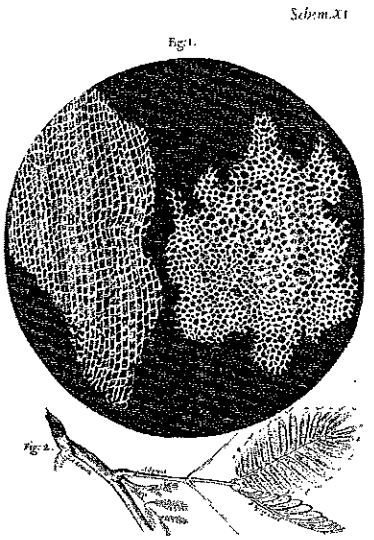
Review 4

Structure, Function, and Development in Organisms

In 1665, Robert Hooke peered through his microscope at a very thin slice of bark from a cork tree. He saw tiny little chambers arranged next to each other. These reminded him of the small cells in which monks lived, so he called them **cells.** The image below is the first drawing showing the cells in a biological specimen, drawn by Hooke. The discovery of the cell changed the way scientists approached the study of life. Previously, it was thought that four fluids, called humors, ran throughout the world and combined to make all matter, including organisms. After Hooke's discovery, however, scientists eventually learned that all organisms are composed of cells. This review looks at how these little machines of life organize themselves to form the complex systems of living things.

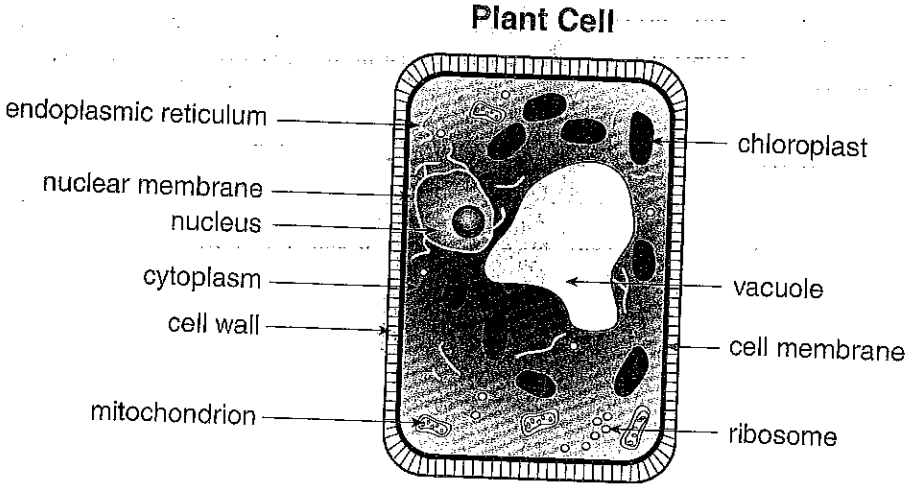


Words to Know

- cell
- cell membrane
- cell wall
- chloroplast
- cytoplasm
- endoplasmic reticulum
- homeostasis
- hormone
- metamorphosis
- mitochondrion
- nuclear membrane
- nucleus
- organ
- organ system
- organelle
- ribosome
- tissue
- vacuole

Cells

Multicellular organisms, such as plants and animals, are made of many cells. These cells, in turn, contain many tiny structures called **organelles**. Each organelle has a special form and purpose in the operation, maintenance, repair, and reproduction of the cell. The basic parts of a plant cell are shown in the following diagram.



The following list briefly explains the function of each labeled component.

Endoplasmic reticulum: transports materials within the cell

Nuclear membrane: encloses and protects the nucleus

Nucleus: control center for all cell activity; contains chromosomes, which carry the genes that help the organism reproduce

Cytoplasm: clear, thick fluid that holds all the components of a cell

Cell wall: the outer, nonliving cellulose structure that helps the plant cell keep its shape

Mitochondria: organelles that release energy to support all cell activity

Chloroplasts: organelles that contain chlorophyll used by plants in photosynthesis

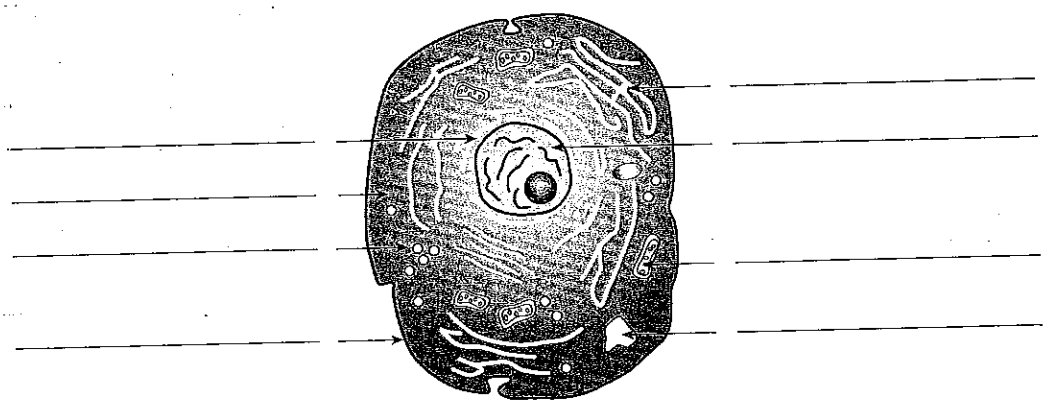
Vacuoles: cavities inside the cytoplasm that contain fluid and pigment (coloring)

Cell membrane: semipermeable membrane that controls movement of molecules in and out of the cell

Ribosomes: organelles that contain the enzymes that help produce proteins

Animal cells have a lot in common with plant cells. Use the list of plant cell components to label the following animal cell. (Two components of plant cells are not found in animal cells.)

Animal Cell



Why don't animal cells need chloroplasts?

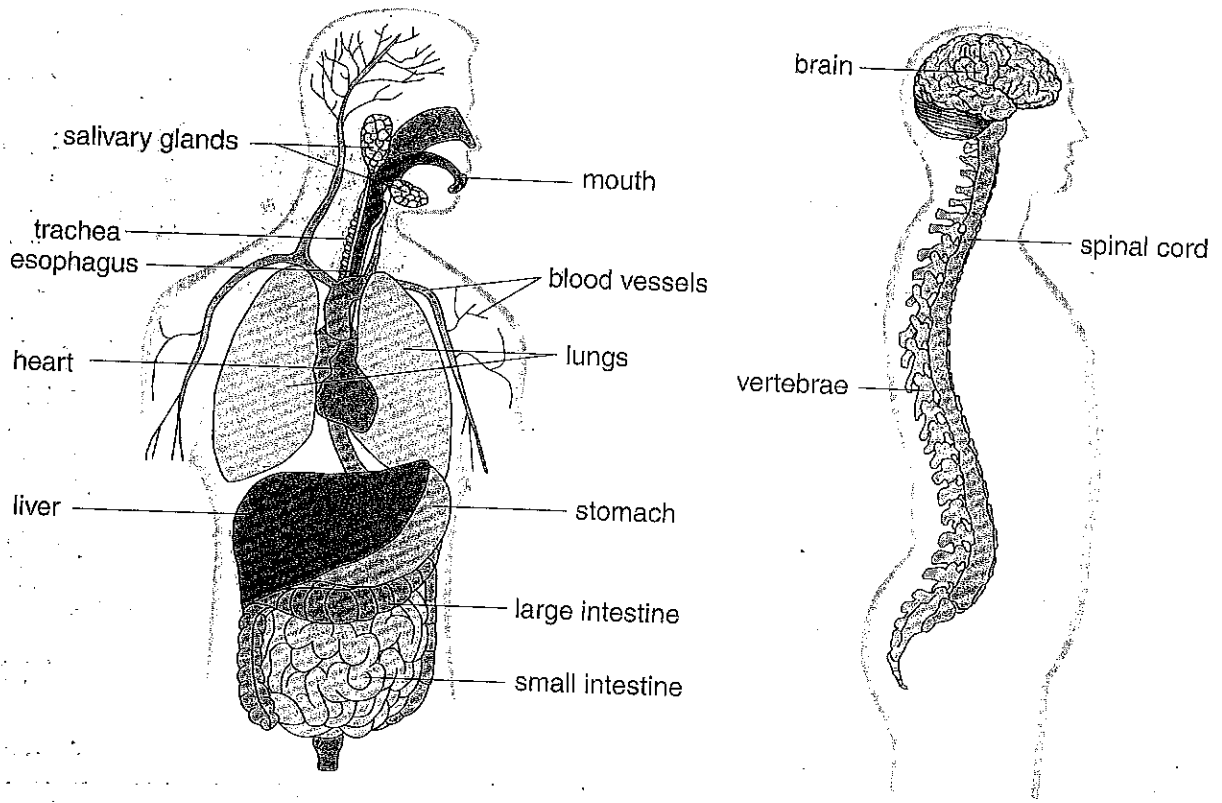
Why is it important for plants to have cell walls? (**Hint:** Do plants have skeletons?)

Organ Systems

Cells that do the same job work together to form body **tissues**. Each body tissue is made of a specific type of cell that has a particular function. For example, muscles are made of muscle cells that have the ability to contract and relax. Groups of tissues form **organs** with specific functions. Organs, in turn, work together in **organ systems**. Each function that humans and most other animals must do to stay alive (breathing, eating, thinking, and so on) is made possible by groups of specialized cells arranged into tissues, organs, and organ systems.

Let's look at the organ systems within the human body. As you study organ systems, you'll notice that you can't think about one system without thinking about at least one other system, too. The systems are closely related, and the body depends on them all working well together. In the muscular system, for example, individual muscle cells in muscle tissues contract and expand

to perform a function. But the muscular system is helpless without the skeletal system. The skeletal system houses and protects important muscles. It also gives the muscular system a framework with which it can move the body. The nervous system controls the actions of the muscular and skeletal systems, allowing us to direct our movements. The nervous system also controls the flow of information in the body, processing all of the stimuli that come in from the senses.



The digestive system begins with the jaws, teeth, and tongue. As the jaws and teeth grind up the food, salivary glands in the tongue start breaking it down into molecules that the body can use. The esophagus takes the food to the stomach, where acid breaks it down into liquid. This liquid moves to the small intestine, which extracts from the liquid as many nutrients as it can. The liver also plays a role in the digestive process, producing a chemical that breaks down fats.

The heart, the blood, and the blood vessels make up the circulatory system. The circulatory system works closely with the respiratory system, which consists of the windpipe and the lungs. What is the relationship between the two systems? To get energy from food nutrients, all cells need a constant supply of oxygen. The process that releases this energy also makes carbon dioxide, a toxic substance that our body must get rid of. The circulatory and respiratory systems work together to supply oxygen to and remove carbon dioxide from the blood.

Aurelie claims that the heart belongs to the circulatory, respiratory, and muscular systems. Is she correct? Why?

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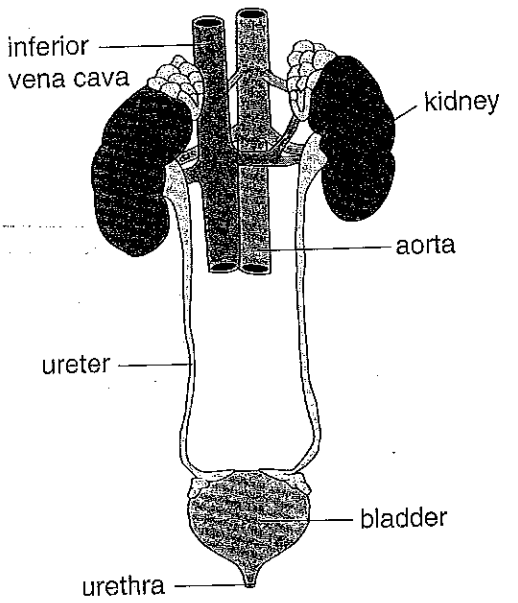
Wastes from the digestive and circulatory systems are gathered by the excretory system and discharged from the body. The main organs involved in excretion are the kidneys. The kidneys bring in and filter toxic substances from the blood. The filtered blood is released back into the body, and the unwanted substances turned into a liquid called urine. The ureters carry urine from the kidneys to the bladder, where it is stored until it can be released.

Excretory System



How are the digestive system and excretory system related?

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Give another example of related body systems and explain how they are related.

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The endocrine system is controlled by the hypothalamus, a part of the brain that controls the glands that produce hormones. **Hormones** are chemicals that travel in the bloodstream to different parts of the body. Hormones have many functions: They stimulate growth, regulate body temperature, help with digestion, and so on. Among other glands, the hypothalamus controls the pituitary gland. The pituitary gland is sometimes called the "master gland" of the human body because it produces so many different kinds of hormones. One important task of the endocrine system is to regulate the reproductive system. In humans, the reproductive system typically becomes mature (physically capable of producing offspring) between the ages of 12 and 16.

Homeostasis

When you think of an organism interacting with its environment, you might first think of the external environment—the air, water, and/or land in which the organism lives. But an organism must also respond to changes inside itself, called its internal environment. In general, organisms must keep their internal environments fairly stable. Take the human body as an example. The human body works best when its temperature is around 37° C. If a human body gets too warm, it releases some of that heat by sweating. If a human body gets too cold, it produces more heat for itself by shivering. The ability to maintain a constant internal environment is called **homeostasis**. (*Homeo-* means "steady" and *stasis* means "state.")

Name two other internal conditions to which your body responds.

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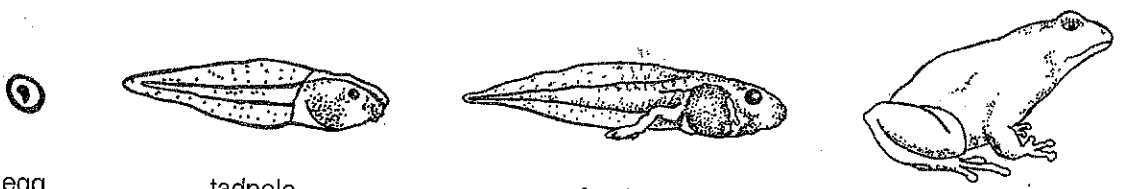
Life Cycles

After a multicellular organism is born, it must grow to become an adult. In some animal species, the young do not resemble the adults. These animals must change forms entirely to become adults. This kind of change is called **metamorphosis**. Amphibians, such as frogs, undergo metamorphoses. Female frogs lay eggs in water. When the egg hatches, a tadpole emerges. Tadpoles are young frogs, but they don't look much like adults. Tadpoles swim with a tail fin and breathe underwater using gills. To become adults, the tadpoles undergo a metamorphosis by losing their tail fins and developing lungs and legs.

Life Cycle of a Frog



egg tadpole froglet frog

In the spring, many frogs lay their eggs in ponds that dry up during the summer. What advantage does metamorphosis provide in such a situation?

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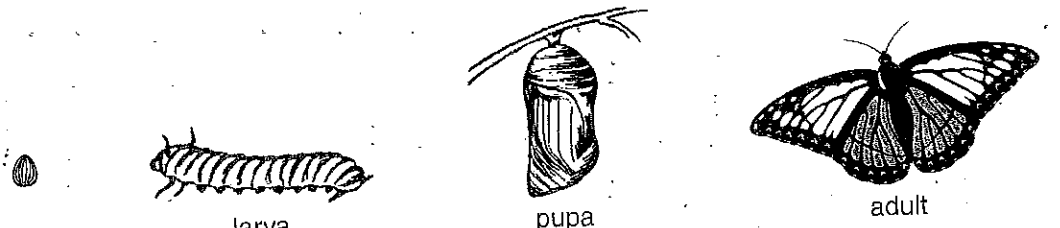
Many insects undergo a metamorphosis from a larval phase to an adult phase. Butterfly larvae are called caterpillars. Caterpillars eat leaves and store energy for metamorphosis and adulthood. When the time comes for metamorphosis, caterpillars turn into pupae and surround themselves in a cocoon. Inside the cocoon, the pupa changes into a butterfly with wings.

Life Cycle of a Butterfly



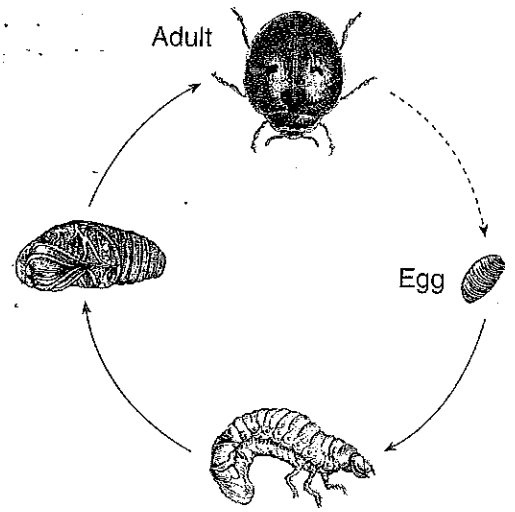
egg larva pupa adult

Caterpillars of the same species are often found far from each other on the leaves of different plants. What advantage does metamorphosis provide in this situation?

Keys to Keep

- **Cells are the building blocks of life.**
- **Multicellular organisms have levels of organization: cells, tissues, organs, and organ systems.**
- **Organ systems work together to perform life functions.**
- **Homeostasis refers to an organism responding to internal conditions.**
- **Some animals undergo metamorphoses to become adults.**

NJ ASK Practice



1. Which process does the diagram illustrate?

   A. homeostasis
   B. metamorphosis
   C. mitosis
   D. reproduction

2. The human body has levels of organization that scientists order from least complex to most complex. Which of the following is the most complex?

   A. cell
   B. organ
   C. tissue
   D. organ system

3. Juan was looking at plant and animal cells under the microscope. Which cell component would Juan see only in a plant cell?

   A. nucleus
   B. cell wall
   C. mitochondrion
   D. cell membrane

4. Which of the following is an example of homeostasis?

   A. A bird breathes faster because of increased physical activity.
   B. A dog gives birth to a litter of pups.
   C. A mammoth is frozen in ice.
   D. A spider stores its food in a cocoon.

5. What is the purpose of the endocrine system in the human body?

   A. to fight off disease
   B. to expel wastes
   C. to regulate hormones
   D. to move bones

6. Which of the following correctly matches the cell component with its function in the cells of multicellular organisms?

   A. cytoplasm—fluid that holds cell components
   B. mitochondria—control center for all cell activity
   C. nucleus—releases energy to power cell activity
   D. vacuole—helps to produce cell proteins

7. Amanda is investigating how oxygen moves through the body. What two organ systems will she find working together to move oxygen to all the cells in the body?

   A. reproductive and muscular systems
   B. endocrine and excretory systems
   C. respiratory and immune systems
   D. circulatory and respiratory systems

8. Describe one way in which the life cycle of a frog and the life cycle of a cat differ from each other.