6.5 Multicellular Organisms Meeting Their Needs

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Go to Nelson Science

As a living thing, you have needs that must be met every day. You need to eat and breathe. You also need to respond to things in your environment. You answer your teacher when she calls your name in class and you pull your hand away from something that feels hot. You also need to be able to move from place to place. Almost all multicellular organisms, from small to large, have these needs (Figure 1).

Figure 1 Cats (a) and bears (b) have to meet the same needs every day.

Systems Working Together

It is important that all systems within a multicellular organism work together. For example, oxygen and nutrients are materials that cells need to survive. The respiratory, digestive, and circulatory systems work together to meet this need. The respiratory system supplies oxygen to blood cells and the digestive system supplies nutrients. The circulatory system then pumps the oxygen- and nutrient-rich blood to all the cells of the body. Cells use the nutrients and oxygen to produce energy. During this process, cells release carbon dioxide as a waste product. The carbon dioxide diffuses out of the cells of the body and into blood cells. The blood cells are then transported to the lungs by the circulatory system, where carbon dioxide can be exhaled from the body.

Like a chain, which is only as strong as its weakest link, an organism is only as strong as its weakest system. For example, the circulatory system depends on at least two other organ systems (respiratory and digestive systems) in order to do its job properly. If one of these organ systems is not doing its job well, the whole organism can be affected.

Nutrition

Animals are unable to make their own food and must survive either by consuming living things (such as fruits, vegetables, and meat) or by consuming products that come from living things (such as eggs and honey). Food material must be broken down into nutrients that the cells of the body can absorb and use for energy.

Nutrition in Humans

In humans, food is taken into the body and broken down by a digestive system made up of specialized organs and tissues. Food enters the mouth, where it is broken down into smaller pieces by the teeth. Cells in the mouth release chemicals that help with this breakdown. Swallowing moves the food into the esophagus.

Muscle cells lining the walls of the esophagus help push food down into the stomach. Cells in the stomach release chemicals that further break down the food. Stomach muscles contract and relax, moving food into the intestines. In the intestine, the nutrients are absorbed into the blood vessels of the circulatory system and are transported to other parts of the body. Undigested food is passed out of the anus as waste (Figure 2).

The cells of the body use these nutrients for energy and pass wastes into the blood for removal from the body. These wastes pass through the kidneys and are eliminated as urine. Each cell involved in this process has a unique task that is necessary for digestion.

LINKING TO LITERACY

Visualizing

As you read, you can remember and understand informational text by picturing the description or explanation in your mind. With a partner, share and compare your visualizations.

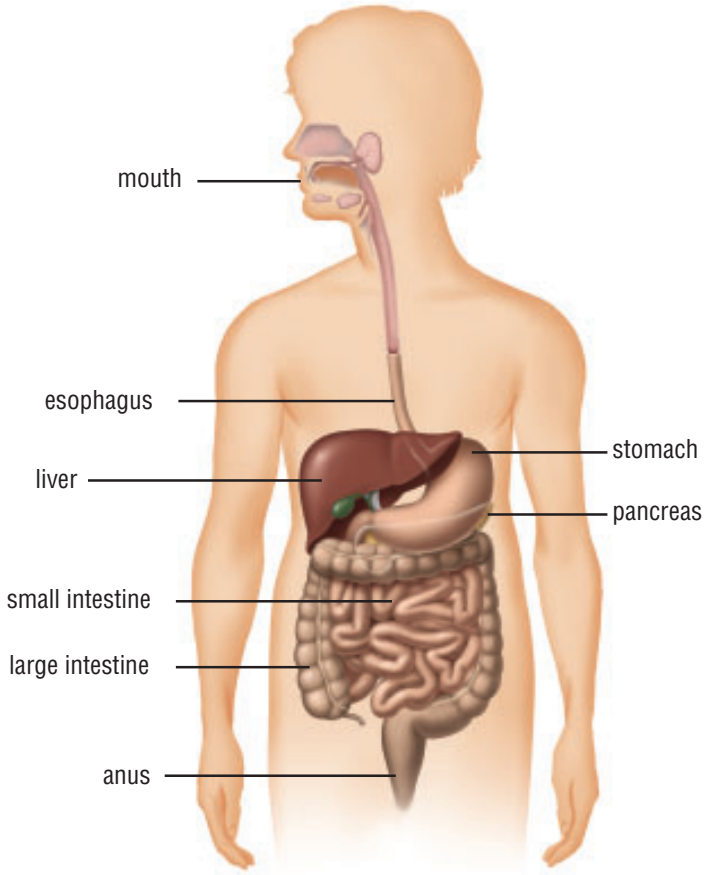

Figure 2 Each part of the human digestive system has a unique task that is needed to complete digestion of food material.

Nutrition in the Earthworm

The earthworm (Figure 3) has a small mouth leading to a pharynx. Earthworms "suck" in food using the pharynx. The esophagus then pushes food into the crop, an organ that moistens and stores food. A specialized stomach called the gizzard contains particles of sand and gravel that help break down tough foods. In the intestine, chemicals further break down the food into nutrients that can be absorbed into the cells of the body. Undigested food is passed through the anus as waste.

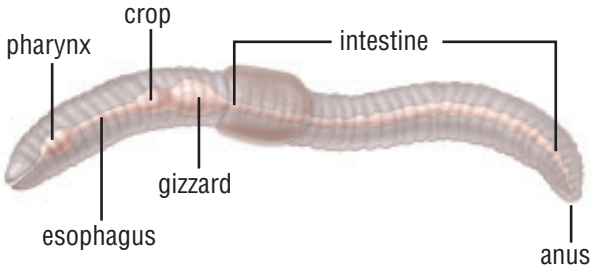

Figure 3 The digestive system of an earthworm

Nutrition in Plants

Plants cannot hunt for nutrients as animals do. Instead, they obtain nutrients directly from their environment. Plants use roots to absorb water and nutrients from the soil. Special tube-like tissues called **xylem vessels** then transport the water and minerals from the roots to other parts of the plant. When water is absorbed by the roots, it is carried up through the shoot system to the leaves of the plant. The plant leaves use sunlight, carbon dioxide, and water to make food by photosynthesis. Other tube-like tissues called **phloem vessels** located outside the xylem transport food from the leaves to the rest of the plant. Excess sugars are transported to the stems and roots for storage. Figure 4 shows xylem and phloem tissues in a plant.

xylem vessels: a system of tubes in a plant that transports water and minerals from the roots to the shoots and leaves

phloem vessels: a system of tubes in a plant that transports nutrients (such as dissolved sugars) from the leaves to the rest of a plant

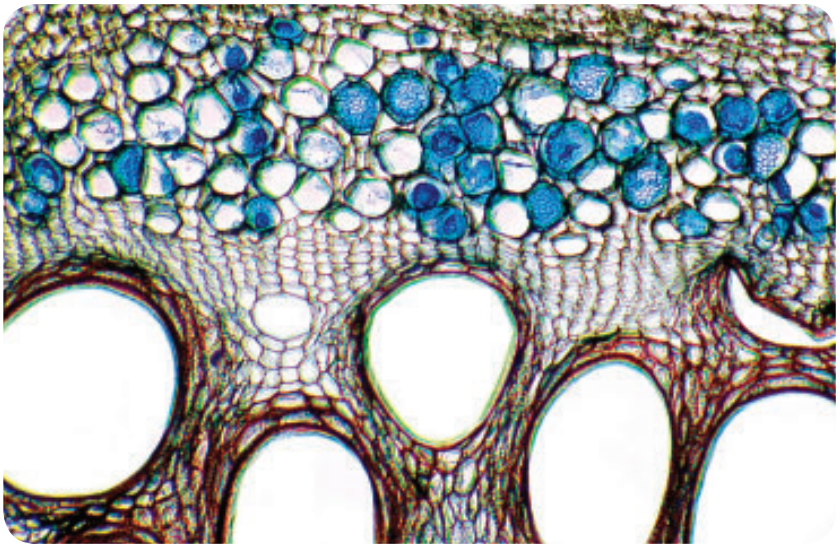

Figure 4 Cross-section of a cucumber stem showing xylem (large white spaces) and phloem (small white and blue spaces)

Gas Exchange

Small multicellular organisms use diffusion to obtain oxygen. For example, the earthworm uses its moist skin to exchange gases with the outside air. Some aquatic organisms, like fish, pass oxygen-rich water through gills, where it diffuses into blood capillaries. Most land animals use lungs for gas exchange. In all cases, oxygen is absorbed from the environment, and carbon dioxide is removed from the blood. The dissolved gases are transported in the blood.

Gas Exchange in Vertebrates

In humans, air is inhaled through the mouth and nose and passes into the trachea (Figure 5). A flap-like structure in the trachea opens when you breathe, but closes when you swallow food. This prevents food from entering the trachea and lungs. Air travels down the trachea into the lungs. In the lungs, tubes called bronchi branch off into smaller tubes called bronchioles. At the end of the bronchioles are round sacs of alveoli, where gas exchange occurs. The walls of the alveoli are only one cell thick. This allows oxygen to diffuse out of the cells of the alveoli and into the blood cells. The circulatory system transports the oxygen-rich blood cells to the rest of the body. As blood circulates throughout the body, oxygen diffuses out of the blood cells and into the cells of the body.

In the same way, carbon dioxide diffuses out of the body cells and into the blood cells. Blood cells are carried to the alveoli. Carbon dioxide diffuses out of the blood cells and into the alveoli. The carbon dioxide then travels through the bronchioles, bronchi, and trachea. It is removed from the body when you exhale.

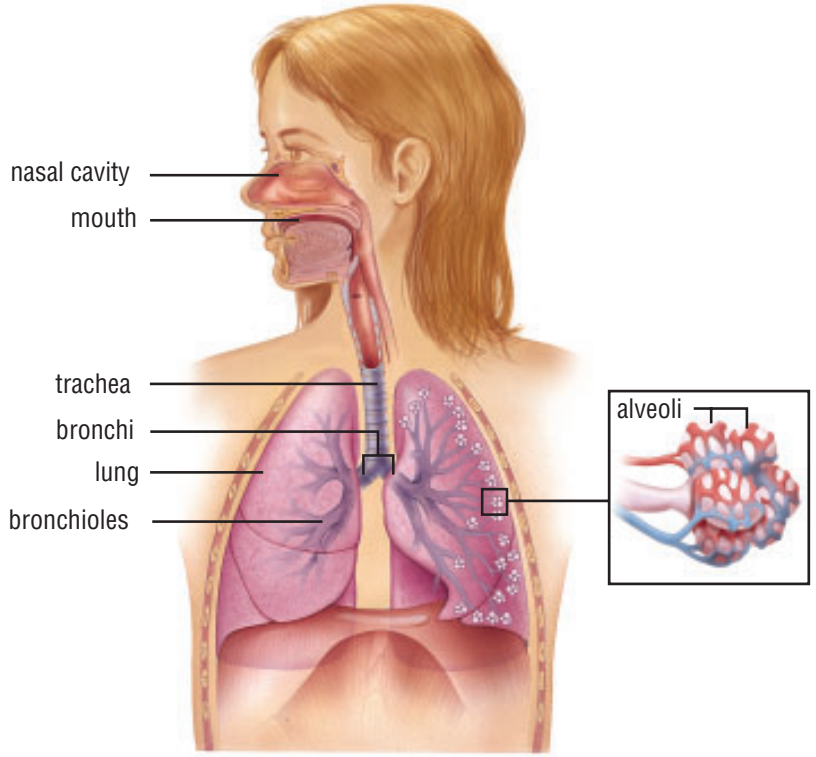

Figure 5 The human respiratory system

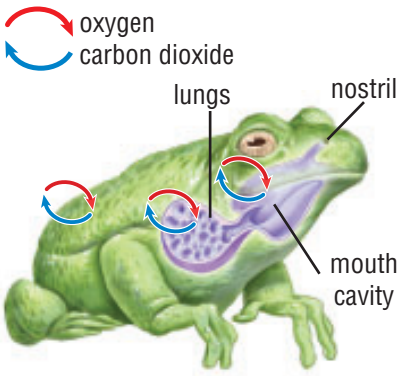

Figure 6 Frogs exchange gases through the lungs and skin.

Not all vertebrates exchange gases in the same way. Figure 6 shows the respiratory system of a frog. When a frog is underwater, its skin becomes permeable to water and gases. Blood vessels in the cells of the moist outer skin allow oxygen to diffuse from the water into the bloodstream. In the same way, carbon dioxide diffuses out of the blood cells into the water. On land, a frog uses lungs similar to those of humans for gas exchange. Air is forced into the lungs by a gulping motion (which fills the throat and causes it to bulge). Oxygen then diffuses into the bloodstream from the lungs.

Gas Exchange in Plants

Plants have special tissues containing stomates, which they use for gas exchange. Stomates are microscopic pores that control the movement of gases and water vapour into and out of the plant. Stomates are mainly found on the bottom surface of a leaf but can also be found in other parts of the plant, including the stems (Figure 7).

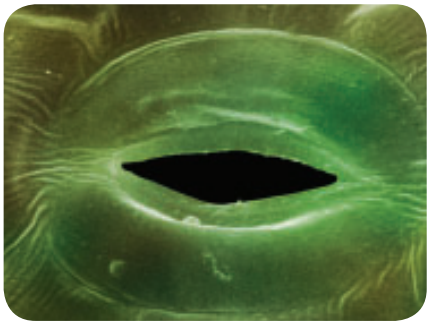

Figure 7 Specialized cells on either side of the stomate help to open and close the pore as needed.

TRY THIS: Observing Stomates

SKILLS MENU: performing, observing, analyzing, communicating

SKILLS HANDBOOK 2.B.6., 2.B.7.

In this activity, you will use the microscope to observe plant stomates.

Equipment and Materials: compound microscope; slide; scissors; clear nail polish; a leaf; clear adhesive tape

Acetone in nail polish can be hazardous to your health. Make sure that there is proper ventilation in the room.

1. Coat a small section of the underside of a leaf with clear nail polish and allow it to dry for 5 min.
2. Once the polish has dried, place a piece of clear adhesive tape over the nail polish patch and gently remove it by peeling away from the leaf.
3. Place the piece of tape with the nail polish film onto a slide.
4. Using the low-power objective lens, locate the film in the field of view. Switch to medium power and focus using the fine-adjustment knob. Scan the slide until you find one or more open stomates.
5. Observe the stomates under high power. Draw a labelled diagram of what you see.
6. Repeat steps 1 to 5, this time coating the top surface of the leaf. Record any differences in the number of stomates.

A. How many stomates did you see?

B. Why did you view the nail polish film (tape) under the microscope rather than the leaf itself?

C. Where did you find more stomates, on the underside of the leaf or on the top? Why do you think this is so?

Responding to the Environment

All vertebrates and some invertebrates have a complex nervous system. Nerve cells are highly specialized to process and transmit information. Nervous systems respond to factors in the environment (such as temperature) by sending signals through the nerve cells, or neurons, to organs. These signals are sent to the brain where they are processed, and a response is initiated.

For example, a cat may see a saucer of milk. Information from the cat's eyes travels along nerve cells to the brain, where the brain processes the information. If the brain decides it wants the milk, the brain sends a signal to the muscles in the cat's limbs, and the cat moves to the saucer of milk and drinks it (Figure 8). Each time an organism responds to a change in its environment, a long chain of messages travels through the nervous system.

Figure 8 Specialized cells respond to factors in the environment and initiate a response from the brain.

Plant Responses to the Environment

Plants are also able to respond to their environment. For example, specialized cells in the leaves of trees detect the decrease in sunlight as winter approaches. Chloroplasts then reduce production of green chlorophyll. As existing chlorophyll is broken down, other coloured particles are revealed, creating the beautiful red- and orange-coloured leaves we see during autumn. The leaves eventually die and fall off. In the spring, increased sunlight and warmer temperatures promote the production of new leaves containing large amounts of chlorophyll, and the green colour returns to the leaves.

Locomotion and Movement

Muscles and bones work together to allow vertebrates to move around. The human musculoskeletal system is made up of more than two hundred bones that support the hundreds of muscles in the body. The muscles are attached to the bones in ways that move the bones when the muscles contract (Figure 9). Muscle contractions are controlled by signals from the nervous system. Muscles also play an important role in the functioning of organs. For example, muscle cells in the walls of the heart contract to move blood into and out of the heart. Muscle cells use a lot of energy. For this reason, they have many mitochondria that convert food energy into motion.

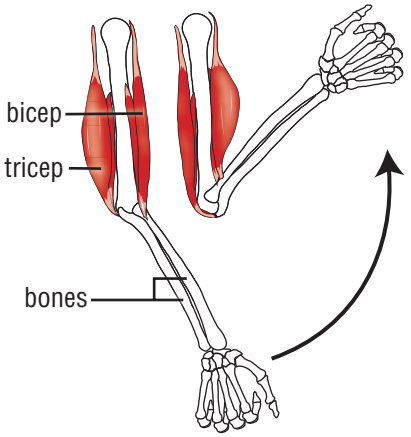

Figure 9 When the tricep is contracted, the arm is extended. When the bicep is contracted, the arm is pulled up and the elbow bends.

Invertebrate animals also use muscles to achieve locomotion, but most do not have bones. The earthworm, for example, uses muscle contractions for locomotion. The earthworm anchors itself to the soil with tiny hair-like projections, and then muscles in the body contract and expand to pull the body through the soil.

CHECK YOUR LEARNING

1. Which of your five senses is the most useful to you? Why did you choose this sense?
2. Describe digestion in humans.
3. Read about digestion in the earthworm. Which parts of the digestive system of the earthworm are also in the human digestive system?
4. Explain the process of gas exchange in humans.
5. How does gas exchange occur in plants?
6. **(a)** Give one example of how animals respond to their environment.
   (b) Give one example of how plants respond to their environment.
7. Describe how muscles work with bones to allow locomotion in humans.