Organ systems working together carry out important tasks in the body.

▼ **Figure 1.26** The reaction that occurs during cellular respiration

Most tasks in the body need the support of two or more organ systems working together. Take cellular respiration, for instance—summarized in **Figure 1.26**. This task requires oxygen and food. The respiratory system brings oxygen into the lungs when you breathe. The digestive system breaks food down into nutrients such as glucose.

Now the circulatory system enters the picture. It transports glucose and other nutrients from the digestive system to the cells. The circulatory system also transports oxygen from the lungs to the cells. Now the cells have what they need for cellular respiration: oxygen and glucose.

The teamwork doesn't end there, however. The circulatory system also transports carbon dioxide waste from the cells to the lungs of the respiratory system. Through gas exchange in the lungs, the carbon dioxide waste is removed from your body when you breathe out.

How the Organ Systems Work Together

In the example in **Figure 1.26**, all the systems have to perform their role for the overall task to be completed successfully. In this way, the organ systems are like the runners in a relay race. Each runner needs to pick up the baton from another runner, run with it, and then pass it to the next runner to complete the race. In your body, organ systems work together in a similar way to complete tasks such as cellular respiration.

Literacy Focus

Activity 1.19

WHICH ORGAN SYSTEMS WORK TOGETHER?

1. Determine which organ systems are working together in each of the following scenarios.

When you run, you begin to breathe heavier and faster. Your heart beats more quickly, bringing more oxygen to your cells. Which organ systems are working together here?

When you lift weights, your arms bulge and your brain signals them to lift despite the resistance. Which two organ systems are working together to raise the weights?

When you finish exercising, you are hot, tired, and sweating. After a bottle of juice, you feel a lot better. Which organ systems are working together in this scenario?

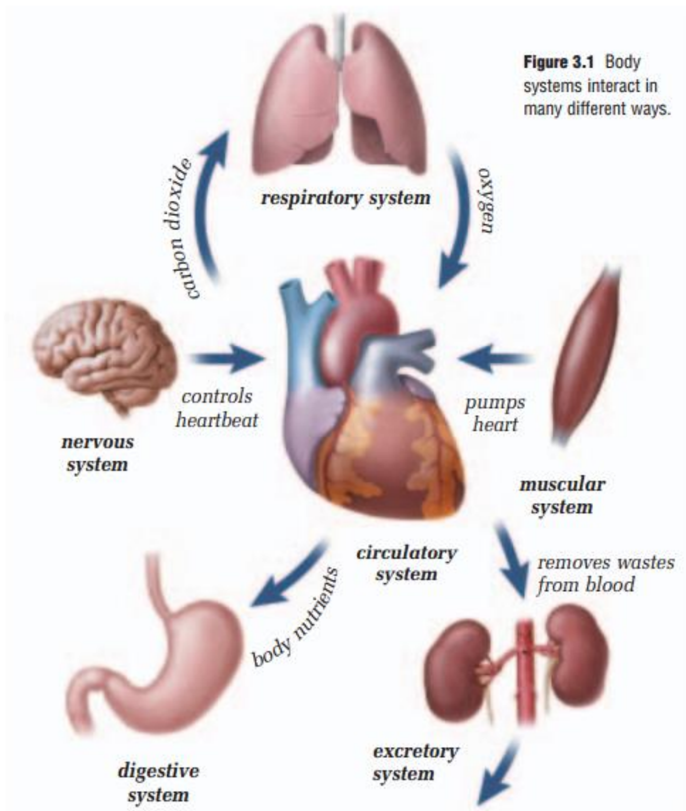


Figure 3.1 Body systems interact in many different ways.

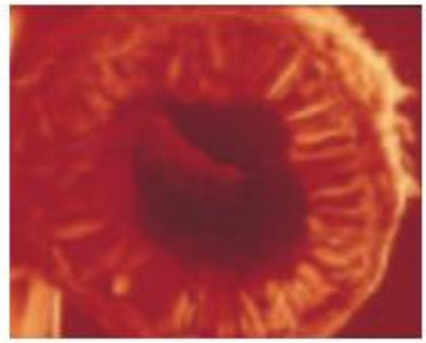


Figure 3.8 A cross-section of the small intestine showing villi on the inner surface

Digestive & Circulatory System Interactions

intestine showing villi on the inner surface

globules of lipids into much smaller droplets.

Once the food has been broken up into small particles, the small intestine absorbs these particles. The inner surface of the small intestine forms into **villi**—small, finger-like projections. These increase the surface area of the intestine to aid in absorbing nutrients. Each villus (the singular term for villi) is covered with epithelial tissue. The food molecules get absorbed by this tissue. Blood vessels lie just below the epithelial tissue, and the nutrients are transferred to the bloodstream.

The small intestine is 6 m long; if your small intestine was stretched so that the villi unfolded, it would cover the whole floor of your classroom!

The cells of the epithelial tissue have modified cell membranes that form more finger-like projections called **microvilli**. Microvilli further increase the surface area of the small intestine to help absorb nutrients.

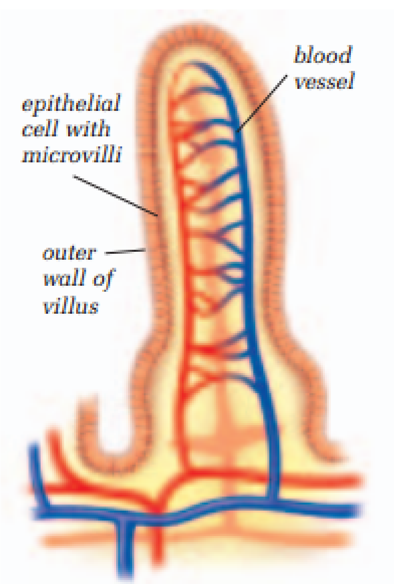


Figure 3.9 The inner structure of a villus

Excretory & Circulatory System Interactions

The Kidneys

The kidneys are about 10 cm long. They are the main organs of excretion; they act as filters to the blood, straining out the unwanted urea, water, and other salts, and they produce urine. Every drop of your blood is filtered about 300 times a day by the kidneys. Even though about 180 L of blood pass through the kidneys each day, you produce only about 1.5 L of urine. The amount of urine you produce also depends on how much water you drink. The kidneys keep the proper amount of water in your blood. If there is too much water, they excrete lots of water and so produce a lot of urine.

The Formation of Urine

The formation of urine is quite a complicated process. First, the blood enters the kidney by the renal artery. The artery branches into smaller and smaller vessels. These small capillaries enter filtering units called **nephrons**, as shown in Figure 3.25. The kidney has millions of nephrons. These microscopic units remove wastes from the blood and produce urine. The "clean" filtered blood returns to the body through the renal vein. The urine flows out a separate vessel and into the ureter.

Dialysis

Sometimes, as a result of damage or disease, kidneys don't work properly. Luckily, people whose kidneys don't function well can still lead normal lives thanks to a machine that acts as a kidney. It's called a kidney **dialysis** machine, and it removes all the wastes from the blood that a kidney normally would.

When a person undergoes dialysis, his or her blood flows into special tubing inside the machine. The tubing is made of a selectively permeable material, allowing only certain substances to diffuse through it. This tubing is surrounded by fluid. Wastes from the blood diffuse out of the blood into the fluid, and certain substances from the fluid diffuse into the blood. The blood then flows back into the person. It takes four to six hours to fully clean the blood.

Figure 3.28 People undergo dialysis roughly three times a week.

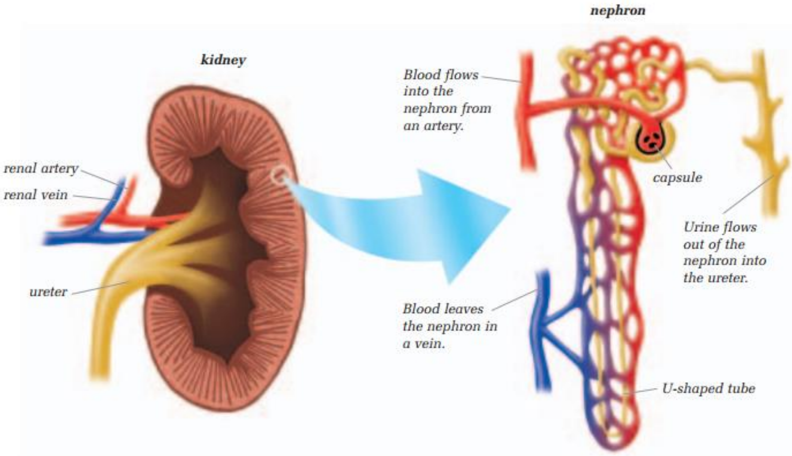


Figure 3.25 The structures of the excretory system

Respiratory & Circulatory System Interactions

Gas Exchange Takes Place in the Alveoli

Once air reaches the lungs, the actual exchange of gases occurs between the blood and the **alveoli**. Alveoli are clusters of tiny air sacs in the lungs. The wall of each alveolus is a single layer of cells.

Alveoli are surrounded by a network of tiny blood vessels called **capillaries**. The wall of each capillary also is a single layer of cells. The ultra-thin walls of both the alveoli and the capillaries allow the exchange of gases between the air and the blood, as shown in **Figure 1.20**.

Once the air enters the capillaries, oxygen from the air is taken up by the **red blood cells**. The red blood cells are responsible for transporting gases in the bloodstream. Oxygen diffuses through the walls of the alveoli, through the capillary walls, and into the red blood cells.

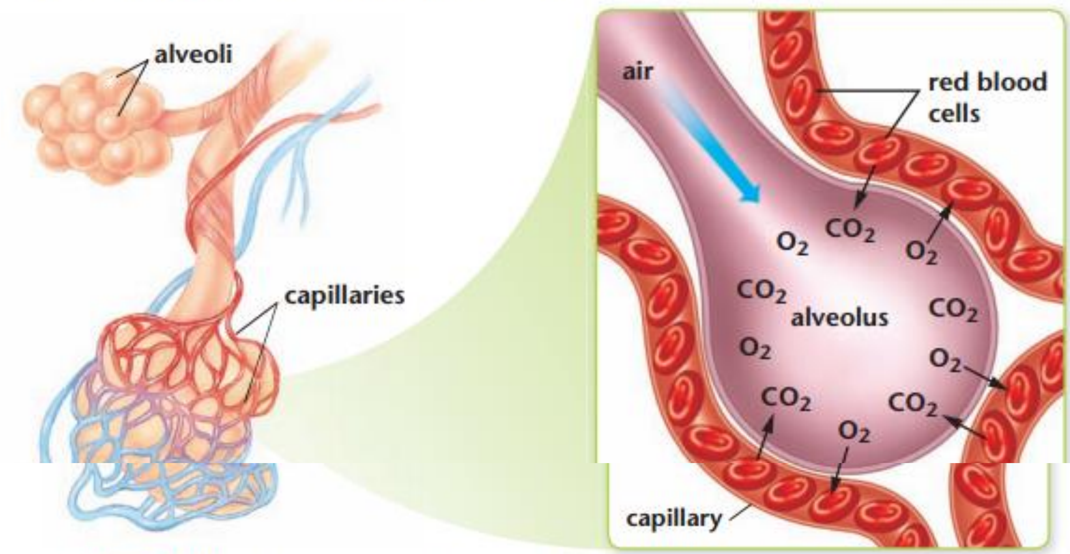
The blood also releases carbon dioxide into the lungs. The path that carbon dioxide follows is the reverse of the path that oxygen follows. Carbon dioxide diffuses from the blood through the capillary walls, through the walls of the alveoli, and into the alveoli. Once in the lungs, the carbon dioxide is exhaled with the next breath.

gas exchange: the process of taking in oxygen and releasing carbon dioxide

alveoli: air sacs in the lungs where gas exchange occurs (singular is alveolus)

capillary: the smallest blood vessel

red blood cells: blood cells that carry oxygen and carbon dioxide in the blood



▲ **Figure 1.20** Gas exchange occurs between the air in the alveoli and the blood in the capillaries.

Nervous & Muscular System Interactions

THE REFLEX RESPONSE

In some situations, sensory and motor neurons may work together without involving the brain. This is known as a reflex. A **reflex** is an automatic response by the nervous system to an external stimulus.

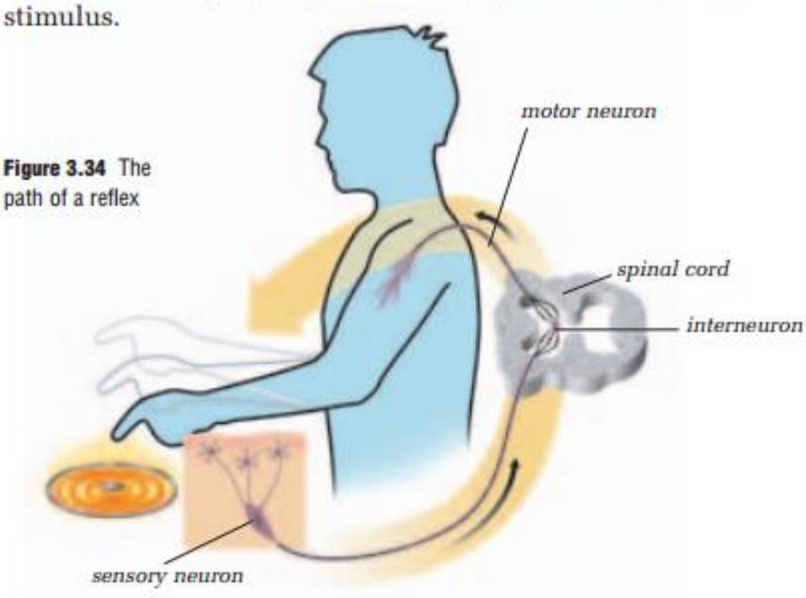


Figure 3.34 The path of a reflex

Suppose you accidentally touch a red-hot element on the stove. The stimulus is the intense heat. Sensory nerves in your hand react to the stimulus by sending nerve impulses to the spinal cord. Interneurons relay the message to the motor neurons. The impulse travels to the muscles of your arm, which quickly contract to remove your hand from the element.

The sensory neurons also send a message to your brain. But, by the time the message gets there and your brain decides to change your facial expression to a grimace and have you cry out in pain, your hand is already off the element. Reflexes protect you from injury by reducing the time it takes to react to harmful stimuli.

4. K/U Identify two characteristics of alveoli that make gas exchange easier.

5. K/U How do nutrients pass from the digestive system to the circulatory system?

6. T/I Explain how your digestive system would be affected if your circulatory system failed.

7. T/I A A condition called anemia often results from too few red blood cells. People who are anemic are often tired. Explain why this is so using what you know about the respiratory and circulatory system.

8. C The diagram below shows four disorders that can impair the proper function of the respiratory system. Predict how each disorder would impair respiratory system function.

   a) pneumonia: alveoli fill with thick fluid

   b) bronchitis: airways (the branches leading to alveoli) are inflamed due to infection or irritation

   c) asthma: airways are inflamed and constricted

   d) emphysema: alveoli burst and fuse into enlarged air spaces