

CHAPTER 8**HANDOUT****How Much Blood Does Your Heart Pump?****BLM 8.1.10****Investigate the relationship between cardiac output and heart rate**

Cardiac output is the volume of blood pumped by each ventricle per minute. Because humans have a closed circulatory system, the cardiac output is the same as the volume of blood that traverses the systemic or pulmonary circulations per minute. It is calculated by multiplying the heart rate by the stroke volume. **Stroke volume** is the volume of blood ejected by each ventricle per beat.

A healthy heart with a normal cardiac output pumps about 5 to 6 litres of blood every minute when a person is at rest. The heart pumps about 75 mL each time it beats, and it beats an average of 70 times each minute.

$$\text{Cardiac output} = \text{stroke volume} \times \text{heart rate}$$

$$\text{Cardiac output} = 75 \text{ mL} \times 70 \text{ beats per minute}$$

$$\text{Cardiac output} = 5.3 \text{ litres per minute}$$

Cardiac output increases during exercise because of an increase in heart rate and stroke volume. When exercise begins, the heart rate increases up to about 100 beats per minute. As exercise becomes more intense, skeletal muscles squeeze on veins more vigorously, returning blood to the heart more rapidly. In addition, the ventricles contract more strongly, so they empty more completely with each beat.

During exercise, the cardiac output increases to a maximum of about 25 litres per minute in an average young adult. Although the cardiac output has increased by five times, not all organs receive five times the blood flow; some receive more, others less. This is because the arterioles in some organs, such as those in the digestive system, constrict, while arterioles in the muscles that are working and in the heart (another muscle) dilate. Vasodilation greatly increases blood flow; vasoconstriction greatly decreases blood flow.

What to do

1. Determine your heart rate by taking your pulse.
2. Multiply your pulse rate by the stroke volume (75 mL). Assume for the purposes of this activity that the stroke volume remains constant.
3. Do this for different levels of activity (sitting at rest, lying on the floor, running on the spot), and compare your results.

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Answer the questions below

Type of Activity	Pulse rate per minute	Stroke volume (mL)	Cardiac Output (L)
Sitting, at rest			
Lying on the floor			
After 2 minutes of running on the spot			

1. Define the terms “cardiac output” and “stroke volume.”

2. Did your cardiac output increase or decrease during the 2 minutes of exercise? Explain why.

3. Explain why some of your arterioles dilate while others constrict when you exercise.

4. Your body contains approximately 5 litres of blood. How long does it take for the entire volume of blood to pump through your heart when you are sitting?
