Chapter 4: Cell Theory and Cell Study

A. THE CELL THEORY. The cell is the basic unit of structure and function of living things. Hundreds of years of cell study have given us information about the cell known as the cell theory. The cell theory states that:

The Cell Theory

- The cell is the basic unit of structure of all living things. This means that all living things are made up of cells. The smallest living things are one-celled or unicellular. Large organisms contain millions of cells. They are many-celled or multicellular.

- The cell is the basic unit of function of all living things. Therefore, all of the organism’s life functions are carried out by cells or parts of cells.

- Cells arise (come) from other living cells—not from nonliving matter.

REVIEW QUESTIONS

1. The cell is the basic unit of _______ structure _______ and _______ function _______ of living things.

2. List the three parts of the cell theory.

   The cell is the basic unit of structure of all living things.

   The cell is the basic unit of function of all living things.

   Cells arise (come) from other living cells not from nonliving matter.

B. EXCEPTIONS TO THE CELL THEORY. As scientists continued to study the cell they discovered facts that could not be explained by the cell theory. These unexplained facts are called exceptions to the cell theory. Two exceptions to the cell theory are:

Exceptions To The Cell Theory

- Viruses are not made up of cells. They do contain genetic material. Viruses reproduce inside another cell called the host cell.

- The first cell could not have arisen from a previously existing cell. Scientists do not know the origin (beginning) of the first cell.
1. State two exceptions to the cell theory.

*Viruses are not made up of cells.*

*The first cell could not have arisen from a previously existing cell.*

C. HISTORY OF CELL STUDY. Scientists did not know much about cells until the discovery of the microscope. Cells are so small they cannot be seen without a microscope. Once the microscope was developed many scientists made important contributions to our knowledge of the cellular nature of living things. Some of the most important contributions to the cell theory are listed in Table 2-1.

<table>
<thead>
<tr>
<th>SCIENTIST</th>
<th>CONTRIBUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anton van Leeuwenhoek</td>
<td>A Dutch naturalist who worked in the 1600’s. He is credited with the development of the first simple microscope. This microscope was just a single lens but it enabled him to examine drops of pond water. He drew pictures of the organisms he saw. These observations were thought to be the first drawings of microscopic light.</td>
</tr>
<tr>
<td>Robert Hooke</td>
<td>An Englishman who, in 1665, put two lenses together and made a crude compound microscope. Through this microscope he observed thin slices of cork. He saw tiny box-like structures that reminded him of rooms, or cells, in a monastery. He called them “cells.” What he really saw were cell walls.</td>
</tr>
<tr>
<td>Robert Brown</td>
<td>A very important discovery was made in England in 1831. Robert Brown noticed a small round structure inside a plant cell. He named this structure the nucleus.</td>
</tr>
<tr>
<td>Matthias Schleiden</td>
<td>About the same time that Brown was working in England Schleiden, a botanist, was studying plant tissue in Germany. He concluded that all plants were made up of cells.</td>
</tr>
<tr>
<td>Theodor Schwann</td>
<td>A German scientist who was studying animal cells at the same time that Schleiden was working with plant cells. Schwann reported that all animals were made up of cells.</td>
</tr>
<tr>
<td>Rudolf Virchow</td>
<td>In 1858 he formulated the idea that all new cells must come from other previously existing cells.</td>
</tr>
</tbody>
</table>

**TABLE 2-1. THE HISTORY OF CELL STUDY.**
1. What instrument had to be developed before cells could be studied? **microscope**

2. The first simple microscope was developed by **Laeuwenhoek**

3. The first compound microscope was made by **Hooke**

4. Why did Hooke name the box-like structures “cells”? He saw tiny box-like structures that reminded him of rooms, or cells, in a monastery.

5. What part of the cell was Hooke actually observing? **cell wall**

6. The nucleus was named by **Brown**

7. State Schleiden’s contribution to the cell theory.
   **He concluded that all plants were made up of cells.**

8. What was Schwann’s contribution to the cell theory?
   **Schwann reported that all animals were made up of cells.**

9. What was Virchow’s contribution to the cell theory?
   **He formulated the idea that all new cells must come from other, previously existing cells.**

**D. THE COMPOUND LIGHT MICROSCOPE.** Because the cell is so small various tools and techniques (procedures) are needed so that the cell can be seen. The microscope used most commonly for cell study is called the **compound light microscope**. It increases the apparent size of materials making them easier to study. For study with this microscope the **specimen** (material being viewed) must be thin enough for light to pass through it easily. Compound microscopes have two lenses or systems of lenses. Light passing through a specimen then passes through the **objective lens**. The enlarged **image** (picture) produced by the objective lens is magnified again by the **ocular** or **eyepiece lens**. The final image appears enlarged (made bigger) and upside down and backward (Figure 4-1).
The parts and the functions of each part of the compound microscope are shown in Figure 4-2.

**FIGURE 4-2. THE COMPOUND LIGHT MICROSCOPE.**

1. The microscope most commonly used for cell study is called the **compound microscope**.
2. The compound light microscope increases the apparent size of materials making them easier to study.

3. The material being viewed is called the specimen.

4. Name the two lenses of the compound microscope: objective lens and the ocular or eyepiece lens.

5. Describe the final image of the compound microscope: enlarged, upside down, and backward.

6. Complete the following chart.

<table>
<thead>
<tr>
<th>PART</th>
<th>FUNCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eyepiece</td>
<td>Magnifies or enlarges image.</td>
</tr>
<tr>
<td>Objectives</td>
<td>Magnifies of enlarges image.</td>
</tr>
<tr>
<td>Diaphragm</td>
<td>Controls amount of light passing through specimen.</td>
</tr>
<tr>
<td>Coarse Adjustment</td>
<td>Used for rough focus.</td>
</tr>
<tr>
<td>Fine Adjustment</td>
<td>Used for fine focus.</td>
</tr>
<tr>
<td>Arm</td>
<td>Used for carrying microscope.</td>
</tr>
<tr>
<td>Clips</td>
<td>Holds slide on stage.</td>
</tr>
</tbody>
</table>

E. STAINING TECHNIQUES. Many parts of the cell are almost colorless and are hard to distinguish from other cell parts. Staining techniques have been developed to “color” certain cell parts so that they are more easily studied with the compound light microscope. The most commonly used stains are iodine and methylene blue.

REVIEW QUESTIONS

1. Staining techniques have been developed to add _______ color _______ to certain cell parts.

2. Name two commonly used laboratory stains. iodine and methylene blue
F. THE DISSECTING MICROSCOPE. The dissecting microscope (Figure 4-3) allows you to study large specimens that cannot be easily seen with the compound light microscope. It has two eyepieces and two objective lenses. The lower magnification, usually from 5X to 50X, and three-dimensional quality are useful in performing dissections. This microscope is used to examine specimens that are small, but can be seen by the unaided eye. This microscope is also called the stereo-microscope.

**FIGURE 4-3. DISSECTING MICROSCOPE.**

**REVIEW QUESTIONS**

1. When would you use a dissecting microscope?
   
   **To study large specimens that cannot be easily seen with the compound light microscope.**

2. Compare the number of lenses and eyepieces of the dissecting microscope and the compound microscope.
   
   **Dissecting microscope has two eyepieces and two objective lenses. The lower magnification is usually from 5X to 50X. Compound microscope has one eyepiece and two objective lenses. The lower magnification is usually 100X and the higher magnification is 400 to 500X.**

3. Why is the dissecting microscope useful in performing dissections?
   
   **Its three-dimensional quality are useful in performing dissections.**

G. THE ELECTRON MICROSCOPE. Electron microscopes can produce magnifications of more than 100,000X. These microscopes use a narrow beam of electrons instead of light. The electron beam is focused by sets of magnets instead of lenses. Specimens to be viewed in an electron microscope must be embedded in plastic and cut into very thin slices. This special preparation is a disadvantage because live specimens cannot be viewed. However, because of its high magnification, the electron microscope allows biologists to see the internal structure of the cell.

**REVIEW QUESTIONS**

1. The magnification of the electron microscope is ________ more than 100,000X ________.

2. Instead of light the electron microscope uses ________ a narrow beam of electrons ________.
3. Name one disadvantage of the electron microscope.

Live specimens cannot be viewed.

H. THE ULTRACENTRIFUGE. The ultracentrifuge is an instrument that is used to separate cell parts according to density (Figure 4-4). The material to be separated is whirled around in a test tube at very high speeds. The heaviest parts settle to the bottom of the test tube, the next to heaviest form the next layer, and so on. The lightest material collects as the top layer.

--- REVIEW QUESTIONS ---

1. The centrifuge is an instrument used to separate cell parts according to density.

--- REVIEW QUESTIONS ---

I. MAGNIFICATION IN CELL STUDY. When you use the microscope it is important to understand how it magnifies and its use as a measuring tool for small objects. In a compound microscope each lens magnifies, or enlarges, the image. To determine the total magnification produced by the microscope the magnifying power of the objective lens is multiplied by the magnifying power of the eyepiece lens. For example, if the eyepiece lens has a magnifying power of 10X, or 10 times, and the objective lens has a magnifying power of 10X the total magnifying power of the microscope is 100X. If the magnifying power of the eyepiece is 10X and the magnifying power of the objective is 40X the total magnifying power of the microscope is 400X. Total magnification refers to the total amount that the image is enlarged.

\[
\text{EYEPiece POWER} \times \text{OBJECTIVE POWER} = \text{TOTAL MAGNIFICATION}
\]

\[
10X \times 40X = 400X
\]

--- REVIEW QUESTIONS ---

1. Total magnification is the total amount that the image is enlarged.
2. To find the total magnification of a microscope, multiply the magnifying power of the objective lens by the magnifying power of the eyepiece lens.

3. A 10X eyepiece and a 50X objective would produce an image that is 500X. 

4. If the total magnification is 100X, and the eyepiece power is 5X, what is the power of the objective? 20X.

J. MEASUREMENT IN CELL STUDY. Objects viewed through the microscope are very small and cannot be measured with the standard units of length used to measure larger objects. The unit of length used to measure microscopic specimens is the micrometer (µ m) or the micron (µ). One thousand microns (micrometers) is equal to one millimeter.

REVIEW QUESTIONS

1. The unit of length used for microscopic measurement is the micrometer or micron.

2. One thousand microns equals one millimeter.

CAREER OPPORTUNITIES

MICROBIOLOGIST: A microbiologist is a life scientist who works with organisms that are so tiny that they must be seen under a microscope. These scientists do research on bacteria, yeasts, and other microorganisms. They isolate and make cultures of microorganisms, identify their characteristics, and observe their reactions to chemicals and other kinds of stimuli. They use special methods and equipment such as compound microscopes, electron microscopes, centrifuges, glass tubes, and slides.

Education and training requirements differ according to the type of job. Laboratory technicians in microbiology need a high school diploma and at least a two year associate degree. Other jobs require a bachelor's, master's or doctoral degree.

REVIEW QUESTIONS

1. Name one career opportunity for people who like to work with microscopes.

microbiologist (others)
CHAPTER 4: QUIZ

A. FILL-IN QUESTIONS

DIRECTIONS: Complete each of the following statements by writing the correct word or phrase in the space provided.

1. The basic unit of structure and function of living things is called the _________ cell _________.
2. Cells come from other living cells not from _________ nonliving _________ matter.
3. Viruses contain genetic material and can _________ reproduce _________.
4. Leeuwenhoek developed the first _________ simple microscope _________.
5. The cell was named by _________ Hooke _________.
6. Robert Brown named the _________ nucleus _________.
7. The microscope used most commonly for cell study is called the _________ compound microscope _________.
8. The material to be seen under to microscope is called the _________ specimen _________.
9. Light passing through a specimen first passes through the _________ objective _________ lens.
10. The position of the final microscope image is enlarged, upside down, and _________ backwards _________.
11. The _________ diaphragm _________ of the microscope controls the amount of light that enters the microscope.
12. The microscope used to study large specimens is called the _________ dissecting microscope _________.
13. The electron microscope uses _________ electrons _________ instead of lenses.
14. The instrument used to separate cell parts according to density is the _________ centrifuge _________.
15. In the compound microscope, images are enlarged by the _________ lenses _________.
16. The _________ total _________ amount that the image has been enlarged is called _________ total magnification _________.
17. Microscopic specimens are measured in units called _________ microns or micrometers _________.
18. The microscope lens located at the top of the microscope is the _________ eyepiece (ocular) _________.
19. The concept that all animals are made up of cells was reported by _________ Schwann _________.
20. The word unicellular means _________ one-celled _________.

B. MULTIPLE-CHOICE QUESTIONS

DIRECTIONS: Circle the number of the expression that best completes each of the following statements.

1. If a wet-mounted specimen is to be viewed with a compound microscope the specimen should be
   (1) taken from an aquatic environment   (3) glued to the slide
   (2) placed on top of the eyepiece   (4) thin enough to let light pass through it

2. Which statement is not a part of the cell theory?
   (1) Cells are the basic unit of structure of living things.
   (2) All cells are multicellular.
   (3) Cells are the basic unit of function of living things.
   (4) Cells come from other living cells.
3. A laboratory project required students to estimate the width of a piece of human hair with the microscope. Which unit of measurement would be most appropriate?
   (1) inches
   (2) millimeters
   (3) feet
   (4) meters

4. In a compound microscope, the lens located closest to the slide is the
   (1) objective
   (2) nosepiece
   (3) eyepiece
   (4) mirror

5. In the diagram at the right, which part of the microscope would a student have to adjust to change from low power to high power?

(1) A
   (2) B
   (3) C
   (4) D

6. Which of the following scientists first observed and named the cell?
   (1) Robert Brown
   (2) Matthias Schleiden
   (3) Robert Hooke
   (4) Theodor Schwann

7. Which part of the microscope controls the amount of light that passes through a specimen?
   (1) eyepiece
   (2) objective lens
   (3) diaphragm
   (4) fine-adjustment knob

8. Adding stain to a specimen on a slide helps to
   (1) cause cells to absorb water.
   (2) make cell structures easier to see.
   (3) make the cover glass stick to the slide.
   (4) cause more light to pass through the specimen.

9. Which organisms are noncellular?
   (1) protozoans
   (2) algae
   (3) trees
   (4) viruses

10. Which of the following instruments will produce the greatest enlargement of a specimen?
    (1) compound light microscope
    (2) dissecting microscope
    (3) electron microscope
    (4) centrifuge

C. ESSAY QUESTION

DIRECTIONS: Use complete sentences to answer the question in this part.
1. State one way that the microscope is used in the field of medicine.

Answers vary.
Chapter 5: Cell Structure and Function

A. ORGANELLES. There are many small structures located inside the cell. These structures are called organelles, which means “little organs”. These tiny structures perform certain functions that keep the cell (and the organism) alive. Some organelles are found only in animal cells and others are located only in plant cells. Most organelles, however, are found in both plant and animal cells (Figure 5-1).

![Diagram of an animal cell and a plant cell with labeled parts]

**FIGURE 5-1. STRUCTURE OF ANIMAL AND PLANT CELLS.**

**REVIEW QUESTIONS**

1. The small structures located inside the cell are called ___________ organelles ___________.

2. List six organelles found in both plant and animal cells.

   See Figure 5-1.

   ____________________________________________
   ____________________________________________
   ____________________________________________
the molecule to be taken in (Figure 5-3). This folded in section of the cell membrane then pinches off inside the cell forming a vacuole. In phagocytosis the cell surrounds and engulfs large undissolved particles by flowing around them and enclosing them in a vacuole.

**REVIEW QUESTIONS**

1. Describe the cell membrane. **A doubled-layered structure that surrounds the cell. Membranes are selectively permeable. Some substances can pass through it and others cannot.**

2. Explain the following terms:
   - passive transport **The passage of materials through the cell membrane without the use of energy by the cell.**
   - diffusion **The movement of molecules or ions from an area of high concentration to an area of low concentration.**
   - equilibrium **The particles become evenly distributed in the space and there is no further net change in concentration.**
   - osmosis **The diffusion of water through a membrane.**
   - active transport **A process in which cellular energy is used to move particles through a membrane.**
   - pinocytosis **Large dissolved molecules are taken into the cell by the formation of vacuoles. The cell membrane forms an indentation containing the molecule to be taken in.**
   - phagocytosis **The cell surrounds and engulfs large undissolved particles by flowing around them and enclosing them in a vacuole. Some substances can pass through it and others cannot.**

C. **CYTOPLASM.** The watery cell fluid that contains the cell organelles is called the cytoplasm. The cytoplasm is located between the cell membrane and the nucleus. Many life processes take place in the cytoplasm. The cytoplasm exists in two different phases—a watery (sol) phase and a thicker (gel) phase.

**REVIEW QUESTIONS**

1. Cytoplasm is the watery cell fluid that contains **the cell organelles**

2. Where is the cytoplasm located? **Between the plasma membrane and the nucleus.**

3. Describe the two phases of cytoplasm. **The cytoplasm exists in two different phases: a watery (sol) phase and a thicker (gel) phase.**
D. NUCLEUS. The **nucleus** is a large round structure located inside the cytoplasm of the cell (Figure 5-4). It is surrounded by its own membrane, called the **nuclear membrane**, and it contains other organelles (chromosomes and nucleoli). Cell activities are controlled by the nucleus. The **nucleolus** is located in the nucleus. It is involved in the production of ribosomes.

![Figure 5-4. Nucleus.](image)

**REVIEW QUESTIONS**

1. Where is the nucleus located? **Inside the cytoplasm of the cell.**
2. The function of the nucleus is to **control cell activities.**
3. What is the function of the nucleolus? **It is involved in the production of ribosomes.**

E. CHROMOSOMES. The **chromosomes** are long threadlike structures located in the nucleus of the cell. They contain heredity information organized as genes. **Genes** are hereditary units made up of DNA that control cell activities and may be passed on to the next generation.

**REVIEW QUESTIONS**

1. The chromosomes contain **heredity** information.
2. What is a gene? **Genes are hereditary units made up of DNA that control cell activities and may be passed on to the next generation.**

F. MITOCHONDRIA. **Mitochondria** are the organelles involved in cellular respiration (Figure 5-5). They are called the “powerhouses” of the cell. Mitochondria contain materials necessary for respiratory reactions. It is here that energy is released in the cell. Without the constant supply of energy produced by respiration the cell would die.

There are two types of respiration carried out by living cell known as aerobic respiration and anaerobic respiration. **Aerobic respiration requires oxygen** to aid in the release of energy. Aerobic respiration releases more energy per molecule of food than anaerobic respiration.

![Figure 5-5. Mitochondrion.](image)
Cells of most complex animals and plants carry on aerobic respiration. The word equation for aerobic respiration is:

\[
\text{enzymes} \\
\text{SUGAR} + \text{OXYGEN} \rightarrow \text{ENERGY} + \text{CARBON DIOXIDE} + \text{WATER}
\]

This equation tells you that during aerobic respiration the organism combines sugar (food) and oxygen, in the presence of enzymes, to make energy that the organism uses for its life processes. In addition to energy the organism makes carbon dioxide and water that are either used by the organism or excreted from the cells into the environment.

Anaerobic respiration or fermentation does not require oxygen. A small amount of energy is produced along with carbon dioxide and either alcohol or lactic acid. The word equation for anaerobic respiration is:

\[
\text{enzymes} \\
\text{SUGAR} \rightarrow \text{ENERGY} + \text{CARBON DIOXIDE} + \text{ALCOHOL or LACTIC ACID}
\]

---

**Review Questions**

1. What is the function of the mitochondria? **Mitochondria are the organelles involved in cellular respiration. They are called the “powerhouses” of the cell.** Mitochondria **contain enzymes necessary for respiratory reactions. It is here that energy is released in the cell.**

2. Mitochondria are called the ______ powerhouses ______ of the cell.

3. The two types of respiration are ______ aerobic ______ and ______ anaerobic ______.

4. Another name for anaerobic respiration is ______ fermentation ______.

5. Which type of respiration releases more energy? ______ aerobic ______.

6. Write the word equation for aerobic respiration.

\[
\text{enzymes} \\
\text{SUGAR} + \text{OXYGEN} \rightarrow \text{ENERGY} + \text{CARBON DIOXIDE} + \text{WATER}
\]

7. Write the word equation for anaerobic respiration.

\[
\text{enzymes} \\
\text{SUGAR} \rightarrow \text{ENERGY} + \text{CARBON DIOXIDE} + \text{ALCOHOL or LACTIC ACID}
\]

8. Fermentation produces energy and ______ either alcohol or lactic acid ______.
G. ENDOPLASMIC RETICULUM. Materials are transported throughout the cell by a system of channels or canals called the endoplasmic reticulum (ER). Chemical reactions take place on the surface of the endoplasmic reticulum. In some places it has a rough surface and in other places it is smooth. The rough surface is due to the presence of ribosomes. Cells making proteins contain a large amount of rough endoplasmic reticulum (Figure 5-6).

![Figure 5-6. Endoplasmic Reticulum](image)

--- REVIEW QUESTIONS ---

1. The function of the endoplasmic reticulum is **transport**.

2. Name the two kinds of endoplasmic reticulum. **In some places it has a rough surface and in other places it is smooth.**

H. RIBOSOMES. Proteins are synthesized (made) at the ribosomes. They may be attached to the endoplasmic reticulum or free in the cytoplasm.

--- REVIEW QUESTIONS ---

1. The ribosomes synthesize **proteins**.

2. Ribosomes are located on the **endoplasmic reticulum** and in the **cytoplasm**.

I. GOLGI COMPLEX. The Golgi complex or apparatus is a stack of membrane-bounded channels and vacuoles. They synthesize (make), package, and secrete cell products (Figure 5-7).

![Figure 5-7. Golgi Complex](image)

--- REVIEW QUESTIONS ---

1. The Golgi complex **synthesize**, **package** and **secrete** cell products.
J. VACUOLES. Vacuoles are sac-like structures used by the cell to store various materials including water, wastes, and food. They are located in the cytoplasm. Plant cell vacuoles are bigger than those found in animal cells.

**Review Questions**

1. Vacuoles are located in the **cytoplasm** and are used by the cell for **storage of** various materials including water, wastes, and food.

K. LYSOSOMES. Membrane-bounded sacs, called lysosomes, contain digestive enzymes. They are involved in food digestion in one-celled animals. Lysosomes destroy damaged or old cell parts or cells in multicellular animals. Although they have been seen only in animal cells, plant cells are now thought to have a similar organelle.

**Review Questions**

1. Digestive enzymes are found in the **lysosomes** of the cell.

L. CHLOROPLASTS. The organelles involved in the manufacture of food (photosynthesis) are called chloroplasts (Figure 5-8). They are located in the cytoplasm and contain the green pigment chlorophyll. Also present are enzymes (organic catalysts) that are necessary for food-making reactions. Inside the chloroplasts are stacked disks called grana. It is in the grana that chlorophyll is held and light energy for photosynthesis is trapped. The spaces inside the chloroplasts contain a protein-containing fluid called stroma.

The pigments in chloroplasts can be separated and identified by a laboratory technique called paper chromatography. This process involves putting a drop of plant extract along one edge of a square of absorbent paper. The paper is then dipped into a solvent. The solvent moves up the sheet because of capillary attraction. As the solvent moves the substances in the drop of plant extract are carried along at different rates that are unique to each substance. Because of this movement the different substances separate at distinct places on the sheet of paper thus forming what is called a chromatogram. Each substance can then be identified by comparing its position with the positions occupied by known substances under the same conditions.

Chloroplasts are also found in one-celled organisms called algae. Because algae are not multicellular they are not classified as plants but as protists. Green plant cells and algae make their own food by the process of photosynthesis. This process involves a series of complex chemical reactions that use light as an energy source. Photosynthesis provides food for green plants and algae. The food that is manufactured by photosynthesis is also used by other living things.
Photosynthesis involves chemical reactions in which carbon dioxide and water are converted into sugar. Energy for cell activities is stored in sugar. Oxygen gas is a by-product of this reaction. In addition to light, photosynthesis needs chlorophyll and enzymes (organic catalysts) which aid the reaction. Enzymes are necessary for all cell reactions. The word equation for photosynthesis is:

\[
\text{CARBON DIOXIDE + WATER} \xrightarrow{\text{enzymes and light}} \text{chlorophyll} \rightarrow \text{SUGAR + OXYGEN + WATER}
\]

This equation tells you that the plant combines carbon dioxide and water in the presence of enzymes, light, and chlorophyll to produce sugar (food), oxygen, and water. The sugar is used by the organism as a source of energy and the oxygen is used for its respiration. Excess oxygen is released into the air and is used by animals for respiration. Water is released into the environment.

**REVIEW QUESTIONS**

1. What is the function of the chloroplast? **It is involved in the manufacture of food (photosynthesis).**
2. The green pigment in chloroplasts is called **chlorophyll**.
3. Why aren’t algae classified as plants? **Because algae are not multicellular they are not classified as plants.**
4. Photosynthesis is the process by which **green plant cells and algae make their own food**.
5. The energy source for photosynthesis is **light**.
6. Write the word equation for photosynthesis.

\[
\text{CARBON DIOXIDE + WATER} \xrightarrow{\text{enzymes and light}} \text{chlorophyll} \rightarrow \text{SUGAR + OXYGEN + WATER}
\]

7. Why do scientists use chromatography? **To separate and identify the pigments in chloroplasts.**

**M. CENTRIOLES.** These structures are found mainly in animal cells. They look like cylinders and are located in pairs near the nucleus. Centrioles are involved in cell division.

**REVIEW QUESTIONS**

1. The centrioles are **cylindrical** in shape and are located near the **nucleus** in **animal** cells. They are involved in the process of **cell division**.
N. CELL WALL. The cell wall is the stiff outer layer of plant cells. It surrounds the cell membrane and its contents. Cell walls are composed of a nonliving material called cellulose. The stiffness of the cell wall limits the plant's growth and movement. The cell wall gives the plant its shape (Figure 5-9).

**Review Questions**

1. Describe the cell wall. The stiff outer layer of plant cells. It surrounds the cell
   membrane and its contents. Cell walls are composed of a nonliving material called
   cellulose.

2. Cellulose is a nonliving material.

O. COMPARISON OF PLANT AND ANIMAL CELLS. Most cell organelles are found in both plant and animal cells. However, there are some structural differences between a typical animal cell and a typical green plant cell. Table 5-1 compares the structural similarities and differences between the two types of cells.

<table>
<thead>
<tr>
<th>ORGANELLE</th>
<th>GREEN PLANT</th>
<th>ANIMAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plasma Membrane</td>
<td>present</td>
<td>present</td>
</tr>
<tr>
<td>Cytoplasm</td>
<td>present</td>
<td>present</td>
</tr>
<tr>
<td>Nucleus</td>
<td>present</td>
<td>present</td>
</tr>
<tr>
<td>Chromosomes</td>
<td>present</td>
<td>present</td>
</tr>
<tr>
<td>Mitochondria</td>
<td>present</td>
<td>present</td>
</tr>
<tr>
<td>ER</td>
<td>present</td>
<td>present</td>
</tr>
<tr>
<td>Ribosomes</td>
<td>present</td>
<td>present</td>
</tr>
<tr>
<td>Golgi Complex</td>
<td>present</td>
<td>present</td>
</tr>
<tr>
<td>Vacuoles</td>
<td>large</td>
<td>small</td>
</tr>
<tr>
<td>Lysosomes</td>
<td>present</td>
<td>present</td>
</tr>
<tr>
<td>Centrioles</td>
<td>absent</td>
<td>present</td>
</tr>
<tr>
<td>Chloroplasts</td>
<td>present</td>
<td>absent</td>
</tr>
<tr>
<td>Cell Wall</td>
<td>present</td>
<td>absent</td>
</tr>
</tbody>
</table>

**Table 5-1. Comparison and Animal Cells.**

**Review Questions**

1. Name two structures that are found only in plant cells. See Table 5-1.
2. Name one structure that is found only in animal cells.

See Table 5-1.

3. Name five structures that are found in both plant and animal cells.

See Table 5-1.

P. CELL SPECIALIZATION. Certain cells in multicellular organisms do certain jobs. This is called cell specialization. Examples of specialized cells are shown in Table 5-2.

<table>
<thead>
<tr>
<th>CELL TYPE</th>
<th>FUNCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cell Blood Cells</td>
<td>Carry oxygen to body cells.</td>
</tr>
<tr>
<td>Muscle Cells</td>
<td>Move parts of organism.</td>
</tr>
<tr>
<td>Nerve Cells</td>
<td>Carry impulses (messages) throughout organism.</td>
</tr>
<tr>
<td>Xylem and Phloem Cells</td>
<td>Transport materials throughout plants.</td>
</tr>
</tbody>
</table>

TABLE 5-2. SPECIALIZED CELLS.

REVIEW QUESTIONS

1. Name two specialized cells and state the function of each. See Table 5-2.
Q. CELL ORGANIZATION. In multicellular organisms cells are grouped together into units or levels. These specialized units perform similar functions. Groups of cells make up tissues and groups of tissues form organs. Organs working together make systems and systems make up organisms. Plants and animals are examples of organisms.

- **Cells.** The cell is the basic unit of structure and function of all living things.
- **Tissues.** Groups of similar cells performing the same function are called tissues. Muscle tissue and blood tissue are examples of tissues.
- **Organs.** A group of specialized tissues performing one main function is known as an organ. Examples of organs are the stomach and kidney.
- **Systems.** A group of organs that carry on one of the major body function is known as a system. Examples of some major body systems are digestive and nervous systems.
- **Organism.** An organism is made up of systems that perform its life functions. Plants and animals are examples of organisms.

---

**REVIEW QUESTIONS**

1. A group of cells performing the same function is known as a _______ tissue _______.

2. A group of organs working together to perform the same function is called a _______ system _______.

3. Systems make up units called _______ organisms _______.

4. List and define the levels organization of living systems beginning with the simplest unit and ending with the most complex unit.
   - **Cells:** The cell is the basic unit of structure and function of all living things.
   - **Tissues:** Groups of similar cells performing the same function are called tissues.
   - **Organs:** A group of specialized tissues performing one main function is known as an organ.
   - **Systems:** A group of organs that carry on one of the major body function is known as a system.
   - **Organism:** An organism is made up of systems that perform its life functions.
CHAPTER 5: QUIZ

A. FILL-IN QUESTIONS

DIRECTIONS: Complete each of the following statements by writing the correct word or phrase in the space provided.

1. Cell activities are controlled by the __________ nucleus ________ of the cell.
2. The double-layered structure surrounding all cells is called the _______ plasma membrane ______.
3. The _______ Golgi complex ________ synthesizes and secretes cell products.
4. The part of the cell where life processes take place is the _______ cytoplasm ________.
5. Similar cells are grouped together to form _______ tissues ________.
6. _______ Genes ________ are hereditary units made up of DNA.
7. The organelles involved in the manufacture of food are called _______ chloroplasts ________.
8. The cell stores wastes in structures called _______ vacuoles ________.
9. Oxygen is needed during _______ aerobic ________ respiration.
10. Materials are transported around the plant by _______ xylem ________ and _______ phloem ________ cells.
11. _______ Organelles ________ are small structures located inside the cell.
12. Nerve cells carry _______ impulses ________.
13. Osmosis involves the movement of _______ water ________ across a semipermeable membrane.
14. Materials are moved across cell membranes by the process of _______ diffusion ________.
15. One-celled green organisms are called _______ algae ________.
16. _______ Cellulose ________ is the nonliving material found in cell walls.
17. Plants make food during the process of _______ photosynthesis ________.
18. Cell respiration takes place at the _______ mitochondria ________.
19. The pair of structures involved in animal cell division are called _______ centrioles ________.
20. Proteins are made at the _______ ribosomes ________.

B. MULTIPLE-CHOICE QUESTIONS

DIRECTIONS: Circle the number of the expression that best completes each of the following statements.

1. Which organisms contain chlorophyll in their cells?
   (1) algae ____________________________ (3) grasshoppers
   (2) earthworms ________________________ (4) tapeworms

2. The stiff outer part of a plant cell is the
   (1) nucleus ____________________________ (3) cell membrane
   (2) cytoplasm __________________________ (4) cell wall

3. By which life process does a leaf produce sugar?
   (1) respiration ________________________ (3) transpiration
   (2) excretion __________________________ (4) photosynthesis
4. Which structure controls the movement of materials into and out of the cell?
   (1) cell wall
   (2) cell membrane
   (3) chloroplast
   (4) vacuole

5. What process is taking place if an organism produces alcohol from a sugar solution?
   (1) fermentation
   (2) locomotion
   (3) growth
   (4) reproduction

6. A group of specialized tissues performing one main function is known as
   (1) an organ
   (2) an organism
   (3) a cell
   (4) a system

7. The movement of perfume molecules throughout a room is an example of the process of
   (1) respiration
   (2) synthesis
   (3) diffusion
   (4) fermentation

**Directions (8-9):** Base your answers to questions 8 and 9 on the diagrams below that represent two cells observed under a microscope.

8. Which cell structure is involved with the production of food?
   (1) A
   (2) B
   (3) C
   (4) E

9. Which cell structure directs the function of the other cell parts?
   (1) A
   (2) B
   (3) C
   (4) E

**10. Which process is represented by the following equation?**

\[
\text{CARBON DIOXIDE + WATER } \xrightarrow{\text{light}} \text{ SUGAR } + \text{ OXYGEN } + \text{ WATER }
\]

(1) reproduction
(2) photosynthesis
(3) respiration
(4) digestion

**C. ESSAY QUESTION**

**DIRECTIONS:** Use complete sentences to answer the question in this part.

1. Describe one occupation where a knowledge of the cell would be useful.

**Answers vary.**