APPENDIX A | THE PERIODIC TABLE OF ELEMENTS

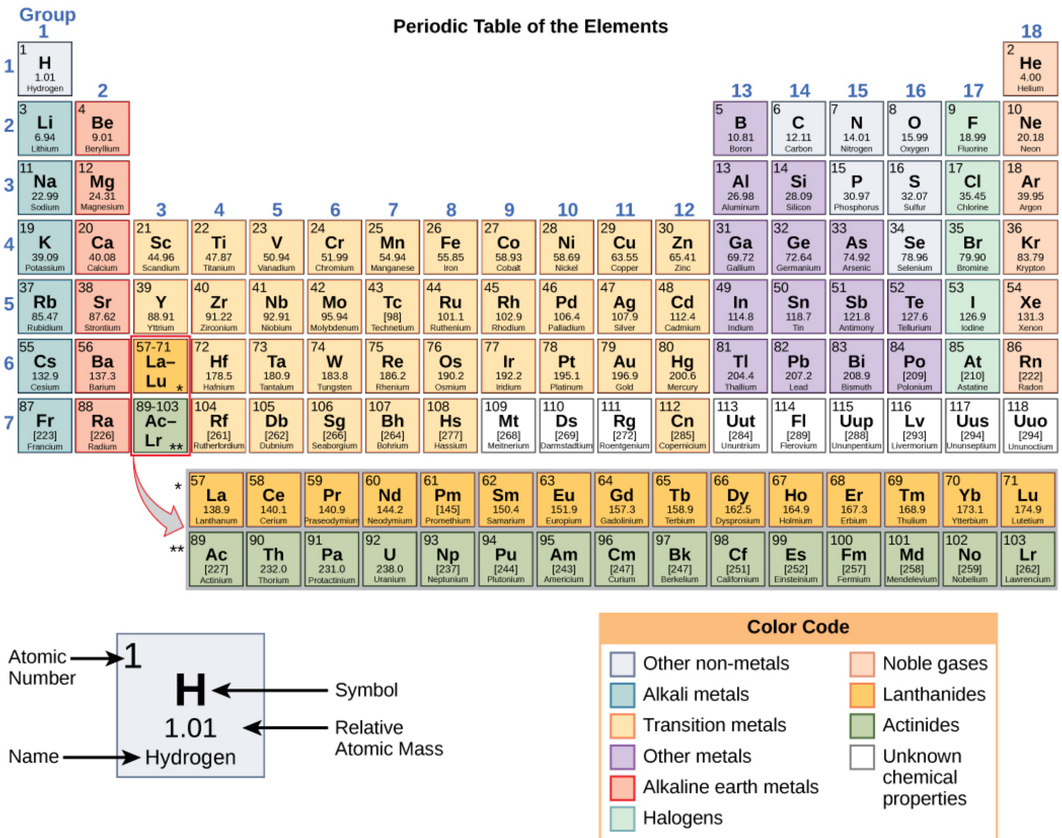

Figure A1

APPENDIX B | GEOLOGICAL TIME

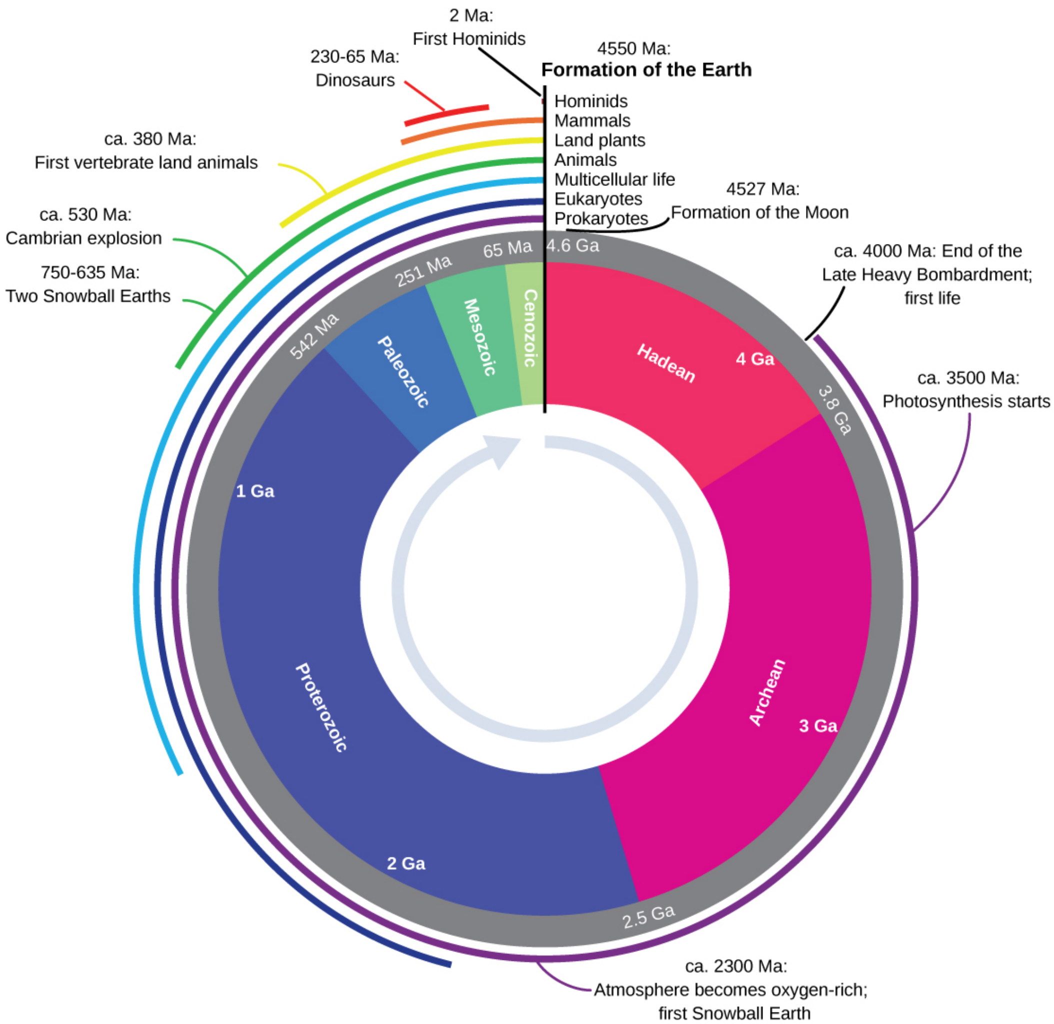

Figure B1 Geological Time Clock

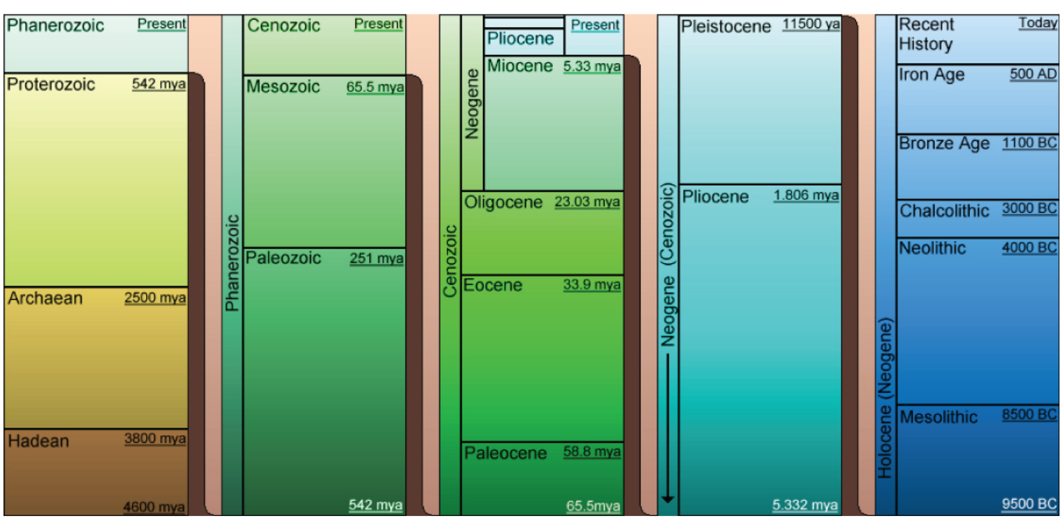

Figure B2 Geological Time Chart
(credit: Richard S. Murphy, Jr.)

APPENDIX C | MEASUREMENTS AND THE METRIC SYSTEM

C1 | Measurements and the Metric System

Measurements and the Metric System

Measurement	Unit	Abbreviation	Metric Equivalent	Approximate Standard Equivalent
Length	nanometer	nm	1 nm = 10^{-9} m	1 mm = 0.039 inch 1 cm = 0.394 inch 1 m = 39.37 inches 1 m = 3.28 feet 1 m = 1.093 yards 1 km = 0.621 miles
	micrometer	µm	1 µm = 10^{-6} m	
	millimeter	mm	1 mm = 0.001 m	
	centimeter	cm	1 cm = 0.01 m	
	meter	m	1 m = 100 cm 1 m = 1000 mm	
	kilometer	km	1 km = 1000 m	
Mass	microgram	µg	1 µg = 10^{-6} g	1 g = 0.035 ounce 1 kg = 2.205 pounds
	milligram	mg	1 mg = 10^{-3} g	
	gram	g	1 g = 1000 mg	
	kilogram	kg	1 kg = 1000 g	
Volume	microliter	µl	1 µl = 10^{-6} l	1 ml = 0.034 fluid ounce 1 l = 1.057 quarts 1 kl = 264.172 gallons
	milliliter	ml	1 ml = 10^{-3} l	
	liter	l	1 l = 1000 ml	
	kiloliter	kl	1 kl = 1000 l	
Area	square centimeter	cm^2	1 cm^2 = 100 mm^2	1 cm^2 = 0.155 square inch 1 m^2 = 10.764 square feet 1 m^2 = 1.196 square yards 1 ha = 2.471 acres
	square meter	m^2	1 m^2 = 10,000 cm^2	
	hectare	ha	1 ha = 10,000 m^2	
Temperature	Celsius	°C	—	1 °C = 5/9 × (°F − 32)

Table C1

ANSWER KEY

Chapter 1

1 **Figure 1.8** B **3** C **5** A **7** Researchers can approach biology from the smallest to the largest, and everything in between. For instance, an ecologist may study a population of individuals, the population's community, the community's ecosystem, and the ecosystem's part in the biosphere. When studying an individual organism, a biologist could examine the cell and its organelles, the tissues that the cells make up, the organs and their respective organ systems, and the sum total—the organism itself.

Chapter 2

1 **Figure 2.3** Potassium-39 has twenty neutrons. Potassium-40 has twenty one neutrons. **2** A **4** A **6** C **8** D **10** A **12** Hydrogen bonds and van der Waals interactions form weak associations between different molecules. They provide the structure and shape necessary for proteins and DNA within cells so that they function properly. Hydrogen bonds also give water its unique properties, which are necessary for life. **14** Water molecules are polar, meaning they have separated partial positive and negative charges. Because of these charges, water molecules are able to surround charged particles created when a substance dissociates. The surrounding layer of water molecules stabilizes the ion and keeps differently charged ions from reassociating, so the substance stays dissolved. **16** A change in gene sequence can lead to a different amino acid being added to a polypeptide chain instead of the normal one. This causes a change in protein structure and function. For example, in sickle cell anemia, the hemoglobin β chain has a single amino acid substitution. Because of this change, the disc-shaped red blood cells assume a crescent shape, which can result in serious health problems.

Chapter 3

1 **Figure 3.7** Plant cells have plasmodesmata, a cell wall, a large central vacuole, chloroplasts, and plastids. Animal cells have lysosomes and centrosomes. **3** **Figure 3.22** No, it must have been hypotonic, as a hypotonic solution would cause water to enter the cells, thereby making them burst. **4** C **6** D **8** D **10** A **12** C **15** The advantages of light microscopes are that they are easily obtained, and the light beam does not kill the cells. However, typical light microscopes are somewhat limited in the amount of detail that they can reveal. Electron microscopes are ideal because you can view intricate details, but they are bulky and costly, and preparation for the microscopic examination kills the specimen. Transmission electron microscopes are designed to examine the internal structures of a cell, whereas a scanning electron microscope only allows visualization of the surface of a structure. **17** "Form follows function" refers to the idea that the function of a body part dictates the form of that body part. As an example, organisms like birds or fish that fly or swim quickly through the air or water have streamlined bodies that reduce drag. At the level of the cell, in tissues involved in secretory functions, such as the salivary glands, the cells have abundant Golgi. **19** Water moves through a semipermeable membrane in osmosis because there is a concentration gradient across the membrane of solute and solvent. The solute cannot effectively move to balance the concentration on both sides of the membrane, so water moves to achieve this balance.

Chapter 4

1 **Figure 4.6** A compost pile decomposing is an exergonic process. A baby developing from a fertilized egg is an endergonic process. Tea dissolving into water is an exergonic process. A ball rolling downhill is an exergonic process. **3** **Figure 4.16** The illness is caused by lactic acid build-up. Lactic acid levels rise after exercise, making the symptoms worse. Milk sickness is rare today, but was common in the Midwestern United States in the early 1800s. **4** D **6** C **8** D **10** C **12** B **14** Physical exercise involves both anabolic and catabolic processes. Body cells break down sugars to provide ATP to do the work necessary for exercise, such as muscle contractions. This is catabolism. Muscle cells also must repair muscle tissue damaged by exercise by building new muscle. This is anabolism. **16** Most vitamins and minerals act as cofactors and coenzymes for enzyme action. Many enzymes require the binding of certain cofactors or coenzymes to be able to catalyze their reactions. Since enzymes catalyze many important reactions, it is critical to obtain sufficient vitamins and minerals from diet and supplements. Vitamin C (ascorbic acid) is a coenzyme necessary for the action of enzymes that build collagen. **18** The oxygen we inhale is the final electron acceptor in the electron transport chain and allows aerobic respiration to proceed, which is the most efficient pathway for harvesting energy in the form of ATP from food molecules. The carbon dioxide we breathe out is formed during the citric acid cycle when the bonds in carbon compounds are broken. **20** They are very economical. The substrates, intermediates, and products move between pathways and do so in response to finely tuned feedback inhibition loops that keep metabolism overall on an even keel. Intermediates in one pathway may occur in another, and they can move from one pathway to another fluidly in response to the needs of the cell.

Chapter 5

1 **Figure 5.7** Levels of carbon dioxide (a reactant) will fall, and levels of oxygen (a product) will rise. As a result, the rate of photosynthesis will slow down. **2** C **4** C **6** C **8** B **10** A **12** To convert solar energy into chemical energy that cells can use to do work. **14** The energy is present initially as light. A photon of light hits chlorophyll, causing an electron to be energized.

The free electron travels through the electron transport chain, and the energy of the electron is used to pump hydrogen ions into the thylakoid space, transferring the energy into the electrochemical gradient. The energy of the electrochemical gradient is used to power ATP synthase, and the energy is transferred into a bond in the ATP molecule. In addition, energy from another photon can be used to create a high-energy bond in the molecule NADPH. **16** Photosynthesis takes the energy of sunlight and combines water and carbon dioxide to produce sugar and oxygen as a waste product. The reactions of respiration take sugar and consume oxygen to break it down into carbon dioxide and water, releasing energy. Thus, the reactants of photosynthesis are the products of respiration, and vice versa.

Chapter 6

1 **Figure 6.4** D. The kinetochore becomes attached to the mitotic spindle. Sister chromatids line up at the metaphase plate. The kinetochore breaks apart and the sister chromatids separate. The nucleus reforms and the cell divides. **2** C **4** B **6** A **8** C **10** C **12** Human somatic cells have 46 chromosomes, including 22 homologous pairs and one pair of nonhomologous sex chromosomes. This is the 2*n*, or diploid, condition. Human gametes have 23 chromosomes, one each of 23 unique chromosomes. This is the *n*, or haploid, condition. **14** If one of the genes that produce regulator proteins becomes mutated, it produces a malformed, possibly non-functional, cell-cycle regulator. This increases the chance that more mutations will be left unrepaired in the cell. Each subsequent generation of cells sustains more damage. The cell cycle can speed up as a result of loss of functional checkpoint proteins. The cells can lose the ability to self-destruct. **16** The common components of eukaryotic cell division and binary fission are DNA duplication, segregation of duplicated chromosomes, and the division of the cytoplasmic contents.

Chapter 7

1 **Figure 7.2** Yes, it will be able to reproduce asexually. **2** C **4** B **6** D **8** B **10** D **12** The offspring of sexually reproducing organisms are all genetically unique. Because of this, sexually reproducing organisms may have more successful survival of offspring in environments that change than asexually reproducing organisms, whose offspring are all genetically identical. In addition, the rate of adaptation of sexually reproducing organisms is higher, because of their increased variation. This may allow sexually reproducing organisms to adapt more quickly to competitors and parasites, who are evolving new ways to exploit or outcompete them. **14** Random alignment leads to new combinations of traits. The chromosomes that were originally inherited by the gamete-producing individual came equally from the egg and the sperm. In metaphase I, the duplicated copies of these maternal and paternal homologous chromosomes line up across the center of the cell to form a tetrad. The orientation of each tetrad is random. There is an equal chance that the maternally derived chromosomes will be facing either pole. The same is true of the paternally derived chromosomes. The alignment should occur differently in almost every meiosis. As the homologous chromosomes are pulled apart in anaphase I, any combination of maternal and paternal chromosomes will move toward each pole. The gametes formed from these two groups of chromosomes will have a mixture of traits from the individual's parents. Each gamete is unique. **16** The problems caused by trisomies arise because the genes on the chromosome that is present in three copies produce more product than genes on chromosomes with only two copies. The cell does not have a way to adjust the amount of product, and the lack of balance causes problems in development and the maintenance of the individual. Each chromosome is different, and the differences in survivability could have to do with the numbers of genes on the two chromosomes. Chromosome 21 may be a smaller chromosome, so there are fewer unbalanced gene products. It is also possible that chromosome 21 carries genes whose products are less sensitive to differences in dosage than chromosome 18. The genes may be less involved in critical pathways, or the differences in dosage may make less of a difference to those pathways.

Chapter 8

1 **Figure 8.9** You cannot be sure if the plant is homozygous or heterozygous as the data set is too small: by random chance, all three plants might have acquired only the dominant gene even if the recessive one is present. **3** **Figure 8.16** Half of the female offspring would be heterozygous (X^WX^w) with red eyes, and half would be homozygous recessive (X^wX^w) with white eyes. Half of the male offspring would be hemizygous dominant (X^WY) with red eyes, and half would be hemizygous recessive (X^wY) with white eyes. **4** B **6** A **8** C **10** D **12** C **14** The garden pea has flowers that close tightly during self-pollination. This helps to prevent accidental or unintentional fertilizations that could have diminished the accuracy of Mendel's data. **16** The Punnett square will be 2 × 2 and will have *T* and *t* along the top and *T* and *t* along the left side. Clockwise from the top left, the genotypes listed within the boxes will be *TT*, *Tt*, *Tt*, and *tt*. The genotypic ratio will be 1*TT*:2*Tt*:1*tt*. **18** Yes this child could have come from these parents. The child would have inherited an *i* allele from each parent and for this to happen the type A parent had to have genotype I^Ai and the type b parent had to have genotype I^Bi.

Chapter 9

1 **Figure 9.10** Ligase, as this enzyme joins together Okazaki fragments. **2** A **4** B **6** A **8** C **10** D **12** The DNA is wound around proteins called histones. The histones then stack together in a compact form that creates a fiber that is 30-nm thick. The fiber is further coiled for greater compactness. During metaphase of mitosis, the chromosome is at its most compact to facilitate chromosome movement. During interphase, there are denser areas of chromatin, called heterochromatin, that contain DNA that is not expressed, and less dense euchromatin that contains DNA that is expressed. **14** Telomerase has an inbuilt RNA template that extends the 3' end, so a primer is synthesized and extended. Thus, the ends are protected. **16** The cell controls which protein is expressed, and to what level that protein is expressed, in the cell. Prokaryotic cells alter the transcription rate to turn genes on or off. This method will increase or decrease protein levels in response to what is needed by the cell. Eukaryotic cells change the accessibility (epigenetic), transcription, or translation of a gene. This will alter the amount of RNA, and the lifespan of the RNA, to alter the amount of protein that exists. Eukaryotic cells also change the protein's translation to increase or decrease its overall levels. Eukaryotic organisms are much more complex and can manipulate protein levels by changing many stages in the process.

Chapter 10

1 **Figure 10.7** Because even though the original cell came from a Scottish Blackface sheep and the surrogate mother was a Scottish Blackface, the DNA came from a Finn-Dorset. **2** B **4** A **6** C **8** D **10** The polymerase chain reaction is used to quickly produce many copies of a specific segment of DNA when only one or a very few copies are originally present. The benefit of PCR is that there are many instances in which we would like to know something about a sample of DNA when only very small amounts are available. PCR allows us to increase the number of DNA molecules so that other tests, such as sequencing, can be performed with it. **12** Genome mapping helps researchers to study disease-causing genes in humans. It also helps to identify traits of organisms that can be used in applications such as cleaning up pollution.

Chapter 11

1 **Figure 11.7** Genetic drift is likely to occur more rapidly on an island, where smaller populations are expected to occur. **2** B **4** C **6** C **8** C **10** A **12** B **14** B **15** The plants that can best use the resources of the area, including competing with other individuals for those resources, will produce more seeds themselves and those traits that allowed them to better use the resources will increase in the population of the next generation. **17** The theory of natural selection stems from the observation that some individuals in a population survive longer and have more offspring than others, thus passing on more of their genes to the next generation. For example, a big, powerful male gorilla is much more likely than a smaller, weaker gorilla to become the population's silverback, the pack's leader who mates far more than the other males of the group. The pack leader will, therefore, father more offspring, who share half of his genes, and are thus likely to also grow bigger and stronger like their father. Over time, the genes for bigger size will increase in frequency in the population, and the population will, as a result, grow larger on average. **19** Organisms of one species can arrive to an island together and then disperse throughout the chain, each settling into different niches, exploiting different food resources and, evolving independently with little gene flow between different islands. **21** In science, a theory is a thoroughly tested and verified set of explanations for a body of observations of nature. It is the strongest form of knowledge in science. In contrast, a theory in common usage can mean a guess or speculation about something, meaning that the knowledge implied by the theory may be very weak.

Chapter 12

1 **Figure 12.3** Cats and dogs are part of the same group at five levels: both are in the domain Eukarya, the kingdom Animalia, the phylum Chordata, the class Mammalia, and the order Carnivora. **3** C **5** D **7** B **9** A **11** B **13** The phylogenetic tree shows the order in which evolutionary events took place and in what order certain characteristics and organisms evolved in relation to others. It does not generally indicate time durations. **15** Dolphins are mammals and fish are not, which means that their evolutionary paths (phylogenies) are quite separate. Dolphins probably adapted to have a similar body plan after returning to an aquatic lifestyle, and therefore this trait is probably analogous. **17** The biologist looks at the state of the character in an outgroup, an organism that is outside the clade for which the phylogeny is being developed. The polarity of the character change is from the state of the character in the outgroup to the second state.

Chapter 13

1 **Figure 13.6** A **2** B **4** D **6** C **8** D **10** C **12** C **14** Antibiotics kill bacteria that are sensitive to them; thus, only the resistant ones will survive. These resistant bacteria will reproduce, and therefore, after a while, there will be only resistant bacteria, making it more difficult to treat the diseases they may cause in humans. **16** Eukaryote cells arose through endosymbiotic events that gave rise to energy-producing organelles within the eukaryotic cells, such as mitochondria and plastids. The nuclear genome of eukaryotes is related most closely to the Archaea, so it may have been an early archaean that engulfed a bacterial cell that evolved into a mitochondrion. Mitochondria appear to have originated from an alpha-proteobacterium, whereas chloroplasts originated from a cyanobacterium. There is also evidence of secondary endosymbiotic events. Other cell components may have resulted from endosymbiotic events. **18** The trypanosomes that cause this disease are capable of expressing a glycoprotein coat with a different molecular structure with each generation. Because the immune system must respond to specific antigens to raise a meaningful defense, the changing nature of trypanosome antigens prevents the immune system from ever clearing this infection. Massive trypanosome infection eventually leads to host organ failure and death.

Chapter 14

1 **Figure 14.19** B. The diploid zygote forms after the pollen tube has finished forming so that the male generative nucleus (sperm) can fuse with the female egg. **3** A **5** A **7** D **9** A **11** A **13** The sporangium of plants protects the spores from drying out. Apical meristems ensure that a plant is able to grow in the two directions required to acquire water and nutrients: up toward sunlight and down into the soil. The multicellular embryo is an important adaptation that improves survival of the developing plant in dry environments. The development of molecules that gave plants structural strength allowed them to grow higher on land and obtain more sunlight. A waxy cuticle prevents water loss from aerial surfaces. **15** It became possible to transport water and nutrients through the plant and not be limited by rates of diffusion. Vascularization allowed the development of leaves, which increased efficiency of photosynthesis and provided more energy for plant growth. **17** The resemblance between cycads and palm trees is only superficial. Cycads are gymnosperms and do not bear flowers or fruit. Unlike palms, cycads produce cones; large, female cones that produce naked seeds, and smaller male cones on separate plants.

Chapter 15

1 **Figure 15.3** B **3** **Figure 15.33** A **4** B **6** D **8** B **10** A **12** B **14** C **16** C **18** A **20** Specialized tissues allow more efficient functioning because differentiated tissue types can perform unique functions and work together in tandem to allow the animal to perform more functions. For example, specialized muscle tissue allows directed and efficient movement, and specialized nervous tissue allows for multiple sensory modalities as well as the ability to respond to various sensory information; these functions are not necessarily available to other non-animal organisms. **22** The sponges draw water carrying food particles into the spongocoel using the beating of flagella in the choanocytes. The food particles are caught by the collar of the choanocyte and brought into the cell by phagocytosis. Digestion of the food particle takes place inside the cell. The difference between this and the mechanisms of other animals is that digestion takes place within cells rather than outside of cells. It means that the organism can feed only on particles smaller than the cells themselves. **24** In a complete digestive system, food material is not mixed with waste material, so the digestion and uptake of nutrients can be more efficient. In addition, the complete digestive system allows for an orderly progression of digestion of food matter and the specialization of different zones of the digestive tract. **26** Mollusks have a large muscular foot that may be modified in various ways, such as into tentacles, but it functions in locomotion. They have a mantle, a structure of tissue that covers and encloses the dorsal portion of the animal and secretes the shell when it is present. The mantle encloses the mantle cavity, which houses the gills (when present), excretory pores, anus, and gonadopores. The coelom of mollusks is restricted to the region around the systemic heart. The main body cavity is a hemocoel. Many mollusks have a radula near the mouth that is used for scraping food. **28** During embryonic development, we also have a notochord, a dorsal hollow nerve tube, pharyngeal slits, and a post-anal tail. **30** A moist environment is required as frog eggs lack a shell and dehydrate quickly in dry environments.

Chapter 16

1 **Figure 16.2** Pyrogens increase body temperature by causing the blood vessels to constrict, inducing shivering, and stopping sweat glands from secreting fluid. **3** **Figure 16.9** B **5** **Figure 16.14** A **6** C **8** B **10** C **12** A **14** C **16** A **18** A **20** A **22** B **24** C **26** A **27** The body has a sensor that detects a deviation of the state of the cells or the body from the set point. The information is relayed to a control center, usually the brain, where signals go to effectors. Those effectors cause a negative feedback response that moves the state of the body in a direction back toward the set point. **29** Accessory organs play an important role in producing and delivering digestive juices to the intestine during digestion and absorption. Specifically, the salivary glands, liver, pancreas, and gallbladder play important roles. Malfunction of any of these organs can lead to disease states. **31** In the United States, obesity, particularly childhood obesity, is a growing concern. Some of the contributors to this situation include sedentary lifestyles and consuming more processed foods and less fruits and vegetables. As a result, even young children who are obese can face health concerns. **33** The sac-like structure of the alveoli increases their surface area. In addition, the alveoli are made of thin-walled cells. These features allows gases to easily diffuse across the cells. **35** The cells of both exocrine and endocrine glands produce a product that will be secreted by the gland. An exocrine gland has a duct and secretes its product to the outside of the gland, not into the bloodstream. An endocrine gland secretes its product into the bloodstream and does not use a duct. **37** Blood-glucose levels are regulated by hormones produced by the pancreas: insulin and glucagon. When blood-glucose levels are increasing, the pancreas releases insulin, which stimulates uptake of glucose by cells. When blood-glucose levels are decreasing, the pancreas releases glucagon, which stimulates the release of stored glucose by the liver to the bloodstream. **39** Neurons contain organelles common to all cells, such as a nucleus and mitochondria. They are unique because they contain dendrites, which can receive signals from other neurons, and axons that can send these signals to other cells. **41** The sympathetic nervous system prepares the body for "fight or flight," whereas the parasympathetic nervous system allows the body to "rest and digest." Sympathetic neurons release norepinephrine onto target organs; parasympathetic neurons release acetylcholine. Sympathetic neuron cell bodies are located in sympathetic ganglia. Parasympathetic neuron cell bodies are located in the brainstem and sacral spinal cord. Activation of the sympathetic nervous system increases heart rate and blood pressure and decreases digestion and blood flow to the skin. Activation of the parasympathetic nervous system decreases heart rate and blood pressure and increases digestion and blood flow to the skin.

Chapter 17

1 **Figure 17.5** D **3** **Figure 17.17** If the blood of the mother and fetus mixes, memory cells that recognize the Rh antigen of the fetus can form in the mother late in the first pregnancy. During subsequent pregnancies, these memory cells launch an immune attack on the fetal blood cells of an Rh-positive fetus. Injection of anti-Rh antibody during the first pregnancy prevents the immune response from occurring. **4** B **6** B **8** B **10** C **12** A **14** B **16** The virus cannot attach to dog cells because dog cells do not express the receptors for the virus or there is no cell within the dog that is permissive for viral replication. **18** If the MHC class

I molecules expressed on donor cells differ from the MHC class I molecules expressed on recipient cells, NK cells may identify the donor cells as not normal and produce enzymes to induce the donor cells to undergo apoptosis, which would destroy the transplanted organ. **20** T cells bind antigens that have been digested and embedded in MHC molecules by APCs. In contrast, B cells function as APCs to bind intact, unprocessed antigens. **22** This is probably a delayed sensitivity reaction to one or more chemicals in the developer. An initial exposure would have sensitized the individual to the chemical and then subsequent exposures will induce a delayed inflammation reaction a day or two after exposure.

Chapter 18

1 **Figure 18.12** D **3** B **5** A **7** A **9** D **11** B **13** Temperatures can vary from year to year and an unusually cold or hot year might produce offspring all of one sex, making it hard for individuals to find mates. **15** If multiple sperm fused with one egg, a zygote with a multiple ploidy level (multiple copies of the chromosomes) would form, and then would die. **17** Low levels of progesterone allow the hypothalamus to send GnRH to the anterior pituitary and cause the release of FSH and LH. FSH stimulates follicles on the ovary to grow and prepare the eggs for ovulation. As the follicles increase in size, they begin to release estrogen and a low level of progesterone into the blood. The level of estrogen rises to a peak, causing a spike in the concentration of LH. This causes the most mature follicle to rupture and ovulation occurs.

Chapter 19

1 **Figure 19.2** Smaller animals require less food and others resources, so the environment can support more of them per unit area. **3** **Figure 19.11** Stage 4 represents a population that is decreasing. **4** C **6** A **8** C **10** A **12** C **14** B **16** C **18** The researcher would mark a certain number of penguins with a tag, release them back into the population, and, at a later time, recapture penguins to see what percentage was tagged. This percentage would allow an estimation of the size of the penguin population. **20** If a natural disaster such as a fire happened in the winter, when populations are low, it would have a greater effect on the overall population and its recovery than if the same disaster occurred during the summer, when population levels are high. **22** The competitive exclusion principles states that no two species competing for the same resources at the same time and place can co-exist over time. Thus, one of the competing species will eventually dominate. On the other hand, if the species evolve such that they use resources from different parts of the habitat or at different times of day, the two species can exist together indefinitely.

Chapter 20

1 **Figure 20.12** C: Nitrification by bacteria converts nitrates (NO_3^-) to nitrites (NO_3^-). **3**B **5**B **7** B **9** C **11** D **13** Grazing food webs have a producer at their base, which is either a plant for terrestrial ecosystems or a phytoplankton for aquatic ecosystems. The producers pass their energy to the various trophic levels of consumers. At the base of detrital food webs are the decomposers, which pass their energy to a variety of other consumers. Detrital food webs are important for the health of many grazing food webs because they eliminate dead and decaying organic material, thus clearing space for new organisms and removing potential causes of disease. **15** Fire is less common in desert biomes than in temperate grasslands because deserts have low net primary productivity, thus very little plant biomass to fuel a fire. **17** Organisms living in the intertidal zone must tolerate periodic exposure to air and sunlight and must be able to be periodically dry. They also must be able to endure the pounding waves; for this reason, some shoreline organisms have hard exoskeletons that provide protection while also reducing the likelihood of drying out.

Chapter 21

1 **Figure 21.6** The ground is permanently frozen so the seeds will keep, even if the electricity fails. **2** C **4** C **6** C **8** C **10** Crop plants are derived from wild plants, and genes from wild relatives are frequently brought into crop varieties by plant breeders to add valued characteristics to the crops. If the wild species are lost, then this genetic variation would no longer be available. **12** Human population growth leads to unsustainable resource use, which causes habitat destruction to build new human settlements, create agricultural fields, and so on. Larger human populations have also led to unsustainable fishing and hunting of wild animal populations. Excessive use of fossil fuels also leads to global warming. **14** Larger preserves will contain more species. Preserves should have a buffer around them to protect species from edge effects. Preserves that are round or square are better than preserves with many thin arms.

INDEX

A

B

C

D

E

F

G

H

I

N

O

P

Q

R

S

T

U

V

W

X

Y

Z