 pt) i

8. (1 pt) c

9. (1 pt) g

10. (1 pt) e

11. (5 pts, one for each structure) a. brain, b. hearts, c. dorsal blood vessel, d. gizzard, e. ventral nerve cord

12. (1 pt) It provides protection from predators. (Any answer that means it protects the fish works.)

13. (2 pts: ½ for each stage, one for which produces the planula) The two stages are medusa and polyp. The medusa produces the planula.

Total points: 25

Answers to the Chapter 10 Review

1. a. Spawning – The process by which eggs are laid in the water and then fertilized with sperm
 - b. Cartilage – A connective tissue that is firm but flexible
 - c. Pineal eye – An animal eye that detects the presence or absence of light but does not produce images
 - d. Cloaca – A body cavity that is used in animals for the digestive system, the excretory system, and the reproductive system (in females)
 - e. Ovoviviparous – Producing young by means of eggs that are hatched inside one of the parents
 - f. Oviparous – Producing young by laying eggs that hatch later
 - g. Viviparous – Producing live young that received nutrients and oxygen directly from the mother
 - h. Gonad – The organ that makes gametes, i.e., ovaries in females and testes in males
 - i. Anadromous – A life cycle in which fish are born in freshwater, migrate to saltwater to live, and then return to freshwater to spawn
 - j. Cleaning station – A location on a coral reef where larger fish come to be cleaned of parasites and dead skin by cleaner organisms like wrasse and shrimp
 - k. Tetrapod – An animal that has four limbs (arms, legs, flippers, or wings)
 - l. Extinct – No living examples of the organism exist
 - m. Extant – Living examples of the organism are known to exist
 - n. Living fossil – An organism that is a living example of an otherwise extinct group and has remained virtually unchanged in structure and function
 - o. Spermatophore – A mass of sperm encased inside a gelatinous coating, which dissolves inside a female, where fertilization occurs
 - p. Aposematic coloration – A defense mechanism that involves the use of bright colors to warn predators of danger due to toxicity or a bad taste
 - q. Mimicry – A superficial resemblance between two animals that are not closely related
2. They breathe with gills, have a 2-chambered heart, have fins for swimming, have a swim bladder, are ectothermic, have scales, have a lateral line, and lay eggs. These are summarized in Figure 10.2.
 3. The lateral line senses vibrations in the water, while the swim bladder allows the fish to change the depth at which it is swimming.

4. Agnathans are the jawless fish. We discussed the lampreys and the hagfish. Lampreys have teeth in their mouths, while hagfish have a rasping tongue, and the mouth is surrounded by tentacles.
5. They are also called cartilaginous fish, and they include sharks, rays, and skates.
6. Their endoskeletons are made of cartilage, not bone.
7. Sharks detect electrical fields with their ampullae of Lorenzini. This helps them detect prey, since animals produce weak electrical signals when their muscles move.
8. It is a heterocercal tail, which means the lobes are of different lengths.
9. The pectoral fins are enlarged on rays and skates.
10. a. brain, b. gills, c. kidney, d. swim bladder, e. dorsal fin, f. gonad, g. caudal fin, h. anal fin, i. intestine, j. pelvic fin, k. stomach, l. pectoral fin, m. gall bladder, n. liver, o. heart
11. Bony fish can be ray-finned or lobe-finned. Ray-finned fish have fins made from thin skin over bony spines that attach to the body at several bones, while lobe-finned fish have fins that look like stump-like appendages that attach to the body at one bone. Tuna, cod, and seahorses are ray-finned fish, while coelacanths and lungfish are lobe-finned fish.
12. They live both in water and on land, they have gills at some point in their development, they breathe through their skin, they go through metamorphosis, are ectothermic, and have a 3-chambered heart. You can add that they often have lungs as adults, but that is not as important as the fact that they all start out with gills.
13. Amphibians are divided into orders Caudata, Anura, and Apoda. Those in order Caudata are four-legged animals with tails as adults, Anura are four-legged animals with no tails as adults, and Apoda have no legs.
14. Salamanders and newts are in order Caudata, frogs and toads are in order Anura, and caecilians are in order Apoda.
15. Frog skin is wetter and smoother than toad skin, while toads have drier, bumpy skin.
16. Evolutionists think that fish evolved into amphibians.
17. Tiktaalik is an organism known only from its fossils. Evolutionists think it is an intermediate between fish and amphibians, because its fins have similarities to tetrapod legs. The problem is that the similarities are few, and the fossil appears in rocks younger than rocks that contain tetrapod tracks, at least according to how evolutionists date the rocks. This means that tetrapods came before Tiktaalik according to the evolutionary timescale. Of course, as the coelacanth shows, interpretations drawn solely from fossils are often wrong, and the dating of rocks is very unreliable. At the same time, not all scientists agree that the tracks mentioned above are tetrapod tracks.

Test for Chapter 10

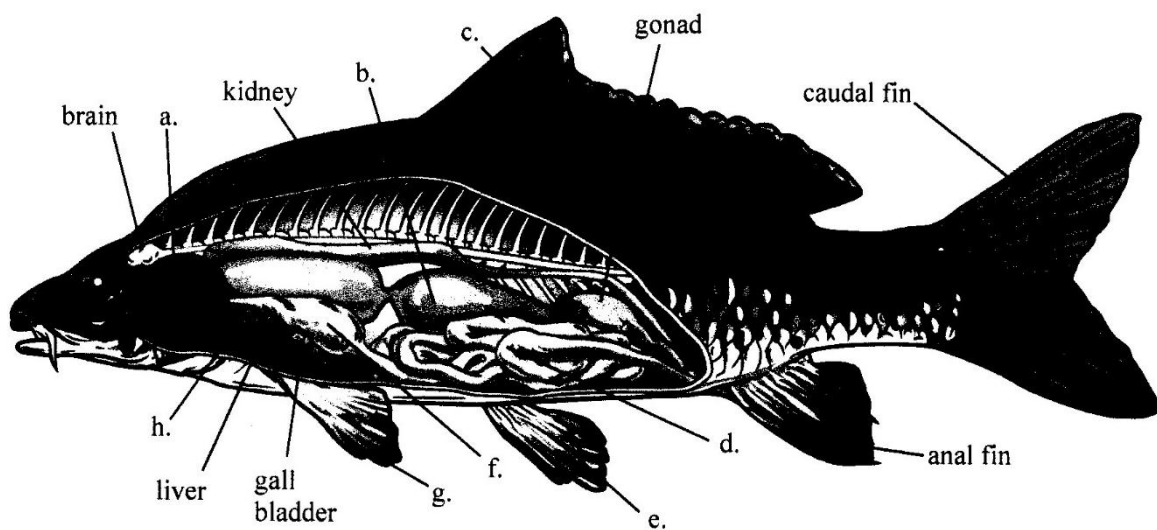
1. Define the following terms:

- | | | | |
|------------------|---------------|---------------------|------------------|
| a. Cartilage | c. Viviparous | e. Cleaning station | g. Living fossil |
| b. Ovoviviparous | d. Anadromous | f. Extant | h. Mimicry |

Match the classifications on the left to the descriptions on the right

- | | |
|----------------------|---|
| 2. Vertebrate | a. A fish with no jaw |
| 3. Fish | b. A bony fish |
| 4. Agnatha | c. An amphibian that has no tail as an adult |
| 5. Chondrichthyes | d. Has a backbone |
| 6. Osteichthyes | e. A fish fossil that has some bones in common with tetrapods |
| 7. Caudata | f. Has scales, gills, fins, and a 2-chambered heart |
| 8. Anura | g. An amphibian with a tail as an adult |
| 9. Apoda | h. An amphibian that has no legs as an adult |
| 10. <i>Tiktaalik</i> | i. Cartilaginous fish with a jaw |

10. Identify the structures pointed out below:



(End of the Test)

Answers to the Test for Chapter 10

1. (8 pts: one for each definition)

- a. Cartilage – A connective tissue that is firm but flexible.
- b. Ovoviviparous – Producing young by means of eggs that are hatched inside one of the parents
- c. Viviparous – Producing live young that received nutrients and oxygen directly from the mother
- d. Anadromous – A life cycle in which fish are born in freshwater, migrate to saltwater to live, and then return to freshwater to spawn
- e. Cleaning station – A location on a coral reef where larger fish come to be cleaned of parasites and dead skin by cleaner organisms like wrasse and shrimp
- f. Extant – Living examples of the organism are known to exist
- g. Living fossil – An organism that is a living example of an otherwise extinct group and has remained virtually unchanged in structure and function
- h. Mimicry – A superficial resemblance between two animals that are not closely related

2. (1 pt) d

3. (1 pt) f

4. (1 pt) a

5. (1 pt) i

6. (1 pt) b

7. (1 pt) g

8. (1 pt) c

9. (1 pt) h

10. (1 pt) e

11 (8 pts, one for each answer) a. gills, b. swim bladder, c. dorsal fin, d. intestine, e. pelvic fin, f. stomach, g. pectoral fin, h. heart

Total points: 25

Answers to the Chapter 11 Review

1. a. Scales – Keratin structures produced by the epidermis that overlap and lie on the surface of the skin
 - b. Scutes – Bone-like structures produced by the dermis that do not overlap and lie on the surface of the skin
 - c. Chorion – The outer membrane of an egg that is involved in gas exchange with the environment
 - d. Amnion – The inner membrane of an egg that contains fluid to provide protection from mechanical shock, abrasion (rubbing), and dehydration of the embryo
 - e. Allantois – The membrane of an egg that stores wastes from the embryo and facilitates respiration
 - f. Venom – A toxin or poison that is produced to be injected into prey or an enemy by a bite or sting
 - g. Incubation – The process of keeping eggs warm
 - h. Plumage – All the feathers of a bird, including their types, coloration, and arrangement
 - i. Diphyodonty – The condition in which a set of primary teeth is later replaced by a secondary set
 - j. Placenta – A structure inside the mother that provides developing young with oxygen and nutrients and removes carbon dioxide and waste
2. Reptiles are ectothermic, while birds and mammals are endothermic. Reptiles have scales or scutes, birds have feathers, and mammals have hair. Mammals lactate.
3. a. inner shell membrane, b. outer shell membrane, c. embryo, d. air space, e. shell, f. albumen, g. chorion, h. yolk, i. allantois, j. amnion
4. It provides nutrients to the embryo. Essentially, it is the embryo's food source.
5. In reptiles, the shell is leathery, while in birds, it is hard.
6. Their skin is covered in scutes, and they have an elongated snout with eyes and nostrils on the top.
7. They are called tuataras, and they have spines on their back all the way to the end of the tail, two rows of teeth in the upper jaw and only one in the lower jaw, and a pineal eye.
8. Their skin is covered with scales and they can move both their upper and lower jaws.
9. Snakes do not have legs, external ears, or eyelids, while lizards have all three.
10. Constrictors suffocate their prey, while venomous snakes inject a venom to kill the prey. Nonvenomous snakes bite their prey and might have a mild toxin in their saliva.

11. They stick out their tongue to sense the chemicals in the air, which helps them understand their surroundings. It is forked so that the snake is sensitive to the direction in which the chemicals are found. The snake uses its Jacobson's organ to analyze the chemicals on the tongue.

12. They have a shell and have no teeth in the mouth.

13. Turtles spend almost all their lives in water, tortoises on land, and terrapins spend a lot of time in both environments.

14. Soft tissue that comes from the dinosaur has been found in the fossils. There is no known way for soft tissue to stay soft for millions of years.

15. The vane is made from barbs and barbules. Barbs attach to the central shaft, and barbules can have hooks.

16. The central shaft of a feather and a flying bird's bones are both hollow with support structures inside.

17. This chapter discusses downy feathers, wing feathers, and tail feathers. The downy feathers have the least barbule interaction.

18. The keel is a place for muscles of the chest and wings to attach, and the furcula keeps the body from twisting when the wings move.

19. The mammal cerebrum and cerebellum have gyri and sulci to increase their surface area.

20. Mammals and reptiles use bidirectional respiration, while birds use unidirectional respiration.

21. Placental mammals nourish their developing young with a placenta, which allows for them to be well-developed when they are born. Monotremes lay eggs, while marsupials give birth to young that are not well-developed and must continue development in the marsupium.

22. The two blood supplies never mix so the mother's immune system doesn't kill the baby.

23. She had seven. There is a placenta for each baby.

24. According to evolutionists' own dates, *Archaeopteryx* is older than most of the dinosaurs that are supposed to have evolved into birds, but it is very, very similar to modern birds.

25. Bidirectional respiration would have to evolve into unidirectional respiration. This isn't demonstrated in the fossil record, and it is hard to conceive of any reasonable process by which it could happen. Also, genetic studies indicate that even if it were possible, there is not enough time to allow for it to happen.

Test for Chapter 11

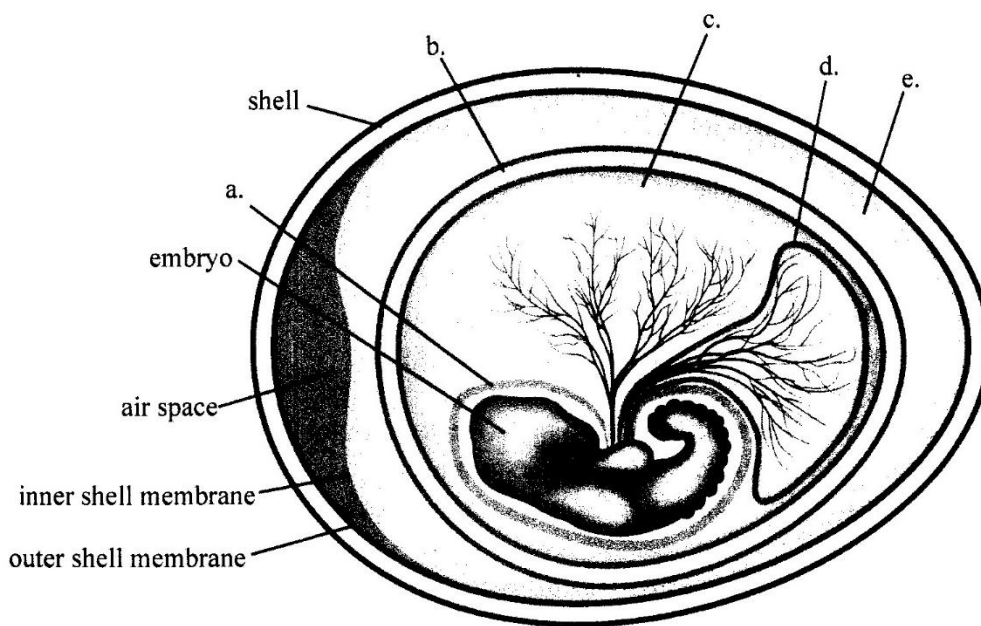
1. Define the following terms:

- | | | | |
|-----------|-----------|---------------|----------------|
| a. Scales | c. Amnion | e. Incubation | g. Diphyodonty |
| b. Scutes | d. Venom | f. Plumage | h. Placenta |

2. For each of the following, give the best classification for the animal being described:

- An animal that lays eggs and lactates
- An animal produces a hard-shelled amniotic egg
- An animal that is ectothermic, covered in scales, and has an external ear
- An animal that is covered in scales and kills its prey by suffocation
- An animal with hair that gives birth to live young that are poorly developed
- An animal with scutes and a shell that spends almost all its life on land

3. Identify the structures pointed out with letters



- From what animals do most evolutionists think birds evolved? Give one problem for such a view.
- What are gyri and sulci?
- A snake is using its Jacobson's organ. What other structure must it be using, and what is it doing?
- If you have a bone and want to know whether or not it comes from a flying bird, what should you do?
- To what order do tuataras belong?

(End of the Test)

Answers to the Test for Chapter 11

1. (8 pts: one for each definition)

- a. Scales – Keratin structures produced by the epidermis that overlap and lie on the surface of the skin
- b. Scutes – Bone-like structures produced by the dermis that do not overlap and lie on the surface of the skin
- c. Amnion – The inner membrane of an egg that contains fluid to provide protection from mechanical shock, abrasion (rubbing), and dehydration of the embryo
- d. Venom – A toxin or poison that is produced to be injected into prey or an enemy by a bite or sting
- e. Incubation – The process of keeping eggs warm
- f. Plumage – All the feathers of a bird, including their types, coloration, and arrangement
- g. Diphyodonty – The condition in which a set of primary teeth is later replaced by a secondary set
- h. Placenta – A structure inside the mother that provides developing young with oxygen and nutrients and removes carbon dioxide and waste

2. (6 pts: one for each answer)

- a. (1 pt) Monotreme (one-third of a point for mammal; ½ for platypus or echidna)
- b. (1 pt) bird (one-third of a point for a specific bird, but all birds lay such eggs)
- c. (1 pt) lizard (½ for order Squamata, but lizard is the best)
- d. (1 pt) constrictor (one-third for Squamata, ½ for snake; ½ for a specific constrictor)
- e. (1 pt) marsupial (one-third of a point for mammal; ½ for a specific marsupial)
- f. (1 pt) tortoise (one-third of a point for order Testudines; ½ for a specific tortoise)

3. (5 pts: one for each answer) a. amnion, b. chorion, c. yolk, d. allantois, e. albumen

4. (2 pts: one for dinosaurs, and one for any of the problems) They think birds evolved from dinosaurs. There are at least two problems, but the student needs only one. (i) Evolutionists' dates show the order isn't right, since *Archaeopteryx* is incredibly similar to modern birds but its fossils are older than the dinosaurs that started the evolutionary process. (ii) *Archaeopteryx* shows that by the evolutionist's own dates, flight existed very early in the evolutionary process, but it should be late in the process. (iii) There is no evidence for the change from bidirectional to unidirectional respiration, and genetic studies indicate there isn't enough time to produce it.

5. (1 pt) They are what separate the cerebrum and cerebellum of mammals from the cerebrums and cerebellums of other animals. The student can also describe them as ridges and grooves in the cerebrum, but take off one-fourth of a point if the student doesn't indicate they are only found in mammal brains.

6. (1 pt: ½ for the structure, and ½ for what it is doing) It must be using its tongue, and it is sensing chemicals. The student can also just say it is using its tongue to sense its environment.

7. (1 pt) See if it is hollow. Only flying birds have hollow bones. The student can also mention support structures.

8. (1 pt) Sphenodontia

Total points: 25

Answers to the Chapter 12 Review

1. a. Quadrupedalism – Movement that involves using forelimbs and hindlimbs to walk, climb, and swing
- b. Brachiation – Movement accomplished by swinging arms from one hold to another
- c. Bipedalism – The ability to comfortably walk, run, or hop upright on two feet
- d. Antibody – A blood protein produced to fight a specific antigen
- e. Vestigial organ – An organ that is thought to be a degenerated remnant from an evolutionary ancestor
- f. Mechanical digestion – The physical breakdown of food particles into smaller sizes
- g. Chemical digestion – The breakdown of food particles by enzymes into smaller molecules, eventually becoming the simple macromolecules that can be absorbed into the blood
- h. Hominid – A member of the family Hominidae, which includes the great apes and humans
- i. Hominin – A member of a sub-group of hominids that only includes those that are bipedal
2. Monkeys have tails, while apes do not.
3. It is when the animal walks on the knuckles of its forelimbs. This is different from most animals, where they walk on their toes or the flat part of the feet. It only happens in the forelimbs, however.
4. Binocular vision gives you great depth perception, but you can't see well to the sides.
5. The skull is placed on the vertebral column through an opening on the bottom rather than towards the back; the vertebral column itself has an S-shaped curve that supports the upright position; the arms are short so there is less strain on the back; the feet are flat and padded, which makes them capable of withstanding the impact of walking.
6. The CNS contains the brain and spinal cord. The PNS is composed of sensory nerves and motor nerves.
7. The decision on how to respond is made without input from the brain. That way, the sensory system doesn't have to send the signal all the way to the brain to decide what to do.
8. Neurons and glia are the cells found in the brain.
9. In a neuron, dendrites often receive the signals, the cell body holds the organelles, and the axon then sends the signal to its next destination.
10. It is called a synapse.

11. Erythrocytes carry oxygen to the tissues and carry carbon dioxide back to the lungs. They are commonly called red blood cells. They do not have nuclei. You can also say they don't have DNA.
12. Leukocytes fight infections and are commonly called white blood cells.
13. Coming back from the lungs, blood is oxygen-rich and enters the left atrium. It then goes into the left ventricle and out to the tissues. After the tissues, it is oxygen-poor and enters the right atrium. It then goes to the right ventricle and out to the lungs.
14. Blood travels away from the heart in arteries and back to the heart in veins. In between, it flows through capillaries, which is where oxygen gets transferred to the tissues and waste gets transferred to the blood.
15. You have innate immunity and adaptive immunity. You can also say acquired immunity.
16. The five lymphoid organs are the tonsils, lymph nodes, thymus, spleen, and appendix. The tonsils check the air you breathe for pathogens. The lymph nodes clean the lymph before it gets put back into the blood. The thymus tests (or trains) T-cells. The spleen monitors blood and destroys the cells that can't function properly. It also has lots of white blood cells to clean the blood. The appendix functions as a hideout for your normal flora so they can survive an intestinal infection. There is also MALT, but it is a tissue, not an organ.
17. They are involved in adaptive immunity. You can also say acquired immunity.
18. Food travels through the mouth, pharynx, esophagus, stomach, small intestine, large intestine, rectum, and anus.
19. Bile aids in the digestion of lipids, and it is made in the liver.
20. The diaphragm is the main muscle of breathing. When it relaxes, you exhale. Rib and neck muscles can be used for breathing as well. You can call the latter two sets of muscle the accessory muscles of respiration.
21. Exchange occurs in the alveoli through the process of diffusion. Surface area is maximized.
22. A nephron is the main functional unit of the kidney.
23. The body doesn't need a chemical that makes it to the collecting duct, because the nephron did not put it back into the blood. If a chemical doesn't make it to the collecting duct, it is something the body needs, because the kidney put it back in the blood.
24. Males can produce gametes most of their lives. Females have a limited number they can produce.
25. Reproductive hormones are made in the pituitary gland and the gonads. You can just say brain instead of pituitary gland.
26. Menopause is the point at which a female can no longer make gametes.
27. The *Imago Dei* is the image of God, and it is found only in people.

28. Human exceptionalism has no explanation if there is no Creator. If we are just highly-evolved animals, we should just be really complicated animals. We shouldn't have all the unique characteristics that we have.

29. *Sahelanthropus*, *Ardipithecus*, *Australopithecus*, *Homo*.

Test for Chapter 12

1. Define the following terms:

- | | | | |
|----------------|--------------------|-------------------------|------------|
| a. Brachiation | c. Antibody | e. Mechanical digestion | g. Hominid |
| b. Bipedalism | d. Vestigial organ | f. Chemical digestion | h. Hominin |

2. A primate knuckle walks and has no tail. What kind of primate is it?

3. You have the upper part of the vertebral column and the lower portion of the skull from a primate. How can you tell if the primate is bipedal?

4. A nerve signal is traveling from the finger to the brain. Is it in the PNS or the CNS? Also, identify the type of nerve that it is in.

5. Fill in the blanks: A neuron receives a signal in a dendrite. The signal travels through the cell body, then down the _____, and then it goes to the next neuron by traveling across a _____.

6. A crime scene investigator does a DNA test on some blood. What cells are being used in the test?

7. List the four chambers in the diagram on the right in the order of how blood flows through them. Start with blood that is coming to the heart from the lungs.

8. In which of the two chambers pointed out in the drawing is the blood low on oxygen?

9. You end up being infected by a pathogen, but after you recover, you are immune to another infection. Which type of immunity overcame the pathogen?

10. Chyme is leaving the stomach. What organ is it about to enter?

11. What must the main muscle involved in breathing do in order for you to inhale?

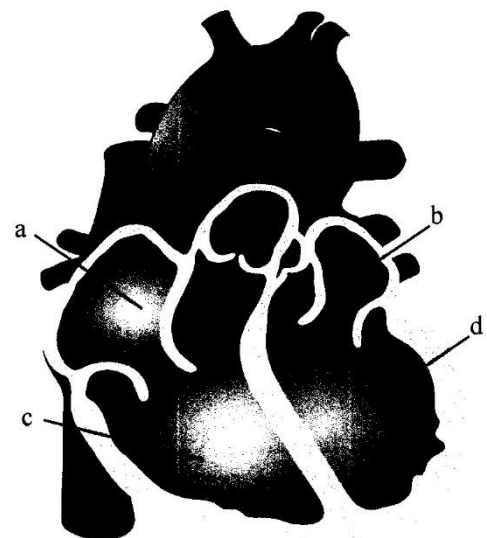
12. Where does diffusion take place in the lungs?

13. If a chemical is needed by the body, what happens to it as it travels through a nephron?

14. If a person enters menopause, what is that person's gender?

15. What separates humans from the animals?

16. A paleontologist digs up a fossil that she identifies as being part of a primate from genus *Australopithecus*. From an evolutionary perspective, when did that primate live relative to members of genus *Sahelanthropus*?



(End of the Test)

Answers to the Test for Chapter 12

1. (8 pts: one for each definition)

- a. Brachiation – Movement accomplished by swinging arms from one hold to another
- b. Bipedalism – The ability to comfortably walk, run, or hop upright on two feet
- c. Antibody – A blood protein produced to fight a specific antigen
- d. Vestigial organ – An organ that is thought to be a degenerated remnant from an evolutionary ancestor
- e. Mechanical digestion – The physical breakdown of food particles into smaller sizes
- f. Chemical digestion – The breakdown of food particles by enzymes into smaller molecules, eventually becoming the simple macromolecules that can be absorbed into the blood
- g. Hominid – A member of the family Hominidae, which includes the great apes and humans
- h. Hominin – A member of a sub-group of hominids that only includes those that are bipedal

2. (1 pt) It is an ape

3. (1 pt) Look at where the vertebral column attaches to the skull. If it attaches towards the back, it is not bipedal. If it attaches at the bottom, it is bipedal. Take off ½ of a point if the student only says to look at where the vertebral column attaches to the skull.

4. (1 pt: ½ for PNS and ½ for sensory) It is part of the PNS and is in a sensory nerve. Since it is traveling towards the brain, it is not in the CNS, and it contains sensory information that goes back to the brain.

5. (2 pts: one for each) A neuron receives a signal in a dendrite. The signal travels through the cell body, then down the axon, and then it goes to the next neuron by traveling across a synapse.

6. (1 pt) The leukocytes. The student can also say “white blood cells.” They are the only blood cells with DNA.

7. (2 pts: ½ for each in the correct order) b, d, a, c. Blood comes from the lungs and into the left atrium, then to the left ventricle, and then out to the tissues. It comes back into the right atrium and then into the right ventricle.

8. (1 pt: ½ for each, take ½ off if there are three letters listed and give no credit if all are listed) a and c. It is low on oxygen when it returns from the tissues.

9. (1 pt) Your adaptive immunity. It can also be called acquired immunity.

10. (1 pt) The small intestine

11. (1 pt) It must contract. The diaphragm contracts to inhale and relaxes to exhale.
12. (1 pt) In the alveoli
13. (1 pt) It gets put back into the blood. The student can also say that it gets reabsorbed. The nephron works by reabsorbing the chemicals the blood needs and allowing the rest to travel all the way through and end up in the urine.
14. (1 pt) That person is female. Menopause is when the individual is no longer capable of making gametes, and that happens to women.
15. (1 pt) The *Imago Dei*. The student can also say the image of God. Take off ½ for only saying human exceptionalism, because it is a result of the image of God.
16. (1 pt) After. *Sahelanthropus* is supposed to be the start of the human evolutionary line.

Total points: 25

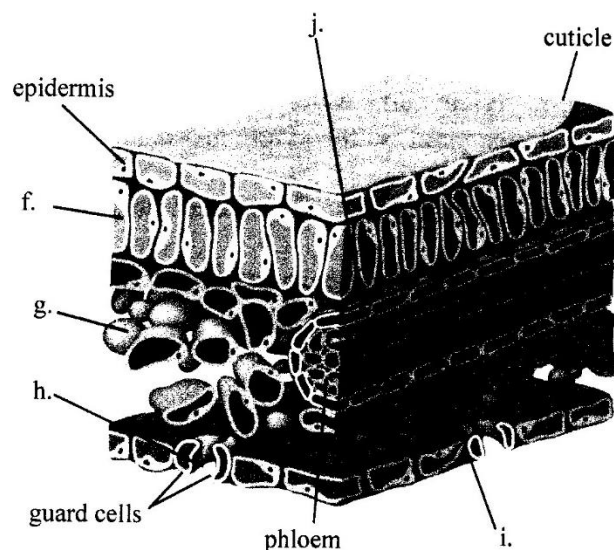
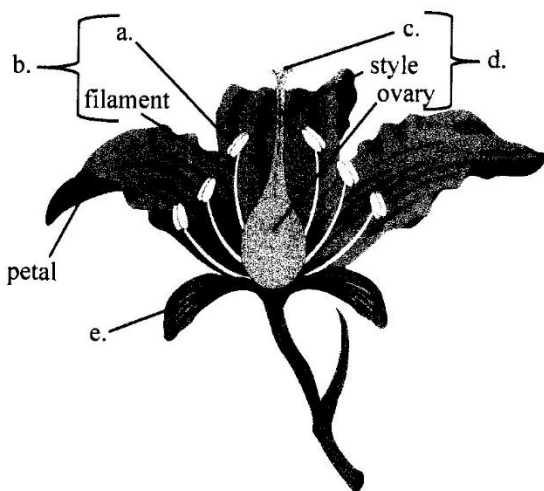
Answers to the Chapter 13 Review

1. a. Fiber – In nutrition, a carbohydrate that the body cannot digest
 - b. Turgor pressure – Pressure exerted by the cytoplasm being pushed against the cell wall
 - c. Xylem – The part of the plant transport system that moves water and minerals upward from the roots to the leaves
 - d. Phloem – The part of the plant transport system that moves nutrients (like sugars) from a location in the plant that has a high concentration of nutrients to a location that has a low concentration.
 - e. Adventitious roots – Roots that grow from structures that are not part of the original root system
 - f. Transpiration – The evaporation of water from the leaves of a plant
 - g. Biomimicry – Using a design found in living organisms to develop an artificial system
 - h. Fruit – A ripened ovary that includes fleshy or dry material surrounding a seed
 - i. Dichotomous key – A tool that uses a series of *yes-no* questions to classify things
 - j. Cotyledon – The embryonic leaves in a seed that will become the source of nutrients in the early stages of the plant's development
 - k. Deciduous – Falling off at a specific stage of development or time of the year
2. The cell wall supports the cell, central vacuole stores water, storage vesicles store substances, plastids hold pigments for photosynthesis, and plasmodesmata directly connect one cell to another, allowing substances to be passed between them.
 3. A plant wilts because its central vacuole doesn't have enough water to maintain turgor pressure. Giving the plant water will restore it to its healthy state. Usually, this happens because the plant hasn't gotten water for a long time, so the central vacuole releases water to keep the cell alive. If plenty of water exists, the central vacuole will fill back up and produce the needed turgor pressure.
 4. Meristematic, parenchyma, collenchyma, sclerenchyma, epidermal, xylem, and phloem. They work together to form meristematic tissue, epidermal tissue, ground tissue, and vascular tissue.
 5. Xylem carries water and minerals, and they flow up the plant. The phloem carries nutrients like sugars, which flow in whatever direction the plant needs them to flow.
 6. Roots anchor the plant in the ground and enable the plant to obtain water and minerals from the soil. Stems are the primary support structure of the plant and connect the roots to the leaves. They also do photosynthesis in some plants. Leaves produce the food for the plant. Flowers are the plant's reproductive structures. Angiosperms have all four.

7. The tip of the root is called the root cap. In the zone of cell division, cells are reproducing. In the zone of elongation, cells are getting longer. In the zone of maturation, cells are differentiating into one of the seven types.
8. A stem has an epidermis, cortex, vascular system (or vascular bundles), and a pith. The vascular system has the cambium, and it makes new vascular tissue.
9. A seed has an embryo and everything the embryo needs to start developing, just like a bird's egg. However, the embryo determines when it leaves the egg, while the seed determines when the plant embryo should start developing. Its pericarp senses the surroundings and won't let the embryo emerge until conditions are right.
10. Non-vascular plants have no vascular tissue. Seedless vascular plants have vascular tissue but don't make seeds. Gymnosperms are vascular plants that make seeds but not flowers, and angiosperms are vascular plants that make flowers.
11. Non-vascular plants are the smallest, most plants are angiosperms, and non-vascular plants have a dominant gametophyte.
12. a. anther, b. filament, c. stamen, d. stigma, e. style, f. ovary, g. pistil, h. petal, i. sepal, j. receptacle, k. peduncle, l. epidermis, m. palisade mesophyll, n. spongy mesophyll, o. guard cells, p. stoma, q. bundle sheath, r. xylem, s. phloem, t. cuticle

Test for Chapter 13

- Define the following terms:
 a. Turgor pressure b. Adventitious roots c. Transpiration d. Deciduous
- What structures in a plant cell allow the individual cells to connect directly to one another?
- If a fluid is moving from one part of the plant to another, what kind of tissue is carrying it?
- What four organs can be found in an angiosperm?
- In one zone of a root, there is no mitosis, and the cells are not changing in size. What zone is it?
- There have been several cases in which seeds have been found in a storage vessel that is hundreds to thousands of years old. Some of those seeds grew into plants when planted. Why didn't they try to grow into plants while they were sitting in the storage vessel?
- A plant makes seeds, but those seeds are not surrounded by a fruit. To which of the four groups of plants does it belong?
- A plant's gametophyte form is not dominant. What form is?
- A plant has two different organs performing photosynthesis. Which organs are they?
- A plant with a white flower is put in a glass with water that has been colored blue. In just over a day, the white flower has turned blue. Which part of the vascular system is responsible for this?
- In a stem, new vascular tissue is being made. What structure is making it?
- Identify the structures in each of the diagrams below:

**(End of the Test)**

Answers to the Test for Chapter 13

1. (4 pts: one for each definition)

- a. Turgor pressure – Pressure exerted by the cytoplasm being pushed against the cell wall
- b. Adventitious roots – Roots that grow from structures that are not part of the original root system
- c. Transpiration – The evaporation of water from the leaves of a plant
- d. Deciduous – Falling off at a specific stage of development or time of the year

2. (1 pt) plasmodesmata

3. (1 pt) vascular tissue

4. (2 pts: ½ for each, take ½ off for each structure not on this list) Roots, stems, leaves, and flowers.

5. (1 pt) The maturation zone. Cells change size in the zone of elongation and do mitosis in the zone of cell division. The root cap is not a zone. It is a structure.

6. (1 pt) The seed is designed to not let the embryo develop until the conditions are right. They weren't right in the storage vessel, but they were right once the seeds were planted.

7. (1 pt) Gymnosperms. If it makes seeds, it cannot be seedless, and it cannot be non-vascular. If it made seeds surrounded by fruit, it would be an angiosperm.

8. (1 pt) Sporophyte. There are only two forms in alternation of generations. If the dominant form is not gametophyte, the other one has to be.

9. (1 pt, ½ for each and ½ off for each wrong answer) leaves and stems. Roots can't do photosynthesis, because they are underground. Flowers don't do photosynthesis. The primary job of leaves is to do photosynthesis, and stems can do photosynthesis, especially if they are green.

10. (1 pt) Xylem. Xylem carry water from the bottom of the plant to the top. The blue was in water, and it traveled up the plant, so the xylem had to carry it.

11. (1 pt) The vascular cambium. The student can also just say "cambium."

12. (10 pts, one for each) a. anther, b. stamen, c. stigma, d. pistil, e. sepal, f. palisade mesophyll, g. spongy mesophyll, h. stoma, i. xylem, j. bundle sheath

Total points: 25

Answers to the Chapter 14 Review

1. a. Physiology – The study of how an organism (or any one of its parts) functions
 - b. Pressure-flow – The movement of a solute due to osmotic pressure from a source (high turgor pressure) to a sink (low turgor pressure)
 - c. Vegetative reproduction – Asexual reproduction in plants in which a new plant grows from a fragment of the parent plant
 - d. Pollination – Transfer of pollen from a stamen to a pistil
 - e. Germination – The process by which a seed develops into a seedling
 - f. Phytochromes – Photoreceptors in bacteria, protists, fungi, and plants that are responsible for detecting red light and far-red light
 - g. Cryptochromes – Photoreceptors in bacteria, animals, and plants that detect blue and ultraviolet light and contribute to the circadian rhythms that result
 - h. Photoperiodism – The response of an organism to seasonal changes in day length
 - i. Thermoperiodism – The responses of a plant to changing temperatures during the changing seasons
 - j. Annual – A plant that lives for one growing season
 - k. Perennial – A plant that lives for multiple growing seasons
 - l. Biennial – A plant that lives for two growing seasons, flowering in the second one
 - m. Abscission – A process in which the plant seals off its connection to a leaf, causing the leaf to die and fall off
 - n. Dormancy – The state in which normal physical functions are suspended or slowed down
 - o. Quiescence – A short-term resting state in seeds where growth of the embryo is suspended
 - p. Senescence – The process of aging that leads to death
 - q. Apical dominance – The influence of the shoot tip to inhibit the growth of lateral buds, reducing branching
 - r. Tropism – The response of a plant to an environmental stimulus whereby roots, stem, or leaves move toward or away from the stimulus
2. Light and water are needed for the guard cells to open a stoma. Guard cells have thicker cell walls where the two cells touch, and their central vacuoles increase in size when they open the stoma.

3. Transpiration in the leaves produces a low pressure, which pulls water into the leaf. However, because the water molecules have cohesion, all the water molecules below are pulled up as well. As a result, water travels up the xylem from the roots because it is being pulled up by transpiration in the leaves.
4. Pressure-flow transports substances in the phloem. Cohesion-tension can't do it because it causes only upward motion. The materials in the phloem need to flow both up and down, depending on the plant's needs.
5. A leaf is a source, because it makes sugar. A root is a sink, because it uses sugar but can't make it. A fruit that is forming is also a sink. Sugar flows from a source towards a sink. We had to say that the root isn't storing anything because a storage root can be a source during the winter.
6. It is converted to ammonium, nitrite, and then nitrate. Bacteria do the conversion. The chemical formulas are NH_4^+ , NO_2^- , and NO_3^- , but the names are more important to remember.
7. Vegetative reproduction results in an identical genome, while self-fertilization does not.
8. a. meiosis, b. mitosis, c. meiosis, d. mitosis. The mother cells are diploid, while the spores are haploid. The rest of the nuclei are all haploid, so once the first haploid cells form, mitosis forms the other haploid cells.
9. The pollen grains are the male gametophyte, while the embryo sac is the female gametophyte.
10. A pollen grain has a single tube nucleus and two sperm nuclei. The tube nucleus will dig a tube through the style to get to the ovary, and the sperm nuclei will fertilize two cells – the egg cell and the large cell with two haploid nuclei.
11. An embryo sac has seven cells. Six have a single haploid nuclei, and one of them is the egg cell. There is also a larger, central cell has two haploid nuclei.
12. There are two fertilizations. One sperm nucleus fertilizes the egg, but the other one fertilizes the larger, two-nucleus cell. The diploid cell becomes the embryo, and the triploid cell becomes the endosperm.
13. The embryo is made of a radicle, hypocotyl, and plumule. The radicle becomes the root and is the first to emerge. The hypocotyl becomes the stem, and the plumule becomes the leaves.
14. The endosperm is supplying the embryo with energy. You can say cotyledons as well, but they are formed from the endosperm.
15. Long-day plants are plants that flower when there are a lot more daylight hours than night hours. Short-day plants flower when there is less daylight. Day-neutral plants flower regardless of the hours of daylight.
16. You can use artificial lights to extend the hours the plant gets light. You can also just turn them on for a little while during the night.

17. It is an evergreen. Evergreens drop their needles (which are their leaves) continuously instead of all at once.
18. It does not have leaves. It drops its leaves so it can go dormant.
19. They are called phytohormones.
20. Auxins
21. Gibberellins
22. Cytokinins
23. Ethylene and abscisic acid control abscission, while ethylene is responsible for fruit ripening.
24. a. phototropism, b. thigmotropism, c. gravitropism

Test for Chapter 14

1. Define the following terms:

- | | | | |
|----------------|-------------------|---------------|---------------------|
| a. Physiology | c. Photoperiodism | e. Abscission | g. Senescence |
| b. Germination | d. Annual | f. Quiescence | h. Apical dominance |

2. If transpiration in a plant increases, how does that affect the way water and minerals flow in the xylem?

3. In a deciduous tree, material in the phloem is traveling up from the roots. Are the tree's leaves doing photosynthesis?

4. Nitrate is being formed in soil. What is making it, and where will it end up?

5. Fill in the blanks: In flowering plants, the pollen grain is the male _____. It consists of two _____ nuclei and a tube nucleus. When the pollen grain lands on the _____ of a pistil, the tube nucleus forms a pollen tube that goes down to the embryo sac, the female _____, which contains a total of _____ cells, one of which has two haploid nuclei. After fertilization of the egg cell, a _____ is formed. A second fertilization produces a triploid cell that becomes the _____.

6. What part of a plant embryo develops into structures that allow the plant to make food for itself once the endosperm is used up?

7. A plant is surrounded by light, but it grows straight up. Which kind of tropism is determining the plant's growth?

8. Name the five major categories of phytohormones.

(End of the Test)

Answers to the Test for Chapter 14

1. (8 pts: one for each definition)

- a. Physiology – The study of how an organism (or any one of its parts) functions
- b. Germination – The process by which a seed develops into a seedling
- c. Photoperiodism – The response of an organism to seasonal changes in day length
- d. Annual – A plant that lives for one growing season
- e. Abscission – A process in which the plant seals off its connection to a leaf, causing the leaf to die and fall off
- f. Quiescence – A short-term resting state in seeds where growth of the embryo is suspended
- g. Senescence – The process of aging that leads to death
- h. Apical dominance – The influence of the shoot tip to inhibit the growth of lateral buds, reducing branching

2. (1 pt) More water and minerals will flow in the xylem. The student could also say that they flow faster.

3. (1 pt) No, they are not. When leaves do photosynthesis, they are a source of sugar, and phloem contents always flows away from the source. Since the phloem contents are traveling up, the top of the tree must be a sink. This means the leaves are starting to grow again.

4. (1 pt: ½ for each) Bacteria are making it, and it will end up going into a plant. The student can add “nitrogen-fixing” to bacteria, and could also say roots instead of a plant.

5. (7 points: one for each) In flowering plants, the pollen grain is the male gametophyte. It consists of two sperm nuclei and a tube nucleus. When the pollen grain lands on the stigma of a pistil, the tube nucleus forms a pollen tube that goes down to the embryo sac, the female gametophyte, which contains a total of seven cells, one of which has two haploid nuclei. After fertilization of the egg cell, a zygote is formed. A second fertilization produces a triploid cell that becomes the endosperm. (The student can have “embryo” instead of “zygote.”)

6. (1 pt) The plumule. The leaves feed the plant after the endosperm is gone, and the plumule develops into the leaves.

7. (1 pt) Gravitropism. Phototropism wouldn’t give it a preferred orientation if light is coming from all directions. However, gravitropism would tell it which way is up.

8. (5 pts: one for each) auxins, gibberellins, cytokinins, abscisic acid, ethylene. Brassinosteroids are plant hormones, but not one of the *major* categories.

Total points: 25

Answers to the Chapter 15 Review

1. a. Environmental Science – The branch of science concerned with the physical, chemical, and biological conditions of the environment and their effect on life
- b. Ecological pyramid – A graphical representation of the trophic relationships between organisms
- c. Climate – The weather conditions prevailing in an area over a long period of time (many years)
- d. Wind – The movement of air in a specific direction
- e. Soil – The upper layers of the surface of the earth that contain a mixture of the remains of decomposed organisms, minerals, sand, silt, clay, and small rock particles
- f. Conservation biology – The study of how to protect nature and fix any damage that has been done
- g. Biodiversity – The wide range of all forms of life on earth or in a specific region
- h. Natural resources – Materials in nature that are needed for a wide variety of life to be sustained
- i. Direct value (biodiversity) – There is a specific product (or products) directly obtained as a result of biodiversity
- j. Indirect value (biodiversity) – Something other than a specific product (or products) that is obtained as a result of biodiversity, including aesthetic, cultural, educational, ethical, or spiritual value
- k. Pollution – The presence or introduction of a substance that is harmful to the environment
- l. Sustainability – An approach where the level of natural resources is maintained so the ecosystem remains in balance across future generations
- m. Renewable resource – A natural resource that can be used in a way that assures it will not be exhausted
- n. Climate change – A change in global or regional weather patterns over a long period of time
2. There must be 10 kg of secondary consumers, 100 kg of primary consumers, and 1,000 kg of producers. Each time you go up a trophic level, you lose 90% of the energy, so each trophic level needs ten times the amount from the lower trophic level.
3. a. Evaporation, condensation, precipitation, percolation. The water must evaporate from the ocean, condense into a cloud, fall as precipitation over land, and then percolate into the ground.
- b. Evaporation, condensation, precipitation, percolation, transpiration. The water must evaporate from the ocean, condense into a cloud, fall as precipitation over land, percolate into the ground, and then leave the plant through transpiration.
- c. Evaporation, condensation, precipitation. The water must evaporate from the ocean, condense into a cloud, fall as precipitation over land. Then it can be part of the run-off.

- 4. a. Adds, since respiration makes carbon dioxide, which must then be released into the atmosphere.
- b. Removes, since photosynthesis uses carbon dioxide that came from the atmosphere.
- c. Adds, since decomposition makes carbon dioxide, which enters the atmosphere.
- d. Adds, since burning things makes carbon dioxide, which must be released into the atmosphere.
- d. Removes, since carbon dioxide leaves the atmosphere to be dissolved in water.

5. Lightning, burning fuels, nitrogen-fixing bacteria, and nitrifying bacteria perform nitrogen fixation, while denitrifying bacteria take fixed nitrogen and put it back in the atmosphere. Consumers get their nitrogen from the plants or animals they eat, and they put it back in the soil as their waste as well as when they decompose.

6. Phosphorus originates in the rocks of the earth, and the water cycle helps to move it around.

7. Farmers add phosphorus and fixed nitrogen to the soil using fertilizer.

8. High humidity produces more rain than low humidity, since humidity is a measure of how much water vapor is in the air. The more water vapor, the more clouds, so the more rain,

9. Trade winds originate in the east and blow to the west, while the westerlies originate in the west and blow to the east. The trade winds are closer to the equator.

10. Clay, silt, sand. Clay is the smallest, silt next, and sand is the largest.

11. Natural resources, benefits, and drivers of change

12. Exploitation, pollution, habitat loss, extinction, and the introduction of invasive species

13. It is when coral lose the algae that live inside them, and they become white.

14. The dodo bird and the passenger pigeon. You need list only one.

15. Zebra mussels in Lake Erie, rabbits in Australia, the mongoose in Hawaii, and the kudzu in the southeastern United States. You need list only one.

16. Solar energy captures light energy and converts it to electricity. Wind energy uses wind to turn turbines which produce electricity. Hydropower uses the motion of water to generate electricity. Geothermal energy uses heat from the earth's interior to make heat and electricity, and bioenergy uses plants to make energy.

17. Wind power is expensive because it takes up land, and it kills many birds and bats. Solar power is expensive because it takes up land and is not truly renewable because the materials are not renewable. Hydropower is affected by rainfall, and it also alters the local environment.

18. This isn't surprising because the earth goes through cycles of warm and cold periods. Had people been measuring the earth's temperature at the height of the Medieval warm period, they would have seen that the warmest years on record were during those times. The same could be said of the Roman Warm period.
19. The Little Ice Age was a period around the 1700s in which the earth was unusually cold.

Test for Chapter 15

1. Define the following terms:
 - a. Ecological pyramid c. Biodiversity e. Indirect value (biodiversity) g. Renewable resource
 - b. Conservation biology d. Natural resources f. Sustainability h. Climate change
2. In a healthy environment, which is more plentiful: tertiary consumers or primary consumers?
3. Which global biogeochemical cycle depends on specific species of bacteria?
4. A molecule of water has just undergone percolation. What two ways could it get into the atmosphere as water vapor?
5. Which global biogeochemical cycle involves an interaction between rocks and another biogeochemical cycle?
6. Carbon that was once in an animal is now in the atmosphere as carbon dioxide gas. List two ways this could happen.
7. A sailboat is traveling near the equator. If it is just using wind, which is the fastest direction in which it can travel?
8. What must be added to a mixture of clay and silt to make it a loam? Compare how the loam will hold water to how the mixture of clay and silt held it.
9. A forest is cleared to make room for a farm. What is the term for this driver of change in biodiversity conservation?
10. Along with drivers of change, what other two components are a part of biodiversity conservation?
11. What is the problem with introducing a species of plant or animal to a region where no such organism exists?
12. Which form of renewable energy that we discussed results in the deaths of large numbers of birds and bats?
13. Describe what geothermal energy is.
14. Put the following in chronological order: Medieval Warm Period, the current warm period, the Little Ice Age, the Roman Warm Period.

(End of the Test)

Answers to the Test for Chapter 15

1. (8 pts: one for each definition)

- a. Ecological pyramid – A graphical representation of the trophic relationships between organisms
- b. Conservation biology – The study of how to protect nature and fix any damage that has been done
- c. Biodiversity – The wide range of all forms of life on earth or in a specific region
- d. Natural resources – Materials in nature that are needed for a wide variety of life to be sustained
- e. Indirect value (biodiversity) – Something other than a specific product (or products) that is obtained as a result of biodiversity, including aesthetic, cultural, educational, ethical, or spiritual value
- f. Sustainability – An approach where the level of natural resources is maintained so the ecosystem remains in balance across future generations
- g. Renewable resource – A natural resource that can be used in a way that assures it will not be exhausted
- h. Climate change – A change in global or regional weather patterns over a long period of time

2. (1 pt) Primary consumers. Each trophic level needs more in the one below it.

3. (1 pt) The nitrogen cycle requires nitrifying and nitrogen-fixing bacteria.

4. (2 pts: one for each way) (1) It could enter the groundwater and travel to the ocean (or another large body of water, like a lake) and then evaporate from the ocean. (2) It could be absorbed by a plant and undergo transpiration.

5. (1 pt) The phosphorus cycle. Phosphorus is found in rocks and is transported by the water cycle.

6. (2 pts: one for each) (1) It could be eaten by another animal, and that animals' respiration could put it in the atmosphere. (2) It could die and be decomposed, which will put its carbon in the atmosphere as carbon dioxide. (3) It could become a fossil fuel and then be burned. The student needs list only two

7. (1 pt) It travels fastest to the west. The trade winds blow near the equator, and they blow to the west.

8. (2 pts: one for sand, and one for holding water less tightly) Sand needs to be added, and that will make the loam hold onto water less tightly.

9. (1 pt) Habitat loss

10. (2 pts, one for each) Natural resources and benefits

11. (1 pt) It can upset the balance of the ecosystem, since it might not have predators to keep its population under control.

12. (1 pt) Wind power

13. (1 pt) It uses the heat in the interior of the earth to make electricity. It can also be used to heat homes, so count that as well.

14. (1 pt: one-fourth for each in the proper order) Roman Warm Period, Medieval Warm Period, the Little Ice Age, the current warm period

Total points: 25

Answers to the Chapter 16 Review

1. a. Population growth – An increase in the number of individuals of a given species in a particular location over a period of time
- b. Ecological succession – The process by which the mixture of species in a particular location changes over time
- c. Habitat – The place where an individual organism or population lives
- d. Biome – A large collection of animals and plants that occupy a particular geographical location
- e. Ecosystem – A collection of living organisms (biotic) interacting with the physical environment (abiotic) within a particular geographical location
- f. Biosphere – All portions of the earth where any form of life can be found
- g. Epiphyte – A plant that grows on another plant in a commensal relationship
- h. Grasses – Short plants that have hollow stems with narrow, blade-shaped leaves and small flowers that are pollinated by wind
- i. Permafrost – A layer of soil about 25 – 100 cm (1 – 3 feet) below the surface that is permanently frozen
- j. Estuary – A body of water where freshwater from rivers or streams mixes with saltwater from the ocean
- k. Salinity – The amount of salt dissolved in a body of water
- l. Bioluminescence – The emission of light by organisms
2. a. competition, b. independence, c. cooperation
3. a. parasitism, b. commensalism, c. mutualism
4. It is not a long-term interaction. The predator hunts, kills, and eats the prey. Symbiosis happens over a longer time period.
5. The population growth at first would be exponential, but as the elephant's body is decomposed, it will eventually become logistic. Initially, there is plenty of animal to decompose, so decomposers can reproduce without restriction. Eventually, however, there will be limited amounts of the elephant left, which means limited resources.
6. The short one that grows quickly is a pioneer species. They are the first to inhabit an ecosystem that has experienced a catastrophe. Thus, they must grow quickly. Also, they tend to be short, since they don't need as many resources.

7. Primary succession happens after a disaster that radically changes an ecosystem. Secondary succession happens when a specific part of the ecosystem changes, such as when a specific species dies out or moves away.
8. The tundra is closest to the poles, while the rainforest is closest to the equator. The rainforests closest to the equator are tropical rainforests.
9. Scrublands are closer. While there are some scrublands in the Southern Hemisphere that are far from the equator, only the Northern Hemisphere has coniferous forests, and in that hemisphere, they are farther from the equator than the scrublands.
10. Rainforests have the greatest diversity of life.
11. Deserts are characterized by low amounts of precipitation.
12. Evergreens dominate coniferous forests.
13. Rainforests have the most epiphytes, because there are so many plants for them to live on, and because there is plenty of water for them to get from the air.
14. Grasslands are dominated by grasses, and that is the definition of grasses.
15. Scrublands are dominated by that kind of plant life.
16. The tundra has permafrost.
17. The lowest zone is the floor, the understory is higher, the canopy is higher, and the emergent layer is the highest.
18. The ground zone is the lowest, the herb zone is next, the shrub zone is next, the small tree and sapling zone is next, and the tree stratum zone is the highest.
19. Fat is stored in a camel's hump. It is not correct to say water. The fat is a means of water storage, but there is no water in the hump. The fat undergoes cellular respiration to make water.
20. There are temperate coniferous forests and boreal forest. The boreal forests are colder and closer to the poles. You can also call the boreal forest a taiga.
21. It is a savannah.
22. The littoral zone is where light reaches and the water is shallow, close to the shoreline. The limnetic zone contains the water away from shore where light reaches. The profundal zone is where there isn't enough light for photosynthesis. The benthic zone is the bottom.
23. Aerenchyma is tissue that allows an aquatic plant to send oxygen from parts that are above the water to its roots. If an aquatic plant doesn't have that tissue, it must get the oxygen and carbon dioxide it needs directly from the water.
24. It is an estuary. The farther you are from the ocean, the lower the salinity of the estuary becomes.

25. The top zone is the epipelagic zone, the next is the mesopelagic zone, next is the bathypelagic zone next is the abyssopelagic zone, and the deepest zone is the hadalpelagic zone. The benthic zone refers to the bottom of the ocean regardless of depth.

26. The neritic province and oceanic province make up the pelagic division, with the neritic province being closer to shore.

27. You find them in the abyssopelagic zone and hadalpelagic zone, since light doesn't reach them.

28. They live on the bottom of a lake or ocean. Rivers also have a benthic zone, so rivers can be included as well.

Test for Chapter 16

1. Define the following terms:

- | | | | |
|--------------------------|--------------|---------------|--------------------|
| a. Ecological succession | c. Ecosystem | e. Permafrost | g. Salinity |
| b. Biome | d. Epiphyte | f. Estuary | h. Bioluminescence |

2. In which zone of a tropical rainforest will you find the most epiphytes?
3. If a plant has processes that conserve a lot of water, in what biome is it most likely to be found?
4. If an ecosystem contains only pioneer species, what can you conclude about its recent past?
5. Based solely on the trees, how do you tell a temperate forest biome from a boreal forest biome?
6. A population of organisms is experiencing logistic population growth, but then very quickly, it begins experiencing exponential population growth. What must have happened?
7. Lions travel in prides, where the females hunt and bring back food for the cubs and the dominant male. Tigers, on the other hand, are generally seen with other tigers only when they mate. Identify the species interactions for each.
8. Order the following biomes in terms of distance from the equator. Start with the one closest, and end with the one farthest away: temperate forest, tropical rainforest, tundra, boreal forest, desert.
9. A grassland is not a savannah. What is it called?
10. What kind of symbiosis is exhibited between epiphytes and the trees with which they associate?
11. In what biome will you find a young tree and sapling zone?
12. What distinguishes the profundal zone of a lake from the limnetic zone?
13. What zone of an ocean or lake is independent of depth?
14. An aquatic plant has roots that go deep into the mud at the bottom of a lake, but its leaves are on top of the water. What kind of specialized tissue will this plant have?
15. An organism is designed to tolerate large changes in salinity but requires a lot of sunlight to survive. What kind of aquatic ecosystem is it designed for?
16. An organism does photosynthesis. In what zone of the ocean will it most likely be found?

(End of the Test)

Answers to the Test for Chapter 16

1. (8 pts: one for each definition)

a. Ecological succession – The process by which the mixture of species in a particular location changes over time

b. Biome – A large collection of animals and plants that occupy a particular geographical location

c. Ecosystem – A collection of living organisms (biotic) interacting with the physical environment (abiotic) within a particular geographical location

d. Epiphyte – A plant that grows on another plant in a commensal relationship

e. Permafrost – A layer of soil about 25 – 100 cm (1 – 3 feet) below the surface that is permanently frozen

f. Estuary – A body of water where freshwater from rivers or streams mixes with saltwater from the ocean

g. Salinity – The amount of salt dissolved in a body of water

h. Bioluminescence – The emission of light by organisms

2. (1 pt) The understory. Epiphytes live on other plants, and the understory contains the most surface area on which they can live. The floor has only the roots, the canopy only the taller parts of the trees, and the emergent layer only the tallest parts of the trees.

3. (1 pt) A desert. Desert plants must conserve water.

4. (1 pt) It experienced a significant disaster. The student can say anything that indicates the ecosystem was mostly destroyed.

5. (1 pt) The temperate forest will have more deciduous trees, while the boreal forest will have more conifers.

6. (1 pt) Resources must have been added. Logistic growth occurs when resources are limited, while exponential growth occurs when they are not. The student can describe anything that makes it clear that resources suddenly became more abundant.

7. (1½ pts: ½ for each term, and ½ for correctly associating lions with cooperation) Lions exhibit cooperation, while tigers exhibit independence.

8. (2½ pts: ½ for each in the proper order, -1 if it's backwards) Tropical rainforest, desert, temperate forest, boreal forest, tundra.

9. (1 pt) It is a temperate grassland

10. (1 pt) Commensalism. The epiphyte benefits, but the tree is not harmed.

11. (1 pt) A temperate forest
12. (1 pt) The amount of light that hits it. The profundal zone doesn't get enough light for photosynthesis.
13. (1 pt) The benthic zone. Regardless of depth, the bottom is the benthic zone.
14. (1 pt) It will have aerenchyma, which allows oxygen to get down to the roots.
15. (1 pt) An estuary. The ocean changes in salinity as well, but that is based on depth, and sunlight decreases with depth.
16. (1 pt) The epipelagic zone. While it could be in the mesopelagic zone, if you have only one choice, you need to choose the one with the most sunlight.

Total points: 25

Semester 2 Final Exam

1. Define the following terms:

- | | | | |
|--------------------------|--------------------|-------------------|-----------------------|
| a. Molting | e. Allantois | i. Transpiration | m. Biodiversity |
| b. Pollinator | f. Diphyodonty | j. Cotyledon | n. Renewable resource |
| c. Anadromous | g. Brachiation | k. Photoperiodism | o. Ecosystem |
| d. Aposematic coloration | h. Vestigial organ | l. Tropism | p. Salinity |

2. What are nematocysts?

3. An animal has an incomplete digestive system. What does that mean?

4. What phylum holds the flatworms?

5. A parasite has three hosts. How many secondary hosts does it have?

6. A worm is round and has segments. To what phylum does it belong?

7. A fish is changing its depth but not using its fins. What is it using?

8. What do the ampullae of Lorenzini detect?

9. In addition to gills or lungs, what do amphibians breathe through?

10. What is the main difference between ray-finned fish and lobe-finned fish?

11. Classify each of the following as ectothermic or endothermic:

- a. Fish
- b. Amphibians
- c. Reptiles
- d. Birds
- e. Mammals

12. What animal has a Jacobson's organ, and what is it used for?

13. An animal breathes with unidirectional respiration. Which of the five animal types listed in question 11 is it?

14. A placenta allows nutrients and gases to be exchanged between the mother and the baby, but it does not allow the mother's blood to mix with the baby's blood. Why?

15. If an animal has binocular vision, what can it do that an animal without binocular vision cannot?

16. What organ system is made up of the brain and the spinal cord?

17. How many chambers are found in a human heart?

18. What happens in alveoli?
19. What is the *Imago Dei*? In what organisms can it be found?
20. If liquid flows only upwards in the vascular system of the tree, what is the liquid made of?
21. A plant has a vascular system, makes seeds, but does not make flowers. To which plant group does it belong?
22. Which plant group contains the smallest plants?
23. A cell is in the palisade mesophyll. What is its main function?
24. What must be present in order for guard cells to open a leaf's stomata?
25. What nuclei are in a pollen grain? What are their jobs?
26. What two cells in an embryo sac get fertilized?
27. What does the radicle in a plant embryo develop into?
28. List the four global biogeochemical cycles covered in this course.
29. List the three kinds of symbiosis and indicate what distinguishes them from one another.

Answers to the Semester 2 Final Exam

1. (16 points: One for each definition)

- a. Molting – The shedding and replacing of an old outer covering
- b. Pollinator – An animal that carries pollen from one plant to another to aid in fertilization
- c. Anadromous – A life cycle in which fish are born in freshwater, migrate to saltwater to live, and then return to freshwater to spawn
- d. Aposematic coloration – A defense mechanism that involves the use of bright colors to warn predators of danger due to toxicity or a bad taste
- e. Allantois – The membrane of an egg that stores wastes from the embryo and facilitates respiration
- f. Diphyodonty – The condition in which a set of primary teeth is later replaced by a secondary set
- g. Brachiation – Movement accomplished by swinging arms from one hold to another
- h. Vestigial organ – An organ that is thought to be a degenerated remnant from an evolutionary ancestor
- i. Transpiration – The evaporation of water from the leaves of a plant
- j. Cotyledon – The embryonic leaves in a seed that will become the source of nutrients in the early stages of the plant's development
- k. Photoperiodism – The response of an organism to seasonal changes in day length
- l. Tropism – The response of a plant to an environmental stimulus whereby roots, stem, or leaves move toward or away from the stimulus
- m. Biodiversity – The wide range of all forms of life on earth or in a specific region
- n. Renewable resource – A natural resource that can be used in a way that assures it will not be exhausted
- o. Ecosystem – A collection of living organisms (biotic) interacting with the physical environment (abiotic) within a particular geographical location
- p. Salinity – The amount of salt dissolved in a body of water

2. (1 pt) They are stingers that paralyze prey. The student can describe them more thoroughly or indicate that they are the distinguishing feature of cnidarians.

3. (1 pt) It means waste is ejected from the same opening in which food enters. The student can also say there is only one opening, or the anus is absent.

4. (1 pt) Platyhelminthes
5. (1 pt) It has two secondary hosts. There is only one primary host, and all the others are secondary.
6. (1 pt) Annelida
7. (1 pt) It is using its swim bladder.
8. (1 pt) Electrical fields. Give ½ point if the student just indicates they are used to detect prey.
9. (1 pt) Their skin
10. (1 pt) Ray-finned fish have fins made from thin skin over bony spines that attach to the body at several bones, while lobe-finned fish have fins that look like stump-like appendages that attach to the body at one bone. The wording can be different, but the spines and the difference in the bones are both necessary.
11. (5 pts, one for each) Choices a-c are ectothermic, while d and e are endothermic.
12. (1 pt. ½ for snakes, ½ for sensing the environment) Snakes use their Jacobson's organ to sense the environment. The student can also say they use it to smell, enhance their sense of smell, or detect chemicals in the air.
13. (1 pt) It is a bird.
14. (1 pt) If the two blood supplies mixed, the mother's immune system would kill the baby. The student just needs to indicate that the baby would die if the blood supplies mixed.
15. (1 pt) It can judge depth. The student can say anything related to having depth perception.
16. (1 pt) Central nervous system
17. (1 pt) Four
18. (1 pt) Gases are exchanged with the blood. The student can be more specific, indicating that oxygen enters the blood, while carbon dioxide leaves it. Also, the student can use the word diffusion.
19. (2 pts, one for what it is and the other for where it is found) It is the image of God and is found only in people.
20. (1 pt) It is made of water and minerals. If it flows only upwards, it is in the xylem, and that's what the xylem carries. If the student doesn't mention minerals, count ½ off.
21. (1 pt) It is a gymnosperm.
22. (1 pt) Non-vascular plants – The student can also say bryophytes.
23. (1 pt) Photosynthesis

24. (1 pt: ½ for each) Water and light

25. (1 pt: one-third for each) There are two sperm nuclei that do fertilization and one tube nucleus that burrows through the style so the sperm cells can get to the ovary.

26. (1 pt: ½ for each) The egg cell and the cell with two nuclei get fertilized. For the cell with two nuclei, the student can also say the large, central cell or the cell that become the endosperm.

27. (1 pt) It becomes the root system. The student can also just say roots.

28. (1 pt: ¼ for each) Hydrologic cycle, carbon cycle, nitrogen cycle, phosphorus cycle. The student can say water cycle instead of hydrologic cycle.

29. (2 pts: two-thirds for each) Mutualism is when two organisms of different species benefit one another, commensalism is where one organism benefits but the other is essentially unaffected, and parasitism is where one organism benefits and the other is harmed. The student can word things differently, but which organism or organisms benefit in each case is the key.

Total points: 50