

The Value of Valves

The circulatory system pumps blood (a fluid) throughout the body. It is a closed hydraulic system. It is a hydraulic system because it is fluid-filled, and it is closed because the heart and blood vessels form a long, convoluted, sealed compartment inside the body.

The circulatory system has special features that help it do its job. The heart is a pump that pushes blood through arteries and veins. The walls of arteries—the vessels that carry blood away from the heart—are thick and muscular to withstand the pressure created by the pumping heart.

Since the pressure in veins—the vessels that collect blood from the body and return it to the heart—is much lower, vein walls are not as thick. In fact, veins have very thin walls compared to those of arteries. However, veins are equipped with valves. **Valves** are devices that control the movement of a fluid through a hollow tube or pipe. Valves

in veins (Figure 1) are like one-way gates that prevent blood from backing up or pooling.

Some people have valves that do not close completely, so blood backs up and pools in certain veins. The veins become large and swollen. These are called varicose veins (Figure 2).

The heart also has valves that force blood to move through it in one direction. As the heart muscle contracts and relaxes, four heart valves keep blood flowing in the right direction (Figure 3).

valve: a mechanism that controls the flow of fluid in a pipe or tube

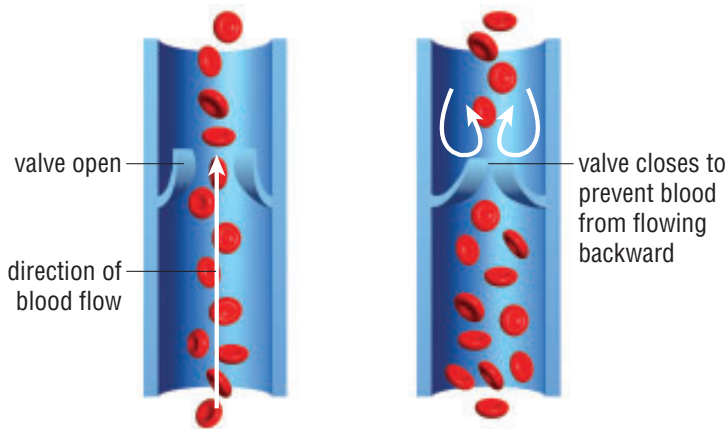


Figure 1 As the heart relaxes, blood pressure in the veins is lowered, but backflow is prevented by closure of the valves.



Figure 2 Incomplete closing of the valve allows blood to flow backwards and pool, causing varicose veins.

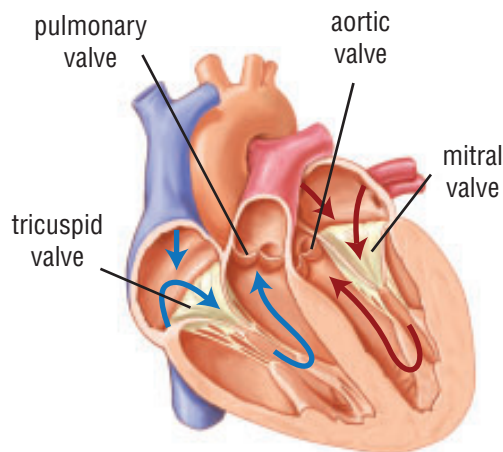


Figure 3 The heart's four valves prevent blood from flowing in the wrong direction.



TRY THIS: Exploring Valves

SKILLS MENU: performing, observing, analyzing

In this activity, you will compare the way fluids flow between syringes, with and without the use of a valve.

Equipment and Materials: two 10 mL syringes; 20 mL syringe; three 5 cm pieces of vinyl tubing; T-connector; T-valve

1. Connect the three syringes to the T-connector, using the 5 cm pieces of tubing as shown in Figure 4.

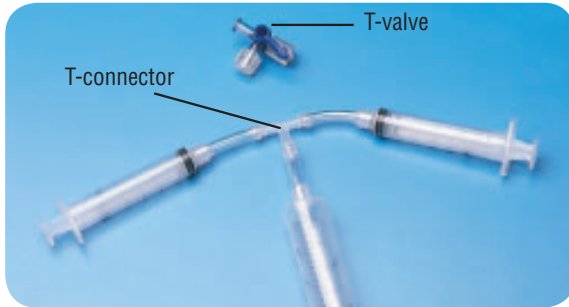


Figure 4

2. Sketch this system.
3. Depress each of the plungers in turn and record your observations.
4. Switch the position of the 20 mL syringe with one of the 10 mL syringes and repeat step 3. Record your observations.
5. Replace the T-connector with the T-valve and repeat steps 3 and 4 as you turn the valve. Record your observations.
 - A. Describe the movement of the plungers in the two smaller syringes when you used the T-connector with the 20 mL syringe in the centre. How did this compare to the movement that resulted when a 10 mL syringe was in the middle?
 - B. Compare the results when using the T-valve versus using the T-connector.

Many human-built systems also use valves. A car engine is called an **internal combustion engine** because it burns (combusts) fuel in chambers inside the engine. The engine relies on valves to allow fuel to enter the chambers and exhaust gases to escape at the correct time and in the correct direction (Figure 5).

internal combustion engine: a device that provides power by burning fuel within its cylinders

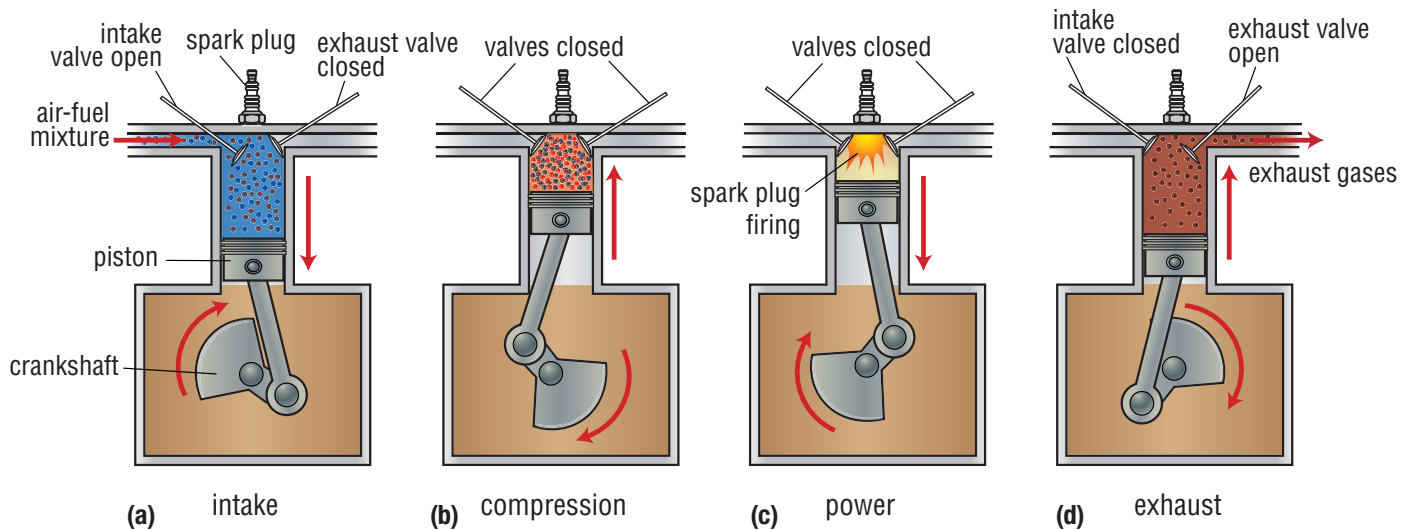


Figure 5 (a) Air and fuel enter in past the open intake valve. (b) Valves are closed to allow compression of the air-fuel mixture. (c) Valves remain closed during combustion so no fuel or gases escape. The explosion pushes the piston down. (d) Exhaust valve opens to allow gases to escape.



CHECK YOUR LEARNING

1. What kind of system—hydraulic or pneumatic—is the human circulatory system?
2. What is the role of valves in the human circulatory system?
3. In the human circulatory system, what is one result from a valve that does not work properly?
4. What is the function of valves in the internal combustion system of a car engine?