Student Workbook for Science in the Atomic Age

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Table of Contents

Daily Assignments

The daily assignments are built into the layout of the textbook. You will basically spend seven days in a given two-week period reading and doing experiments. You will then spend two days answering the questions in the chapter review. Finally, you'll spend one day taking the test.

This book is made up of 16 chapters. The first one is shorter than the others, because it is a general introduction to science and to the process of documenting experiments. Each chapter contains reading and experiments that you need to complete as well as questions you must answer. You are supposed to perform the experiments when they come to you in the reading, because right after the experiment, I will discuss what the experiment means.

The questions that you answer while you are reading are called "Comprehension Check" questions, and they represent important milestones in your work. Each time you reach a "Comprehension Check" box, you are at the end of the day's lesson. You need to answer the questions and then check your answers against the answers that appear right before the Review at the end of the chapter. Once you check your answers and understand anything you answered incorrectly, you are done with science for the day!

Most of the chapters have seven "Comprehension Check" boxes, which means you will use seven school days to work through each chapter. Some of those days will consist of reading, and some of them will consist of less reading and an experiment to do. At the end of those seven days, you need to spend a day or two answering the questions in the Review that appears at the end of each chapter. Your parent/teacher has the answers to those questions, but you should not use them until you have completed the entire Review. Feel free to use the book to help you with the Review.

Once you have finished answering and checking all your answers to the review questions, you are ready to take the test that covers the chapter you have been working on. You cannot use your book for the test, but you can use a calculator if the test has any math-related questions in it. Also, once you learn about the Periodic Table of the Elements, you are free to use that on any test. It is on page 54 as well as the inside cover of the book.

As you read, you will see some statements and equations that are centered and surrounded by pink boxes. You must memorize any information that you see in the pink boxes. In addition, there are definitions that are centered in the text. They also needed to be committed to memory. Finally, there are some words in boldface type scattered through the text. Those are terms with which you need to be familiar. In the same way, some scientists' names will be in boldface type. They represent the most important scientists that are being discussed.

Most students should try to cover this course in one year of school. If you think about it, all of the Chapters but the first have seven "Comprehension Check" boxes, which means it will take seven days to get through all but the first chapter. After that, suppose you spend two days working on the Review and studying for the test. Then on the next day, you take the test. That means it would take ten school days (two weeks of school) to cover the chapter. The first chapter is shorter, so that means you would take less than 32 weeks to finish the entire book. Most school years are 36 weeks long, so you have some built-in "flex time" in case some chapters are harder for you than others.

Worksheets

Chapter 1 Comprehension Check Questions

1.1 You are admiring a flower in a garden. Which of the following questions can be directly studied by science?

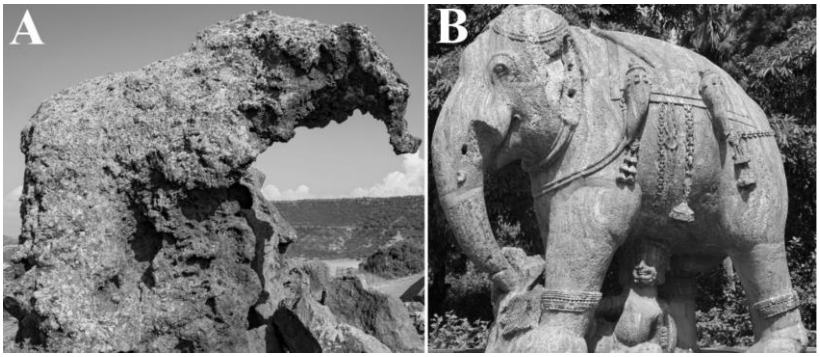
a. What makes the smell that the flower emits?

b. What makes the flower beautiful?

1.2 You have been studying a goldfish in a bowl for a long time. You have observed how it eats, grows, swims, etc. You develop an explanation for how a goldfish gets the energy it needs to survive. It explains everything you have observed. Is your explanation a hypothesis or a theory?

1.3 Suppose you decide to test the explanation you made in question 1.2. You make a prediction about what will happen if you regularly overfeed the goldfish. You start doing that, and what you observe is not what you predicted. At this point, you have two options regarding what to do about your explanation. What are they?

1.4 Look at the two pictures on the right. One of them shows a rock that has been shaped naturally by weather and wind. The other shows a rock that has been shaped by an artist who was following a design. Which is which? What made you choose the way you did?



Photos © shutterstock.com/COLOMBO NICOLA (left), Dr Ajay Kumar Singh (right)

1.5 In an experiment, you are told to boil water and then pull it off the heat until it stops boiling. When you document the experiment, in which section of the report would that information go?

Chapter 1 Review Questions

1. Define the following terms:

a. Science

b. Hypothesis

c. Theory

2. Describe the scientific method in your own words.

3. What part or parts of the scientific method did the ancient Greek natural philosophers use? What did they not use?

4. Why is it often hard to determine whether or not a theory is accurate?

5. What should you say to someone who starts a sentence with, “Science has proven…”?

6. What is the difference between a scientific law and a scientific theory?

7. If a scientific law has been accepted for more than 100 years, can we believe that it is 100% true? Why or why not?

8. While science can only study the natural world directly, give an example of how it can relate to things that go beyond the natural world.

9. What are the three sections you need in every lab report you write in your lab notebook?

10. Indicate what each of the sections in #9 must contain.

Chapter 2 Comprehension Check Questions

2.1 After you rubbed the balloon in your hair, did your hair have a charge? If so, was it positive or negative?

2.2 Suppose the can had been made of something that charges cannot move in. If you did everything exactly the same as you did in your experiment, would the can have been attracted to the negatively-charged balloon?

2.3 Object **A** has twice the mass of object **B**, and object **B** has twice the mass of object **C**. Which object weighs the least?

2.4 Object **A** has a higher density than water, while object **B** has a lower density than water. Which object floats in water, and which sinks?

2.5 Objects **A** and **B** have the same charge. If object **A** has more mass than object **B**, which has the higher charge-to-mass ratio?

2.6 You give an object a negative charge by adding 15 electrons to it. If you represent the charge of an electron with "*e*", what is the charge on the object?

2.7 If you were able to completely remove an electron from an atom, would the atom have a charge? If so, would it be positive or negative?

2.8 Suppose an atom consists of three protons and three electrons. Draw what it would look like according to Rutherford at this point in time.

2.9 Suppose a charged particle that is in motion absorbs light instead of emitting it. Would the charged particle lose energy, gain energy, or end up with the same energy?

2.10 An electron in an atom jumps from an orbit that is close to the nucleus to one that is farther away. Did the atom absorb energy or lose energy?

2.11 An atom is emitting light. Is its electron moving closer to the nucleus or farther from the nucleus?

2.12 In some college laboratories, students do the Franck-Hertz experiment with neon in the tube instead of mercury. When the experiment is performed that way, would you expect the decreases in current to happen at multiples of 4.9 volts or some other number of volts?

2.13 Look at the picture of the neon atom on page 36. Suppose you measure the energy of an electron in the smaller s orbital, and then you measure the energy of the electron in the larger s orbital. How would the energies compare? (**HINT**: Think about electron energy in the Bohr model.)

Consider the following three atoms:

Atom A has six protons and six neutrons in its nucleus

Atom B has ten electrons traveling around a nucleus that contains 12 neutrons

Atom C has six protons and eight neutrons in its nucleus

2.14 How many protons are in the nucleus of atom B?

2.15 Which two atoms are isotopes? Which is the heavier one?

2.16 Which atom is the heaviest of them all?

Chapter 2 Review Questions

1. Define the following terms:

a. Model

b. Matter

c. Conductor

d. Mass

e. Ratio

f. Density

g. Nucleus

h. Centripetal force

i. Mass spectrograph

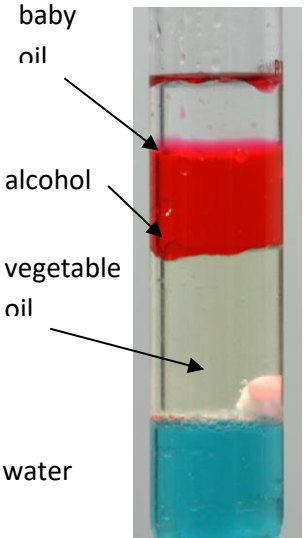
j. Isotopes

2. Dalton's atomic theory was important, but it had two serious errors. What were those two errors?

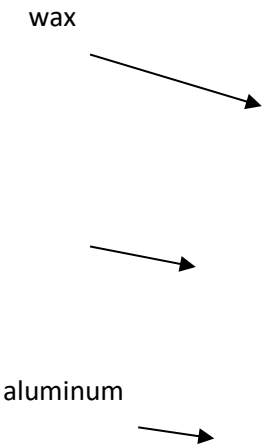
3. If you remove electrons from something that has no charge, will it develop a charge? If so, what kind of charge (positive or negative) will it develop?

4. Object A weighs significantly more than object B. Which has less mass?

5. True or False: Mass and weight are the same.



6. You see a glass tube with solids and liquids in it, as shown on the left. Order all the substances in the glass according to their densities. Start with the substance that has the lowest density and finish with the substance that has the highest density.



7. Looking at the glass tube on the right again, suppose you have equal volumes of wax and alcohol. Which has more mass?

8. When you are making an object negatively charged, what are you adding to the object?

9. Can an object have any amount of negative charge you want to give it?

10. What kind of radioactive particles did Rutherford's gold-foil experiment use? Were they positive, negative, or not charged?

11. To come up with his model of the atom, what did Bohr assume about where the electrons could orbit the nucleus?

12. In the Bohr model of the atom, an electron in the first orbit (the one closest to the nucleus) has an energy of E_1. In the second orbit (which is farther from the nucleus), it has an energy of E_2.

a. Which is larger: E_1 or E_2?

b. If an electron wants to move from the first Bohr orbit to the second, does it lose energy or gain energy?

13. An electron is emitting light. Is it moving towards the nucleus or away from the nucleus?

14. What did the Franck-Hertz experiment demonstrate about mercury atoms?

15. How did Schrödinger treat electrons in order to produce the quantum-mechanical model of the atom?

16. When waves overlap in an interesting way, what do we call the pattern they form?

17. What do we usually represent the quantum-mechanical model's electron clouds with?

18. What particles are found in the nucleus of the atom? What are their charges?

19. Atom A has eight electrons. There are also 8 neutrons in its nucleus.

    a. How many protons are in its nucleus?

b. Another atom has 7 protons and 9 neutrons in its nucleus. Is it an isotope of atom A?

c. Another atom has 8 protons and 10 neutrons in its nucleus. Is it an isotope of atom A?

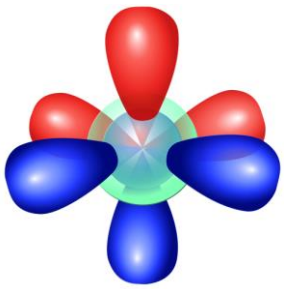
20. Atom A and B are isotopes. A is heavier than B.

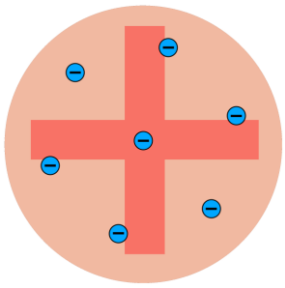
a. Compare the number of protons in each atom.

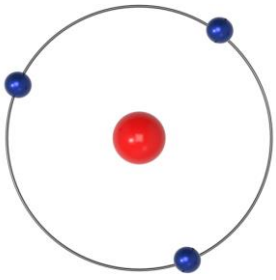
b. Compare the number of electrons in each atom.

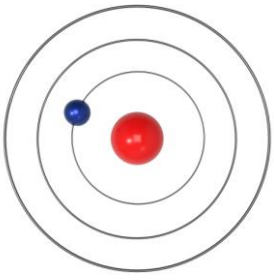
c. Compare the number of neutrons in each atom.

21. Four illustrations of different models for the atom are shown below. Put them in chronological order, starting with the oldest one. Also, name them.

a. 

b. 

c. 

d. 

I just want to remind you that if you didn't understand everything you read in the chapter, that's fine. This review is the key to what I want you to understand. So if you are comfortable with the material covered in this review, you are ready for the test.

Chapter 3 Comprehension Check Questions

3.1 Suppose you have a specific volume of carbon dioxide. Would the mass of the same volume of oxygen be larger or smaller than the mass of the carbon dioxide?

3.2 Ramsay found a gas mixed into what scientists thought was nitrogen that had been isolated from the air. Is the density of that gas higher or lower than the density of pure nitrogen?

3.3 In your experiment, suppose you could have pushed more air into the jar, so that the air pressure inside the jar increased. What would have happen to the size of the marshmallow?

3.4 A steel bar is solid throughout. There are no little spaces inside it. Can the bar have gases trapped in it?

3.5 A chemist is investigating two different elements. The first element will perform several different chemical reactions. The second will not perform any chemical reactions. Which one is more stable? Which one has the lower energy state?

3.6 The element calcium has an atomic number of 20. The element neodymium has an atomic number of 60. Which element emits light of higher energy?

3.7 Looking at the periodic table, what is the chemical symbol for the element that has 12 protons in its atoms? How many electrons are in an atom of that element?

3.8 What is the average mass of the atoms in the element magnesium (abbreviated "Mg")?

3.9 What is the name of an oxygen atom (abbreviated with "O") that has 7 neutrons in its nucleus?

3.10 The element sulfur is abbreviated with "S." What is the mass of the most common isotope of sulfur? How would it be abbreviated?

3.11 Chemists abbreviate table salt as NaCl. How many elements are in NaCl? What about HCN?

3.12 Which of the following elements has only radioactive isotopes: Ir, Hg, Mt, or Eu?

3.13 Where does the element sulfur (S) put all its electrons?

3.14 A nonmetal atom has its largest s orbital filled, and it has three electrons in its largest p orbitals. How many electrons would it need to gain in order to become stable?

3.15 Suppose you react calcium (Ca) with oxygen (O). What would you call the ions that formed? Which is negative and which is positive?

3.16 What charge does aluminum (Al) need to become stable? What is the name of the ion?

3.17 What charge does fluorine (F) need to become stable? What is the name of the ion?

3.18 What is the chemical formula for magnesium oxide? (Magnesium is Mg, and oxygen is O.)

3.19 If lithium (Li) and sulfur (S) react, what is the chemical formula of the compound they make? What is its name?

Chapter 3 Review Questions

1. Define the following terms:

a. Chemical isolation

b. Atomic number

c. Atomic Mass

d. Ion

e. Ionic compounds

2. What was the name of the “lazy” gas that Ramsay isolated?

3. In general, what can you say is being formed if you see bubbles being made in a liquid?

4. A balloon filled with a gas rises in the air on its own. If you have a specific volume of that gas, how would its mass compare to the same volume of air?

5. How can a gas be inside a rock?

6. Helium is pretty common somewhere other than the earth. Where?

7. What is special about the noble gases?

8. Suppose you look at the light coming from beryllium (Be). If you were to then look at the light emitted by excited oxygen (O), which would be producing higher-energy light?

9. The element vanadium is abbreviated "V." What is the mass and abbreviation of its most common isotope?

10. An atom has 27 protons and 31 neutrons. What is its abbreviation?

11. How many atoms (total) are in the compound Na_2SiO_3?

12. Where does a fluorine (F) atom put its electrons?

13. There are many kinds of orbitals we didn't discuss. For example, there are nine g orbitals that can be used by atoms under certain conditions. What is the maximum number of electrons that could fit into those g orbitals?

14. What nonmetal elements have only radioactive isotopes?

15. An atom gains four electrons to become like a noble gas. What is its charge?

16. What is the chemical formula of aluminum nitride? (Aluminum is Al and nitrogen is N)

17. What is the chemical formula and name of the compound formed when lithium (Li) and oxygen (O) are mixed together?

18. What is the chemical formula and name of the compound formed when aluminum and bromine (Br) are mixed together?

19. Which of the following elements would you expect to follow the rules you learned in this chapter: I, Mo, Ir, Se, Ba, Eu?

20. Which of the following compounds is/are ionic: KBr, SO_2, Li_2CrO_4, $NaNO_3$, $C_2H_4O_2$.

Chapter 4 Comprehension Check Questions

4.1 What is the Lewis structure for the element nitrogen (N)?

4.2 What is the Lewis structure for the ion that nitrogen (N) becomes in an ionic compound?

4.3 What is the Lewis structure for the ion that potassium (K) becomes in an ionic compound?

4.4 Draw Lewis structures for the compound formed by potassium and nitrogen. What is its name?

4.5 Ammonia (NH_3) is a foul-smelling gas that is often dissolved in water to make a cleaning solution. Draw its Lewis structure.

4.6 What is the Lewis structure for water (H_2O)?

4.7 Based on what you saw in your experiment, which substance has the lowest melting point? Which substance has the next lowest melting point? What can you say about the melting points of salt and baking soda compared to the melting point of sugar?

4.8 There is a process called "deposition" in which a gas turns directly into a solid. Is energy removed from or added to the gas molecules in order for deposition to take place?

4.9 Some ants make formic acid (CH_2O_2) as a means of protecting themselves. Sodium formate ($NaCHO_2$) can be made from formic acid, and it is sometimes used as a food preservative. Which has the lower melting point?

4.10 Two covalent liquids are studied. When added together, they form two layers that never mix. Liquid B is on the top, and liquid A is on the bottom. The attractive forces between molecules are tested. Liquid A's molecules are more strongly attracted to one another than liquid B's molecules are attracted to one another. Classify each liquid as polar or nonpolar.

4.11 Suppose you had put a water-tight cap on the pill bottles before you put them in the freezer. What would have happened to the pill bottle that had water in it?

4.12 Silicon is another substance that expands when it freezes. Does solid silicon float or sink in liquid silicon?

4.13 When you burn wood, the ashes that are left behind have a lot less mass than the wood that you burned. Using the Law of Mass Conservation, what can you conclude about the other substances produced when wood is burned?

4.14 The molecules of a substance form a pattern and stay in that pattern. What phase is the substance in?

4.15 Which of the following can form hydrogen bonds: H_2, NH_3, or PCl_3?

Chapter 4 Review Questions

1. Define the following terms:

a. Valence electrons

b. Molecule

c. Covalent bond

d. Polar molecule

e. Nonpolar molecule

f. Law of Mass Conservation

g. Hydrogen bond

2. How many valence electrons will make most atoms stable?

3. What atom is the exception to that rule? How many valence electrons makes it stable?

4. Give the Lewis structure for each of the following atoms: silicon (Si), rubidium (Rb), and boron (B).

5. Give the Lewis structures for the ions that each of the following atoms would become in an ionic compound: gallium (Ga), iodine (I), and cesium (Cs)

6. Give the name and Lewis structure for the ionic compounds formed between:

a. calcium (Ca) and oxygen (O)

b. lithium (Li) and sulfur (S)

7. Give the Lewis structure for the following compounds:

a. PF_3

b. HI

c. CCl_4

8. For each of the following, indicate which has the highest melting point:

a. PF_3 or AlF_3

b. Na_2O or H_2S

9. Consider a lake. There are water molecules in the lake, and they are in their liquid phase. There are oxygen molecules in the air above the lake, and they are in their gas phase. There is $CaCO_3$ in the solid rocks at the bottom of the lake. Order the water molecules, oxygen molecules, and $CaCO_3$ in terms of how fast they are moving.

10. When a solid melts, what phase does it become? Has energy been added or removed?

11. Does a freezer add energy to the things put in it or remove energy from them?

12. What phase change occurs in evaporation? Is energy added or removed from the substance to make that happen?

13. You have a liquid that is composed of polar molecules and one that is composed of nonpolar molecules.

a. Which liquid is made of molecules that have slight charges in them?

b. Which liquid has the weaker attraction between its molecules?

c. Will the two liquids mix well together?

14. Silver is like most substances on the planet. Does solid silver sink or float in melted silver?

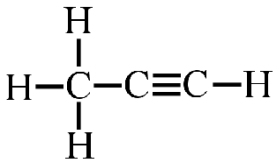
15. You have two samples of water. One is in its liquid phase, and the other is in its solid phase. They both take up exactly the same volume. Are their masses different or the same? If they are different, which has more mass?

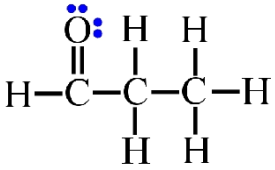
16. You have a sample of water in its liquid phase, and you measure its mass. You then heat it until it boils. You manage to catch all the water vapor, and you measure its mass. Compare the mass of the liquid with the mass of the vapor.

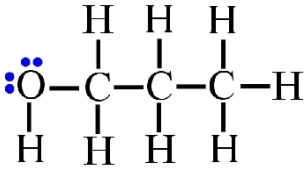
Chapter 5 Comprehension Check Questions

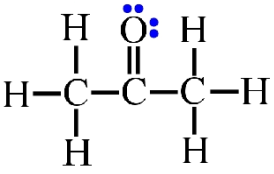
5.1 Which of the following molecules is/are organic: CH_2O, $MgC_4H_6O_2$, NO_2, $C_{12}H_{22}O_{11}$?

The next two questions refer to the Lewis structures below

a. 

b. 

c. 

d. 

5.2 Which molecule has the strongest kind of bond between two of its atoms?

5.3 Which compounds are isomers?

5.4 If a carbohydrate doesn't taste sweet, is it a monosaccharide, a disaccharide, or a polysaccharide?

5.5 The white streaks in a steak (often called the steaks “marbling”) is the fat. Is it saturated or unsaturated?

5.6 Insect blood produces white flakes when treated with vinegar and alcohol, but it is not red. Does insect blood contain protein? Does it contain hemoglobin?

5.7 In the experiment, I had you use a single layer of tape on one of the pencils. Why did I have you use the tape to begin with, and why only one layer?

The next two questions are about the primary structure of insulin, which is shown below:

5.8 List the amino acids (refer to them by number and chain) that make it different from human insulin, the primary structure of which is shown on page 120.

5.9 Which is most similar to human insulin: horse insulin, pig insulin, or cattle insulin. Which is least similar?

5.10 Suppose you eat the same amount of Calories that you burn every day. What will happen to your weight? Will it increase, decrease, or stay the same?

5.11 There are six specific chemicals that link together to form DNA. What are they?

5.12 A chemist claims to have analyzed DNA and found that it has a lot more cytosine in it than guanine. Explain why that can't be true.

5.13 You are looking at one helix of DNA. You see that it has the following sequence of nucleotide bases: cytosine, followed by adenine, followed by guanine. What would be the sequence of nucleotide bases on same section of the other helix?

5.14 It is possible for a gene to be mutated, which means its sequence of nucleotide bases gets changed. In addition to the change in the gene, what other change would this cause?

Chapter 5 Review Questions

1. Define the following terms:

a. Organic compound

b. Monosaccharide

c. Isomers

d. Disaccharide

e. Polysaccharide

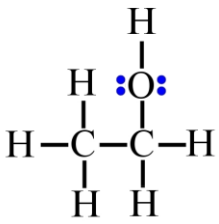
f. Saturated fat

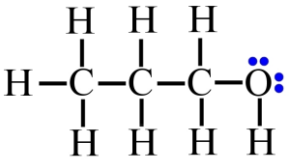
g. Unsaturated fat

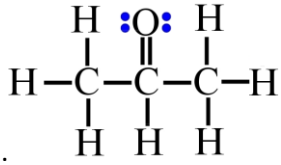
h. Macronutrients

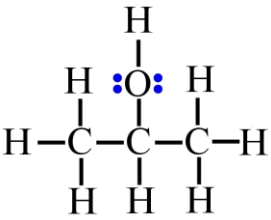
2. Which of the following molecules is/are organic: Na_2CO_3, $C_4H_6O_2$, H_2O, $C_3H_7NO_2$, or PH_3?

3. Given the following Lewis structures:

I. 

II. 

III. 

IV. 

a) Which molecule or molecules has at least one double bond?

b) Which molecule or molecules has at least one triple bond?

c) Which molecules are isomers?

4. Is the sugar that you use to sweeten foods a monosaccharide, disaccharide, or polysaccharide?

5. Is fructose a monosaccharide, disaccharide, or polysaccharide?

6. Is starch a monosaccharide, disaccharide, or polysaccharide?

7. A fat is liquid at room temperature. Are there double bonds between carbon atoms in the molecule?

8. What two types of molecules link together to form lipids? How many of each are found in a single lipid molecule?

9. A fat is liquid at room temperature and then it is hydrogenated. What phase will it now be at room temperature?

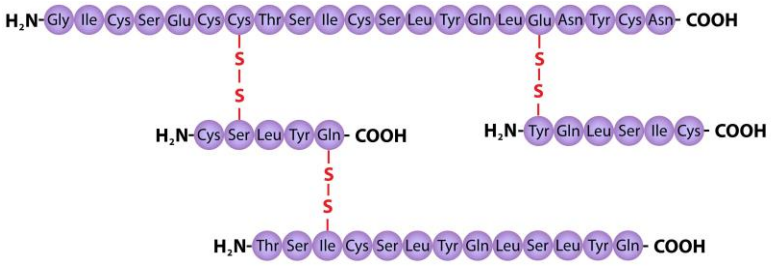
10. Why is your blood red?

11. What happens to a protein when it is treated with alcohol and vinegar?

12. What did X-ray diffraction tell scientists about the nature of a protein?

13. A protein from a particular organism is studied, and the order of amino acids in the protein is figured out. What is this order called, and what in the organism determined it?

14. The drawing below is the primary structure of a made-up protein:

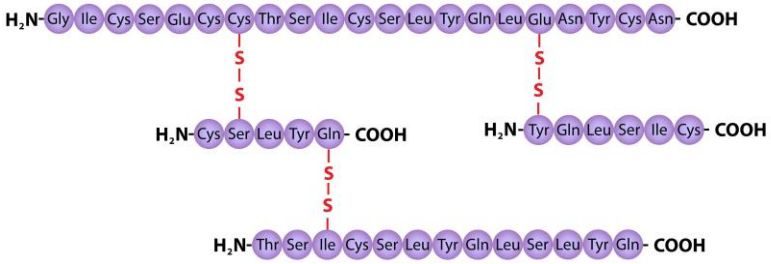


a) How many chains are in this protein?

b) How many amino acids are in its shortest chain?

c) What is the three-letter abbreviation of the third amino acid in the longest chain?

15. Compare the following protein:



to this protein:

The two longer chains are exactly the same in both proteins. What are the differences between the other two chains in the proteins? Specify the number of the amino acid, which chain it is in, and how it is different.

16. A very popular diet that can help some people lose weight is called the “keto diet.” It involves eating mostly proteins and fats. Which macronutrient does the keto diet mostly leave out?

17. Besides being able to provide energy to the body, what more important thing does the body get from eating proteins?

18. Suppose a person needs 2,000 Calories each day in order to do all the things he does. If he consistently eats an average of 1,700 Calories a day, what will happen?

19. How many helixes are in DNA?

20. What holds the helixes in DNA together?

21. Suppose one helix of DNA has adenine, then cytosine, then thymine, and then guanine. What would be the order of the nucleotide bases on the same part of the other helix?

22. How is DNA like a cookbook?

23. Which is better designed: DNA or a top-of-the-line computer disk?

Chapter 6 Comprehension Check Questions

6.1 While all cells are small, you will eventually see that some cells are larger than others. Suppose you have one cell that is large and a second cell that is much smaller. If you compared how quickly each cells moves things around once they get inside, what do you think you would see?

6.2 Two cells (A and B) are being examined under a microscope. Only one of them has a nucleus. Cell A is much larger than cell B. Which cell has a nucleus? Is it eukaryotic or prokaryotic?

6.3 You are trying to look at a eukaryotic cell under a microscope, but you can't see anything inside it. What could you add that might help you see some of the cell's organelles?

6.4 You might have learned that at one time, scientists thought that living things could arise from dead things. Maggots, for example, were thought to come from decaying meat. This idea was called spontaneous generation. What does cell theory say about spontaneous generation?

6.5 Many authors say that you can think of the Golgi apparatus as the "post office" of the cell. Why?

6.6 Different cells have different numbers of mitochondria. Muscle cells, for example, have significantly more mitochondria in them than skin cells. Why?

6.7 White blood cells are shaped like round balls when they are in your blood vessels, but they flatten out like pancakes to leave the blood vessel when they need to. What allows them to change shape like that?

6.8 If the microtubules in the cytoskeleton have a problem, what organelle is probably responsible?

6.9 Part of the endoplasmic reticulum is making a molecule of fat. Is it smooth ER or rough ER?

6.10 Some scientists call lysosomes “suicide sacs.” Why?

6.11 Does the plasma membrane allow oxygen to pass into an animal cell? Why or why not?

6.12 A wilted plant is given a lot of water. What do you predict will happen after a while?

6.13 A cell’s DNA is enclosed in a membrane. Can it be a prokaryotic cell?

6.14 Are bacterial cells smaller, larger, or the same size as most eukaryotic cells?

6.15 Scientists sometimes raise animals like mice in “germ free” environments. That means they are never exposed to bacteria. Would you expect these animals to be more or less healthy than animals that are raised in environments where they are exposed to bacteria?

Chapter 6 Review Questions

1. Define the following terms:

a. Cell

b. Cytoplasm

c. Nucleus

d. Cell Theory

e. Gland

f. Semipermeable membrane

g. Pathogen

h. Mutualism

2. What is the difference between a unicellular organism and a multicellular organism?

3. Are the cells in large animals like elephants a lot bigger than the cells in smaller animals like mice? Why or why not?

4. You are looking at a cell under a microscope. What's the best way to determine whether it is prokaryotic or eukaryotic?

5. In general, which are larger: eukaryotic cells or prokaryotic cells?

6. A virus is a pathogen that causes disease. When you have a cold, for example, it is because you have been infected with a virus. A virus is not a cell. Is it alive?

7. What does the Golgi apparatus do?

8. What do mitochondria do?

9. Endoplasmic reticulum has ribosomes attached to it. Is it rough or smooth, and what does it make?

10. A cell is making chemicals that it does not need. Why?

11. What do lysosomes hold?

12. Are all plasma membranes semipermeable?

13. What three organelles are in plant cells but not animal cells?

14. What important process requires chloroplasts?

15. What do the central vacuole and cell wall work together to produce? What else is required?

16. An organism is a bacterium (singular of bacteria). How many cells does it have? What kind of cell?

17. A scientist makes a pill that, if you take it, it kills all the bacteria in your body. Is it a good idea to take this pill?

18. What do bacteria use for locomotion?

Chapter 7 Comprehension Check Questions

7.1 In the previous chapter, you learned about abiogenesis, the idea that the first cell (or the first group of cells) formed from simple chemicals. This violates cell theory, but it is a necessary belief if you do not accept the idea of a Creator. Most scientists who want to believe in abiogenesis think that the cell or cells formed in abiogenesis were something like today's prokaryotic cells, but probably simpler. The simpler the cell, the more likely it can be formed from simple chemicals. Based on what you have learned, how likely is it that a living cell could form from simple chemicals?

7.2 Suppose you make a culture medium and try to grow a population of a specific kind of bacteria. However, you don't get the population to grow. What can you do to increase your chance of success on your next try?

7.3 Paleontologists (pay' lee ahn tah' luh jists – scientist who study fossils) often examine the shapes of bones in a fossil to determine what animal made the fossil. How would you describe that using a word you learned today?

7.4 Of the following diseases, which would be treated with an antibiotic: rickets, tuberculosis, hemophilia, anthrax?

7.5 Suppose a scientist extracts a chemical from a mold and uses it to try to kill the anthrax bacterium. It doesn't work. Does that mean the chemical can't be used as an antibiotic?

7.6 Many scientists think that domestic dogs (the dogs we keep as pets) are descended from wolves. Would this be an example of microevolution or macroevolution?

7.7 Many scientists think that humans are descendants of an ape-like animal. Would that be macroevolution or microevolution?

7.8 Suppose you put bacteria that are resistant to Streptomycin because of a mutation in their DNA and the same type of bacteria that are *not* resistant to Streptomycin in an environment where there is no Streptomycin. Which type is more likely to survive?

7.9 One of the many enzymes your body makes is called lipase. Which macronutrient does it help you to digest?

7.10 A person doesn't take any micronutrient supplements. He has the right amounts of minerals in his body, but he is lacking certain vitamins. Is this most likely a diet issue or a microbiome issue? Why?

7.11 One diagnostic blood test that is often done is a "white blood cell count," where doctors estimate the number of white blood cells in the body. If a person has a high white blood cell count, it is often a sign of infection. Why?

7.12 A sunburn is caused by skin cells being killed when they are exposed to too much sunlight. What makes a sunburn red?

7.13 Suppose you study the microbiomes of two people in the United States and one person in China. Which two would you expect to have more similar microbiomes? Why?

7.14 A gardener notices that some of his plants are infected by a pathogenic bacterium. He adds an antibiotic to the soil, which stops the infection. However, his plants still die. If the antibiotic itself is not dangerous to plants, what is the most likely reason the plants died?

7.15 Fresh pineapple juice has an enzyme that keeps gelatin from solidifying, but if you heat the pineapple juice first, it doesn't keep the gelatin from solidifying. Why?

7.16 Bacteria have been found living inside the core of a nuclear reactor. What term should be used to describe them?

Chapter 7 Review Questions

1. Define the following terms:

a. Morphology

b. Germ Theory of Disease

c. Antibiotic

d. Microevolution

e. Macroevolution

f. Mutation

g. Digestive enzyme

h. Micronutrients

i. Microbiome

j. Denatured protein

2. Are prokaryotic cells simple? Why or why not?

3. What do we call it when we are getting a large group of bacteria to grow in a certain place?

4. Do all bacteria grow on a single type of culture medium?

5. Give an example of an illness caused by bacteria and one that is not caused by bacteria.

6. You learned about two different kinds of organisms that make antibiotics. What were they?

7. What are antibiotic-resistant bacteria?

8. Did the modern use of antibiotics produce antibiotic-resistant bacteria? How do we know?

9. Some say that the account of Noah's Ark is impossible, since there is no way he could have fit two of every land creature we see today onto the ark. Scientifically, what is wrong with that argument?

10. Some cases of antibiotic resistance are caused by mutation. Does the mutation make new genes?

11. Some people are lactose intolerant because they cannot produce lactase, which breaks the disaccharide lactose down into two monosaccharrides. What type of chemical is lactase?

12. The vitamins we hear about today are A, B, C, D, E, and K. Why is there no F, G, H, I, or J?

13. Evaluate this statement: Since vitamins are good, you should get as much of them as possible.

14. What do red blood cells do? What do white blood cells do?

15. If a part of your body is inflamed, are there more red blood cells or white blood cells than normal?

16. Is your microbiome the same throughout the course of your life? Why or why not?

17. What do cyanobacteria do for other living things? What about nitrogen-fixing bacteria?

18. What kind of bacteria support the organisms at a hydrothermal vent?

19. What two organisms have a mutualistic relationship with leafcutter ants?

20. When you cook food that has proteins in it, what are you doing to the proteins?

Chapter 8 Comprehension Check Questions

8.1 A frog eats a butterfly that ate nectar from a flower. What kind of consumer is the frog?

8.2 A chemical reaction happens too quickly to be safely done in a lab. What could you do to make it slow down so that it is safer?

The next three questions refer to the following chemical equation, which describes what happens when iron rusts:

$$4Fe + 3O_2 \rightarrow 2Fe_2O_3$$

8.3 What are the reactants? What are the products?

8.4 How many iron atoms are involved in the reaction? How many oxygen molecules? How many molecules of rust (Fe_2O_3) are made?

8.5 Suppose you could see the amounts of the chemicals as the reaction happened. Which chemicals would decrease in amount? Which would increase?

8.6 You have three blocks of metal. They are all made of the same metal and all the same size. One is black, one is white, and one is red. If you leave them all out in the sun so that they all get the same amount of sunlight, will there be any difference in the amount of energy each absorbs? If so, which will absorb the most energy, and which will absorb the least?

8.7 Suppose you could take the liquid you made in your experiment and remove the chlorophyll that was in it while leaving everything else that was in it. What color would the liquid be?

8.8 Is there any chlorophyll in the needles that are on the ground in the picture on page 198?

8.9 Suppose you have a bowl and a long, wide tray with sides so that it can hold water. You pour two cups of water in the bowl and two cups of water in the tray. You set them out on a counter. Which will dry out first?

8.10 Suppose a plant's guard cells stop working, and the stoma is left open all of the time. What will happen to the amount of water the plant uses?

8.11 A student writes the following as the chemical equation for photosynthesis:

$$CO_2 + H_2O \rightarrow C_6H_{12}O_6 + O_2$$

What is wrong with the student's equation?

8.12 Look at the picture of the fallen tree on page 204. What kind of root system does it have?

8.13 A plant's roots are cleaned of the fungus that is embedded in them. The leaves of the plant turn a significantly lighter shade of green. Why?

8.14 The DNA of a rosebush is compared to its offspring. They are very similar, but there are many small differences. Was the offspring produced by vegetative or sexual reproduction?

8.15 There is a plant, called the Titan arum, whose flower smells like rotting flesh. Why would a plant produce a foul-smelling flower like that?

8.16 A plant just sprouting through the ground has a single leaf. Is it a monocot or a dicot?

Chapter 8 Review Questions

1. Define the following terms:

    a. Producers

    b. Consumers

    c. Chlorophyll

    d. Chromatography

    e. Evergreen Tree

    f. Deciduous Tree

g. Transpiration

h. Mycorrhiza

i. Clone

j. Angiosperms

2. It is common for biologists to say life on earth depends on the sun. Explain why they say that.

3. A cat eats a mouse that ate seeds from a plant. Classify all three organisms as producers or consumers, including whether the consumers are primary, secondary, or tertiary.

4. Why do chemists often heat up the chemical reactions they are trying to study?

5. Consider the following balanced chemical equation: $2HCl + Zn \rightarrow H_2 + ZnCl_2$

a. What are the reactants? How many of each chemical is used?

b. What are the products? How many of each chemical is produced?

6. Natural gas stoves and furnaces burn methane (CH_4) to produce heat. One CH_4 molecule reacts with two oxygen (O_2) molecules to make one carbon dioxide (CO_2) molecule and two water (H_2O) molecules. Write a balanced chemical equation for this process.

7. What is the balanced chemical equation for photosynthesis? What is not in the equation but is essential to the process?

8. You have a ball made of metal and a thin, flat plate made of the same amount of metal. If you heat them both to the same temperature, which will cool down first?

9. If you put a plastic bag over a leaf that is on a tree, you will eventually see little water droplets appear on the inside of the bag. Where did the water come from?

10. How do leaves get the water they need for photosynthesis? How do they get carbon dioxide?

11. What are the openings in a leaf called? Where do you find most of them?

12. What do producers use oxygen for? Why do they end up making more oxygen than they use?

13. What do roots do besides absorb water from the soil? What helps them with one of those jobs?

14. What's the main difference between offspring made by vegetative reproduction and offspring made by sexual reproduction?

15. Describe how plants sexually reproduce, using the terms “flower,” “pollen,” “stamen,” “carpel,” “DNA,” “embryo,” “seed,” “fruit,” and “germinate.”

16. What is the difference between a dicot seed and a monocot seed?

Chapter 9 Comprehension Check Questions

9.1 Arrange these things from lowest to highest in the levels of organization: organelles, atoms, cells, molecules, tissues.

9.2 Two cells from an organism look very different under the microscope. Most likely, do they come from the same tissue or different tissues?

9.3 Suppose you were looking at a dinosaur fossil under a microscope and found small cells that don't have any organelles in them. Would it be reasonable to think that they are dinosaur cells?

9.4 The body is running low on calcium, so it is getting it from a bone. If you looked at the bone tissue under the microscope, would you see more osteoblasts or osteoclasts?

9.5 A muscle is getting longer. Are the cells contracting, or have they relaxed?

9.6 A muscle called the diaphragm (dye' uh fram) is the most important one involved in breathing. Is it made of skeletal muscle tissue or smooth muscle tissue?

9.7 If two bones are supposed to stay together in a joint but suddenly move apart, what connective tissue tries to keep them from moving too far from one another?

9.8 In Chapter 5, you learned about a protein called insulin. It is produced by epithelial cells and travels in your blood to all the tissues of your body. Which of the three functions (protection, secretion, or absorption) are those cells performing?

9.9 Imagine an axon that is going across the page. If the signal is moving from the left side of the page to the right side of the page, which side is the cell body on?

9.10 Demyelination diseases cause the myelin sheath to deteriorate. If a man has that kind of disease, which would you expect him to lose control of first: his hands or his shoulders?

Chapter 9 Review Questions

1. Define the following terms:

a. Tissue

b. Histology

c. Petrifaction

d. Voluntary muscles

e. Involuntary muscles

f. Tendon

g. Ligament

h. Adipose tissue

i. Secretion

2. From atoms to tissues, list nature's levels of organization that we have covered so far in order.

3. What fact allows a scientist to identify different tissues using a microscope?

4. What do soft osteocytes, red blood cells, and delicate vein valves in dinosaur fossils indicate about the fossils' age?

5. What does hydroxyapatite do for bone tissue? What does collagen do?

6. What do we call the hydroxyapatite and collagen mixture that exists between bone cells?

7. What are the three types of bone cells, and what do they do?

8. Compare compact bone tissue to spongy bone tissue.

9. What are the four general types of tissue in the human body?

10. What are the three kinds of muscles, and what do they do?

11. Which of the types of muscles in question 10 are voluntary? Which are involuntary?

12. What connects muscles to bone?

13. What does cartilage do in a joint?

14. What are the three functions of epithelial tissue?

15. Which of those functions are done by the epithelial tissue in glands?

16. What is gastric juice?

17. In general, what structures receive signals in a neuron? What structure sends signals away from the neuron?

18. What part of the neuron holds the nucleus and most of the organelles?

19. What does the myelin sheath do for nerve signals?

Chapter 10 Comprehension Check Questions

10.1 A sebaceous gland is removed from a patient. When it is removed, some of the tissue that surrounded it is removed as well. Did that tissue come from the epidermis, dermis, or hypodermis.

10.2 One kind of needle that a doctor can use to give you a shot is called a "hypodermic needle." Where does that needle inject its medicine?

10.3 If someone naturally had no fingerprints (which isn't really possible), what could you conclude about the supply of oxygen and nutrients to his or her epidermis?

10.4 Suppose a person's melanocytes cannot produce melanin. What will his or her hair color be?

10.5 Compare the amount of keratin in a skin cell that is absorbing melanin and a squamous skin cell.

10.6 Compare the growth phase of a hair follicle in your eyebrow to that of a hair follicle in your head.

10.7 When sebum is released, what does it encounter first: the hair shaft or the hair root?

10.8 Look at the bone labeled “femur” in the drawing on the previous page. What type of bone is it (long, short, flat, sesamoid, or irregular)?

10.9 What kind of tissue is yellow bone marrow made of?

10.10 Bone marrow is taken from the medullary cavity of a long bone. Is it red or yellow?

10.11 You are looking at bone tissue under the microscope. There are lots of osteocytes, but they are not arranged in circles around canals that contain blood vessels and nerves. Is this compact or spongy bone?

10.12 A doctor is examining the epiphyseal plate of a patient’s bone. Is the patient a child or an adult?

10.13 A person's bone is broken. When seen in an X-ray, it has a very large external callus. Is the break fully healed?

10.14 Of the six types of joints you learned about, which would you think best describes your knee joint?

10.15 When you shake your head to say "no," what type of joint are you using?

10.16 Consider the illustration of the synovial joint on page 261. If the level of monosaccharides in a person's synovial fluid is much lower than it should be, which of the structures pointed out in that illustration will be negatively affected?

Chapter 10 Review Questions

1. Define the following terms:

a. Integumentary system

b. Long bone

c. Short bone

d. Flat bone

e. Sesamoid bone

f. Irregular bone

g. Hemopoiesis

h. Hematoma

i. Ossification

2. From atoms to organ systems, list nature's levels of organization that we have covered so far in order.

3. You learned about three sections of tissue related to the skin: dermis, hypodermis, and epidermis.

a. List them starting with the outermost section and ending with the innermost section.

b. Which section contains dead cells?

c. Which section contains adipose tissue?

d. Which section has hair follicles, sebaceous glands, blood vessels, and nerves?

e. Which section is referred to by the word “subcutaneous?”

4. What is the purpose of the dermal papillae? What visible structures do they give rise to?

5. You are looking at a living cell and a dead cell, each from the skin. Which protein does the dead cell have a lot more of?

6. Which is a better means of identifying a specific person: DNA or fingerprints?

7. What chemical is responsible for the color of a person's skin? What do we call the cells that make it?

8. One person has dark skin, and another has light skin. Which person is more susceptible to sunburns?

9. What do squamous cells, hair, nails, and rhinoceros horns all have in common?

10. What glands are found associated with hair follicles, and what is the function of the substance they produce?

11. Compare the growth phases of eyelash hair to the growth phase of the hair on your head.

12. What are the four primary functions of the skeletal system?

13. What are the two types of bone marrow? What does each do?

14. In a long bone, where is each type of bone marrow found?

15. Which is made of bone: an epiphyseal plate or an epiphyseal line? Which is found in an adult?

16. What is the thin layer of tissue surrounding a bone called?

17. A scientist is studying bone with a microscope and draws what is shown on the right. Is she looking at compact bone or spongy bone?

18. The dark circles it the picture are channels in the bone tissue. What is found in those channels?

19. When a bone breaks, the body starts the healing process with a "quick fix" that holds the pieces of the bone together. As the healing continues, the "quick fix" shrinks. Which callus (internal or external) is the "quick fix."

20. Which type of joint has the widest range of motion?

21. If a joint allows bones to rotate around a fixed point, what kind of joint is it?

22. What are the three functions of synovial fluid?

23. What makes synovial fluid?

Chapter 11 Comprehension Check Questions

11.1 One muscle is contracting. Is its antagonist getting longer or shorter?

11.2 You are comparing two muscles. The first muscle has twice as many fascicles as the second. If the muscle cells are all roughly the same mass, which muscle is stronger?

11.3 In the International Space Station, astronauts spend months being weightless. They have exercise machines they use for more than two hours each day to work their muscles. Why?

11.4 A door is a kind of lever. You pull the door handle, providing effort. You can think of the weight of the door being mostly at its center. What kind of lever is a door?

11.5 A muscle contracts a small amount, but the load that it is moving travels much farther. What kind of lever system is being used?

11.6 A muscle contracts so that it moves a very heavy load with a small force. If the muscle and load both move up, what kind of lever system is being used?

11.7 As food moves through your intestine, it is pushed along by the contraction of muscles. What kind of muscles are contracting (skeletal, smooth, or cardiac)?

11.8 You are looking at muscle cells under the microscope. They are not striped. Does each cell have one nucleus or many?

11.9 You are looking at muscle cells under the microscope. You see stripes. What else should you look for to determine which of the three types of muscle tissue you are observing?

11.10 In a capillary, blood is flowing from right to left. Which side of the capillary is the vein on?

11.11 Blood in an atrium of the heart is oxygenated. Is it in the left or right atrium?

11.12 Oxygenated blood is flowing towards the heart. Is it in a vein or an artery?

11.13 Blood is in a vessel flowing through a one-way valve. Is it in a vein or an artery?

11.14 A doctor is looking at a patient's blood through a microscope. She sees no cells. What is she looking at?

11.15 A blood cell is biconcave. What is its job?

11.16 If you can't tell the shape of the cells under the microscope, what should you look for to determine which are the platelets and which are the white blood cells?

11.17 You are looking at blood from two different people. The first has a lot more white blood cells than the second. What's the most likely reason for that?

11.18 After a cell differentiates, can it use more of its DNA or less than it could use before?

Chapter 11 Review Questions

1. Define the following terms:

a. Superficial

b. Deep

c. Arteries

d. Veins

e. Capillary

f. Differentiation

2. Order the following things from superficial to deep: skeleton, skin, skeletal muscles.

3. A skeletal muscle is contracting. What is happening to its antagonist?

4. A person's biceps brachii muscle is currently at its maximum normal length. Is the person's arm being held straight or is it bent at the elbow?

5. Order the following from superficial to deep: perimysium, endomysium, epimysium

6. What structure in the muscle cell actually does the contracting? What is it made of?

7. If you work out a muscle and make it stronger, what has changed in the muscle cells? What does that do to the mass of the muscle?

8. A person has been sick for many weeks. He has been so sick that he couldn't get out of bed. When he finally gets out of bed, he finds it very difficult to walk, even though his sickness has nothing to do with his legs. Why? What is the term used to describe this?

9. Describe the positions of the load, effort, and fulcrum in each type of lever.

10. The muscle drawn in the figure on the left moves the leg at the hip joint in the direction shown by the arrow. What class of lever system is this?

11. What is the most common class of lever in the skeletal muscle system?

12. Which types of muscle have striations when they are viewed with a microscope?

13. Which types of muscles are involuntary?

14. What type of muscle is made of branched cells?

15. What type of muscle has one nucleus per muscle cell?

16. What color are your veins? Why do they appear blue through the skin?

17. Which is superficial: arteries or veins?

18. In what kind of blood vessel does the blood actually give its oxygen to the tissues?

19. Blood is coming into the heart after giving oxygen to the tissues. List the chambers of the heart that the blood flows through in order. Also, indicate when the blood goes to and comes back from the lungs.

20. Which is thicker, an artery or a similarly-sized vein? Which has one-way valves? Why?

21. What is the part of the blood that carries the macronutrients and other important chemicals called?

22. What are the three categories of things found in the cellular elements of the blood? What are their functions?

23. A blood cell has a nucleus. What kind of blood cell is it?

24. A blood cell is biconcave. What kind of blood cell is it?

25. What are the cell fragments in the blood called?

26. A blood cell has hemoglobin in it. What kind of blood cell is it?

Chapter 12 Comprehension Check Questions

12.1 Think about the body cavity that holds the lungs. As you are inhaling, is it getting larger or smaller?

12.2 You measured the vital capacity of both lungs. You might think that you could just take the number you got from the experiment and divide by 2, and that would be the vital capacity of each lung. However, that's not quite right. Why?

12.3 Smoking and/or lots of pollution can destroy alveoli. If a person loses a lot of alveoli, what happens to the amount of oxygen that his or her blood can get to the tissues?

12.4 When you have an infection in your respiratory system, your vocal cords can become inflamed, which makes them thicker. How does that affect the way your voice sounds?

12.5 Suppose you studied some interstitial fluid and then some lymph right before it is returned to the blood. Would you see any differences between the two fluids? If so, what differences would you see?

12.6 You are studying the efferent vessel and one afferent vessel in a single lymph node. In which vessel do you see the most fluid flow? In which do you see the most pathogens?

12.7 The popliteal lymph nodes (shown in the drawing on page 309) are swollen. Where is the infection that is causing the swelling?

12.8 You are looking at phagocytosis being done by a monocyte. Are you studying fluid from the lymphatic system or the circulatory system?

12.9 There are about 30 proteins in blood plasma that try to kill all foreign cells they encounter. Do they contribute to your innate immunity or your acquired immunity?

12.10 A pathogen is killed by an antibody. Was that a result of innate or acquired immunity?

12.11 As you learned, plasma B-cells can be thought of as artillery, while killer T-cells are infantry, and helper T-cells are generals. In this "army analogy," what cells would be considered the army's advanced warning system?

12.12 A specific kind of virus changes its antigens frequently. Would this be a good virus to fight with a vaccine?

12.13 If a person's thymus is not functioning properly. Will this mostly affect the innate immune response or the acquired immune response? Which cells of the immune system will be strongly affected?

12.14 You know that people who had their tonsils removed are more likely to have infections of the respiratory system. Would you expect such people to be more likely to have skin infections? What about stomach infections?

12.15 The spleen is doing a good job of cleaning the blood, but dead red blood cells start building up in the circulatory system. Which kind of tissue in the spleen is not doing its job?

Chapter 12 Review Questions

1. Define the following terms:

a. Tidal Volume

b. Residual Volume

c. Vital Capacity

d. Diffusion

e. Interstitial fluid

f. Innate immunity

g. Acquired immunity

h. Antibody

2. What is the major muscle used in breathing? Does it contract when you inhale or exhale?

3. What other muscles that you learned about are used in breathing?

4. What process causes oxygen to go into the blood that is entering the lungs while causing carbon dioxide to leave it?

5. What do the alveoli do in the lungs?

6. What does the epiglottis do? How do the vocal cords participate in that same job?

7. You are listening to two people talking. The first has a voice that is higher in pitch than the second. Which has thicker vocal cords?

8. One person is singing. She starts singing very low-pitched notes but then starts singing high-pitched notes. What happened to the tension in her vocal cords?

9. You are comparing three samples of fluid from the body. One sample is interstitial fluid. The second is lymph taken from the dead end of a lymph vessel. The third is lymph that is about to enter back into the circulatory system. How do these three fluid samples compare?

10. Compare the number of efferent lymph vessels to the number of afferent lymph vessels in a lymph node.

11. What do we call the cells that do phagocytosis in the lymph nodes?

12. What happens to the size of the lymph nodes near a part of the body that has an infection?

13. What does the germinal center of a lymph node do?

14. Label each of these body defenses as being part of your innate immunity or your acquired immunity: skin, B-cells, stomach acid (which kills bacteria in your food), antibodies, white blood cells that kill all pathogens, T-cells, chemicals in your blood that kill all pathogens they encounter, and mucus.

15. What kind of T-cell interacts with a macrophage to start the acquired immune response? What four kinds of cells does that cell cause to be produced?

16. What kind of B-cell allows you to be very resistant to a pathogen once you have been infected by that pathogen or once you have been given a vaccine against the pathogen?

17. What does a macrophage present in order to start the acquired immune response?

18. Can good sanitation explain the reduction in polio and the measles?

19. What does the thymus do?

20. What do the tonsils do?

21. What are the three functions of the spleen?

22. What does the appendix do?

23. What is a vestigial organ, according to macroevolution?

24. What organs from this chapter were thought by evolutionists to be vestigial?

25. What harm was caused by the idea that the tonsils and appendix were vestigial?

Chapter 13 Comprehension Check Questions

13.1 As you learned in Chapter 9, the salivary glands produce saliva that starts to break down polysaccharides into monosaccharides. Is that physical digestion?

13.2 When left outside, iron can react with the oxygen in the air to make iron oxide. However, this process happens much faster if the iron is wet. Rust is made of just iron and oxygen, so why is water necessary?

13.3 You had learned about a set of accessory digestive organs earlier in this chapter as well as earlier in this course. What are they?

13.4 When a ship carrying oil spills it in the ocean, the oil floats on top of the water and tends to stay together in one big mass. This concentrated oil can cause real problems for the wildlife. One way to deal with the problem is to put emulsifiers in the oil. What does that accomplish?

13.5 Suppose someone has an injury that destroys many of the villi in the small intestine. What would you expect to happen to the amount of nutrients that his or her body can absorb? How would that affect the gas and feces that comes out of the large intestine?

13.6 There is a disaccharide known as trehalose. What is the name of the enzyme that digests it?

13.7 Some fish live in rivers and lakes that are inside caves. Many are blind. Recently, a study showed that one kind of blind fish has eyesight genes that are identical to a similar kind of fish that isn't blind. If the genes are the same, what explains the lack of eyesight in the cave fish?

13.8 In Chapter 7, you learned about fecal transplants, a procedure meant to give someone a healthy mix of mutualistic bacteria. Where in the digestive system would that procedure be done?

13.9 It is very easy for the kidneys to remove Vitamin C from your blood, but it is more difficult for them to remove Vitamin E. Which of these two vitamins is more likely to cause health problems if you take in too much?

13.10 The cells in a nephron tubule pick up all of the potassium that is passing through the tubule. However, they allow a lot of sodium to pass through. Which ion was present in the blood at too high a concentration?

Chapter 13 Review Questions

1. Define the following terms:

a. Physical digestion

b. Chemical digestion

c. Peristalsis

d. Digestive tract

e. Accessory digestive organs

f. Emulsify

g. Concentration

2. Explain the different functions of the incisors, canines, and molars.

3. What teeth are the last ones to come in? What are they commonly called?

4. What are the four functions of saliva?

5. What is the wet ball of food that is swallowed called?

6. Describe what the soft palate and the epiglottis do when you swallow something.

7. If you were standing on your head and swallowed something, would it go to your stomach? Why or why not?

8. What are sphincters?

9. What do the gastric rugae allow the stomach to do?

10. For the mouth, esophagus, stomach, and small intestine, indicate whether chemical digestion, physical digestion, both, or neither happen in each.

11. In which organ of the digestive tract does most of the digestion take place?

12. For the mouth, esophagus, liver, stomach, pancreas, small intestine, gall bladder, and large intestine, indicate whether each is part of the digestive tract or an accessory digestive organ.

13. Why must the acid in the food be neutralized in the small intestine?

14. How are soap and bile similar? Why is that important for the digestion of fat?

15. What do the intestinal villi do for the absorption of nutrients in the small intestine?

16. What two things happen to the chyme when it reaches the large intestine?

17. The body uses the chloride ion for certain functions. Does that mean the kidneys will never take chloride from the blood? Why or why not?

18. One kind of physician is called a nephrologist. What does this doctor specialize in?

19. Compare how the kidneys clean blood to how some people clean out their junk drawer.

20. If your urine is unusually thin and not very yellow, have you been drinking more or less water than usual?

Chapter 14 Comprehension Check Questions

14.1 People with diabetes can develop a situation in which they can't feel things with their fingers, but they can move their fingers fine. What division of the peripheral nervous system has been damaged? What division is working properly?

14.2 Which of the three parts of the brain contributes most to reading this question and determining the answer?

14.3 Think about the state of your brain before you started this course and the state of your brain now. Assuming no major injuries or illnesses happened, what's the biggest difference between your cerebrum now and your cerebrum back then?

14.4 A man can move his arms, legs, and body. However, he has a difficult time standing up. What part of his brain is probably not working well?

14.5 In many comas, the person affected can't move or talk but can stay alive if the correct nutrients are put into his or her body. What part of the person's brain is probably working fine in this situation?

14.6 Without decussation, which hemisphere of the brain would control your right hand?

14.7 A man is in an accident and suffers a single cut in the spinal cord. Because of where the cut is, the spinal cord can't send signals from the brain to any peripheral nerves below the waist. In addition, the peripheral nerves below the waist can't send any information to the brain. Can the man consciously bend his leg at the knee? If the physician hits the man below the knee, will the leg move?

14.8 Suppose you look at something close, and it is very blurry. No matter what you do, you can't see it clearly. However, when you look at something far away, you can see it clearly. What part of each eye isn't working properly?

14.9 Natural gas (which many houses burn for heat and/or cooking) is made up of a chemical called methane. Your olfactory hairs cannot interact with that chemical in any way. However, if you have a natural gas leak in your house, you can smell it. How is that possible?

14.10 You eat some food and decide it needs some salt, so you add salt. Is the change in flavor that you experience mostly the result of taste bud activity or your sense of smell?

14.11 Based on what you learned in this section, why can very loud sounds damage your tympanic membrane?

14.12 You are shaking your head "no" in response to a question. Is that motion being sensed by nervous tissue in a semicircular canal or by nervous tissue in the vestibule?

14.13 Suppose there was a chemical that traveled in the bloodstream and was able to interact with *every* cell in the body. Could it be considered a hormone? Why or why not?

14.14 Suppose you wanted to block a signal that comes from the endocrine system. You could try to remove the chemical from the circulatory system, but you could also do something to the cells that receive the hormone signals. What could you do to the cells to stop the signal?

Chapter 14 Review Questions

1. Define the following terms:

a. Subconscious motor functions

b. Vital functions

c. Decussation

d. Brain lateralization

e. Reflex

f. General senses

g. Special senses

h. Taste buds

i. Hormones

2. What are the organs of the central nervous system? What are the divisions of the peripheral nervous system?

3. What are the three main parts of the brain, and what are their major functions?

4. What makes up the gray matter in the brain? What about the white matter?

5. What side of the brain controls the motor functions of the right hand?

6. List the parts of the body that tend to be dominated by one hemisphere of the brain.

7. While the brain sends most of the commands down the motor division of the peripheral nervous system, which kinds of commands are sent directly from the spinal cord?

8. The images in your eye appear upside down. Why don't you see the world upside down?

9. Where does the lens focus the light coming from the objects you are looking at?

10. How does the lens change the way it is focusing light?

11. What is the name of the tissue that holds the neurons which are sensitive to smell?

12. If something has no scent, what can you conclude about the chemicals it releases into the air?

13. What structures hold gustatory cells? Where are these structures found?

14. Your sense of taste mixes five basic sensations together to make all the flavors you taste. What are those five basic sensations?

15. What other special sense does your sense of taste depend on?

16. What two senses are controlled by the ear?

17. Explain what happens to the tympanic membrane, the ossicles, and the liquid in the cochlea when sound enters the external ear. How does that lead to the sense of hearing?

18. What two structures provide the sense of balance? Which tells the brain how the head is moving, and which tells the brain about the position of the head, even when it is not moving?

19. Compare signal speeds in the nervous and endocrine system as well as how long their effects last.

20. What two things are necessary for a cell to be able to respond to an endocrine system signal?

Chapter 15 Comprehension Check Questions

15.1 Is it possible for an organism to be neither a vertebrate nor an invertebrate? Why or why not?

15.2 A teacher shows you pictures of two organisms that each belong to the same order. She then shows you pictures of two organisms from the same phylum. Which set of two organisms are more likely to look very similar?

15.3 A student writes the name of the domestic dog as canis familiaris. While the words are correct, that's not the way to report the name. What is wrong with it?

15.4 Timber wolves belong to the species *C. lupus*. Given what you read in 15.3, what is the binomial name for those wolves?

15.5 Two scientists are estimating the populations of two different species. The first one captures 50 individuals the first time. They are marked and released. When more are captured, he gets 50 again, and 2 of the individuals are marked. The second scientist also captures 50 the first time. She marks and releases them. She then captures 50 more, and finds that 10 of them are marked. Which scientist is studying a species that is easier to capture?

15.6 In one study, the population of a species is determined to be 25,000. Another study says the population of that same species is 50,000. Neither can be shown to be wrong. Why?

15.7 Two species are known only from their fossils. One is a 15-foot tall dinosaur. The other is of a 4-inch long rodent. You are told both are extinct. Do scientists know this for sure? If not, which is the one that is more likely to actually be extinct, and why?

15.8 Suppose a disease kills all the predators for a specific prey. If no new predators come into the area, what will happen to the prey population over the next several generations?

15.9 In a community, one species of animal eats only plants. The other species eats only animals. In that community, which species will most likely have the larger biomass?

15.10 Many countries (like New Zealand) strictly forbid bringing in fruits from other countries. Why?

15.11 You are studying a forest that burned down a year ago. Prior to the fire, you had identified all the plants that grew there. Now, there are plant species in the forest that were never there before. How did they become a part of the forest?

15.12 Some small insects live in termite mounds, eating the termite's wastes. The termites are just as healthy whether or not the insects are in the mound. What kind of symbiosis is this?

15.13 Tapeworms can live in the intestines of an animal, absorbing nutrients that the animals intestines would normally absorb. What kind of symbiosis is this?

Chapter 15 Review Questions

1. Define the following terms:

a. Vertebrate

b. Invertebrate

c. Extinction

d. Predator

e. Prey

f. Biomass

g. Symbiosis

h. Commensalism

i. Parasitism

2. Name two things that people have in common with animals. What is the main thing that makes people different from animals?

3. Name the three domains in biology's classification system and what puts an organism into each.

4. What is the order of all the levels of classification, starting with the broadest?

5. Two organisms are randomly selected from a given class, and two other organisms are randomly selected from a family. Which two are likely to be the most similar?

6. The domestic cat is classified in domain Eukarya, kingdom Anamalia, Phylum Chordata, class Mammalia, order Carnivora, family Felidae, genus *Felis*, and species *F. catus*. What is the domestic cat's binomial name? A tiger's scientific name is *F. tigris*. Give the complete classification of a tiger.

7. How can scientists disagree about the populations of animals, even after they have been measured?

8. Explain the mark and recapture method of measuring a population. You don't have to discuss the math. Just explain what happens in it and what the marked individuals allow you to estimate.

9. What is responsible for the extinction of the Passenger Pigeon and the Dodo bird?

10. Why should you be at least a bit skeptical when you are told that a species is extinct?

11. Is it possible to save a species from becoming extinct?

12. Why are some scientists worried about the population of polar bears, while others are not?

13. What does genetic diversity do for a population that is facing changes in its surroundings?

14. If the number of predators in a community grows, what will happen to the number of prey?

15. Draw an ecological pyramid and label the trophic levels. What do the widths represent?

16. Why do countries limit what plants and animals can be brought in from foreign countries?

17. After a community is destroyed, what kinds of organisms are the first to start a new community?

18. Give an example of each kind of symbiosis. Explain why it is considered that kind of symbiosis.

19. How can parasitism be part of a creation that was made by God?

Chapter 16 Comprehension Check Questions

16.1 In your field study, I asked you to concentrate on things you could see, hear, and smell. However, there was one part of the physical environment in the ecosystem you studied that you could not see, and you probably did not smell or hear it. What was it?

16.2 You can actually make oxygen a liquid if you cool it down to a temperature of -183 degrees Celsius (-297 degrees Fahrenheit). Suppose someone poured liquid oxygen on a fire. Would it put out the fire like water does? Why or why not?

16.3 Acid rain is produced when rain encounters air pollution while it is falling from the clouds. Is the problem of acid rain in the U.S. greater than, less than, or the same as it was in 1990?

16.4 If people stopped burning fuel, would the concentration of pollutants like SO_2, NO_2, and CO in the air drop to zero? Why or why not?

16.5 A man says that he has performed a nuclear fission experiment where a neutron and lead nucleus (which has 82 protons) make uranium (92 protons) and oxygen (8 protons). Is this possible?

16.6 If you are studying an area and you think it is composed of two separate ecosystems, what should you compare to determine whether or not they really are different ecosystems?

16.7 When a lake has been frozen for a long time, it is common for lots of fish to die. The fish don't die from the cold or from not being able to eat. What do they die from?

16.8 A bird spends most of its time in the woods, eating fruit that is found on the bushes there. However, it does fly over meadows from time to time, especially when it is moving between two woodland areas. It never stops in the meadows, and it never eats anything from them. It only flies over them. Nevertheless, it causes the woodland and meadow ecosystems to interact. How?

16.9 You are looking at a picture of a large area that is covered with plants, but there are hardly any trees or woody plants, and there is no standing water. However, you are told that the area gets plenty of rain. Without any more information, what possible biomes could this area be a part of?

16.10 You are looking at a picture of a snow-covered landscape that has no visible plants. The snow is not deep. Without any more information, what possible biomes could you be looking at?

16.11 A friend of yours has an elaborate aquarium with many fish. Without asking your friend, what could you do to see whether or not the fish come from a marine biome?

16.12 The scientific community devotes a lot of effort into trying to find out whether or not there was ever a lot of water in its liquid phase on Mars. Why is that an interesting question?

16.13 A few of the planets that have been discovered seem to be in the habitable zone of the star that they orbit. Does that mean there is life on them? Why or why not?

16.14 One way to reduce the buildup of carbon dioxide in the atmosphere is to reduce how much fuel we burn, because that would reduce how much carbon dioxide is being put in the air. However, there is another way to reduce the buildup of carbon dioxide. What is it?

16.15 Lead can be damaging to the human nervous system. There is lead in the water of many homes, but not at the concentration necessary to produce harmful effects. But the lead shouldn't be there to begin with, so why don't we take steps to remove it, regardless of the concentration?

16.16 The problem with Biosphere 2 was that the microscopic consumers were using up too much oxygen. Why couldn't the problem be solved by just killing a lot of those microscopic consumers

Chapter 16 Review Questions

1. Define the following terms:

a. Atmosphere

b. Troposphere

c. Biodegradable

d. Forest biome

e. Grassland biome

f. Tundra biome

g. Desert biome

h. Freshwater biome

i. Marine biome

2. An ecosystem consists of a community of organisms doing what?

3. What makes up the majority of the air you breathe? What gas has the next highest percentage?

4. Why is too much oxygen in the air you are breathing normally a bad thing?

5. What has happened to the level of pollutants in the atmosphere over the past few decades? What caused that to happen?

6. Since burning fuels pollutes the atmosphere and increases the concentration of carbon dioxide in the atmosphere, why do we still generate electricity that way?

7. What do we call the process that nuclear power plants use to produce energy? Explain what it is.

8. Can a nuclear power plant explode like an atomic bomb? If not, is there some other problem that can happen?

9. If nuclear power is so dangerous, why is it used?

10. How do we typically distinguish between ecosystems? Is this an easy thing to do? Why or why not?

11. What is the Great Pacific Garbage Patch? Where does the garbage mostly come from?

12. What is the most likely reason perchlorate has been found in milk that people drink?

13. What do we call the area between biomes where they interact?

14. Is it possible to find the same species of animal in a freshwater biome and a marine biome?

15. You see an area with grasses and no trees. The grass is sparse, however, and you see few animals. What two questions should you ask to determine the biome?

16. When astronomers look at other planets, how do they determine whether or not it is possible for the planet to be warm enough to support life?

17. How does the rate at which a planet spins affect its temperature?

18. Why is the greenhouse effect a good thing?

19. What greenhouse gas worries many scientists? Why?

20. Is the buildup of carbon dioxide in the atmosphere warming the planet too much?

21. At what time period on earth was it most likely warmer than it is today?

22. Why is it dangerous to enact policies that increase the cost of electricity?

23. One way to reduce the carbon dioxide levels in the atmosphere is to stop burning as much fuel. What is another way?

24. When you want to decide on a course of action, what kind of analysis should you do? What determines whether or not you should definitely take the action?

25. What was Biosphere 2? What is Biosphere 1?

Documenting Experiments

The problem with learning things is that you can forget them pretty easily. As a result, it is important to document what you learn. That way, you can always go back later and review the material. When it comes to documenting what you learned by taking this course, you answer questions and take tests. How do you document what you learned in an experiment? By recording important aspects of the experiment in your laboratory notebook.

Start your record by writing the number and title of the experiment. Then write "Data:" underneath the title. That's how you should start to document every lab you do. You should write the experiment number and its title. Underneath, you should write "Data:" to indicate that what follows will be all the data you collect from the experiment.

What are the data you collect in an experiment? Those are your *observations*. Every experiment has data, because every experiment requires you to make observations as the experiment progresses. So under "Data:" you should list every observation you make. Each new observation should be written underneath the previously-made observation. Some experiments require more than just observations. Some require measurements. If the experiment instructions tell you to measure how long something is, that measurement is also considered data and should be written down along with your observations.

Each piece of data needs to have a short explanation regarding when you collected it in the experiment. That allows you to remember what you did right before you made the observation. It doesn't need to be a long explanation. It just needs to be a short note that will help remind you of what was done right before the observation was made.

The data section of each lab report, then, contains the quick notes you make while you are doing the experiment. They help remind you what you saw at each important step in the experiment. You write these things down while you are doing the lab so that they are fresh in your mind.

But that's not all you need to do to document your lab. So far, I have discussed things you write down *while you are doing the lab*. Once the lab is over, you need to finish documenting it. How do you do that? You add another section to your lab report that is labeled "Summary:". In that section of the lab, you write your own summary of what you did. It should not be a step-by-step listing of the instructions, and it *cannot* be a copy of the lab instructions that are in the book. Instead, it needs to be your "story" about what you did in the experiment.

Once you have finished your summary, there is one more section you need to add. Label this section "Conclusions:", and it should contain a discussion of what you were supposed to learn by doing the experiment. This is actually easy, because I always explain that after the experiment. So all you have to do is give that same explanation, but in your own words. Once you've done that, you are finished documenting your lab.

While this might seem like a lot of work, it's important for three reasons. First, it gives you something you can review later so that you can remember what you learned. Second, when you write something out in your own words, you think through it. As a result, you learn it better. Finally, there are times where you have to actually show evidence that you did experiments. Most universities, for example, require that students do experiments as a part of their high-school science courses. If you apply to a university, the people who decide whether or not you can come to the university might ask you to demonstrate that you did experiments. A lab notebook is exactly what they are looking for.

Now remember, the main goal for doing this is so that you can go back and review it later to recall what you did, what you saw, and what you learned. However, it is also possible that you will need to use this report to give evidence that you did laboratory work in your science course. Since that's one of the goals, you need to write your report so that someone who has never seen the book can understand what you did and what you learned. Obviously, just reading the data section will be confusing to someone who doesn't have access to the instructions, but that's why you add a summary after the data. It helps someone who has not read the book to understand what you did, what you saw, and what you learned.

Now please understand that there is no standard among science courses regarding how you should document your labs. Some high school science courses require you to write at least a few of your experiments the way you would write about them in a scientific journal. This is usually called a "formal laboratory report."

I don't think students in middle school and high school should do those kinds of reports. First, most students who take science will never actually write such a report in real life. As a result, it seems like a waste of time for most students. More importantly, the way you write a formal lab report changes depending on the kind of science you are doing. As a nuclear chemist, for example, the papers that I have published in the scientific literature follow a completely different format than the papers my wife (a biophysicist) has published in the scientific literature. In my opinion, you should determine what kind of science you will be doing before you start worrying about writing a formal laboratory report.

Other science courses want you to follow the scientific method when you document your lab work. They want you to start your report with a hypothesis and end your report with a conclusion about whether or not your hypothesis was confirmed. I don't see that as reasonable for most situations involving students. After all, that's not what you are doing. You aren't making or testing a hypothesis. You are simply following my instructions. Also, when you make a hypothesis, you should design your experiment to address the hypothesis. Making a hypothesis for an already-designed experiment is backwards when it comes to the scientific method.

If you follow my method for documenting your labs, you will practice the most important aspect of laboratory work: making a record of what you did, what you saw, and what you learned. No matter what kind of science you end up doing, you will have to do that. Thus, by getting experience documenting labs in this way, you will be honing a skill that you will use if you pursue any kind of science.

This is important, since a scientist's laboratory notebook can become a legal document. If you discover something new and need to demonstrate that you were the one who discovered it, you can do that with your laboratory notebook. In addition, if someone disputes what you have concluded based on your experiments, your laboratory notebook can be used to resolve that dispute. In the end, then, getting used to properly documenting your experiments is an important part of science education.

Laboratory Notebook