

6.6 Blood vessels and blood flow

In order to answer the questions in this exercise, you must be able to

- describe how blood flows from the heart to the capillaries through arteries and arterioles
- describe how blood returns from the capillaries to the heart through venules and veins
- explain how the blood supply to different organs is affected by exercise.

Here are some remarkable facts. The left side of a human heart pumps out approximately five litres of blood every minute. All this blood passes through the aorta. It would take two years, however, for 1 cm³ of blood to pass through a single capillary! We can explain this enormous difference in the rate of blood flow by looking carefully at the features of different blood vessels. Some of their features are summarised in Table 6.6.

Table 6.6 Some features of blood vessels and blood flow in a dog

Blood vessel	Total number of vessels	Mean length/cm	Mean diameter/cm	Total cross-sectional area/cm ²	Total blood volume/cm ³	Rate of blood flow/cm ³ s ⁻¹
Aorta	1	40	1.0	0.8	30	28
Other large arteries	40	20	0.3	3	60	7.8
Arterioles	4×10^7	0.2	0.002	125	25	1.18
Capillaries	1.2×10^9	0.1	0.0008	600	60	0.036
Venules	8×10^7	0.2	0.003	570	110	0.04
Large veins other than vena cava	40	20	0.6	11	220	1.9
Vena cava	1	40	1.3	1.2	50	1.8

Using the figures in Table 6.6, answer the following questions.

- 1 Explain why the number of capillaries is greater than the number of arterioles and the number of venules.
(1 mark)
- 2 Explain how the figures in each of the following columns were calculated:
 - (a) the total cross-sectional area.
(1 mark)
 - (b) the total volume of blood.
(1 mark)

Exercise 6.6 *continued*

- 3 Calculate the length of time it would take for a red blood cell to pass from one end of a capillary to the other. Show your working. (2 marks)
- 4 (a) Describe the relationship between the mean diameters of the blood vessels which take blood to an organ and the rate of blood flow through them. (1 mark)
- (b) There is friction between the blood and the wall of a blood vessel. This frictional force slows down the flow of blood. Use this information to explain why blood flows more slowly in a small artery than in a larger one. (2 marks)
- (c) Explain why it is an advantage to an organism for blood to flow slowly through capillaries. (2 marks)

Although all the organs in the body require a blood supply, the rate of blood flow to a particular organ may vary. Figure 6.7 shows the minimum and maximum rates of blood flow through various human organs.

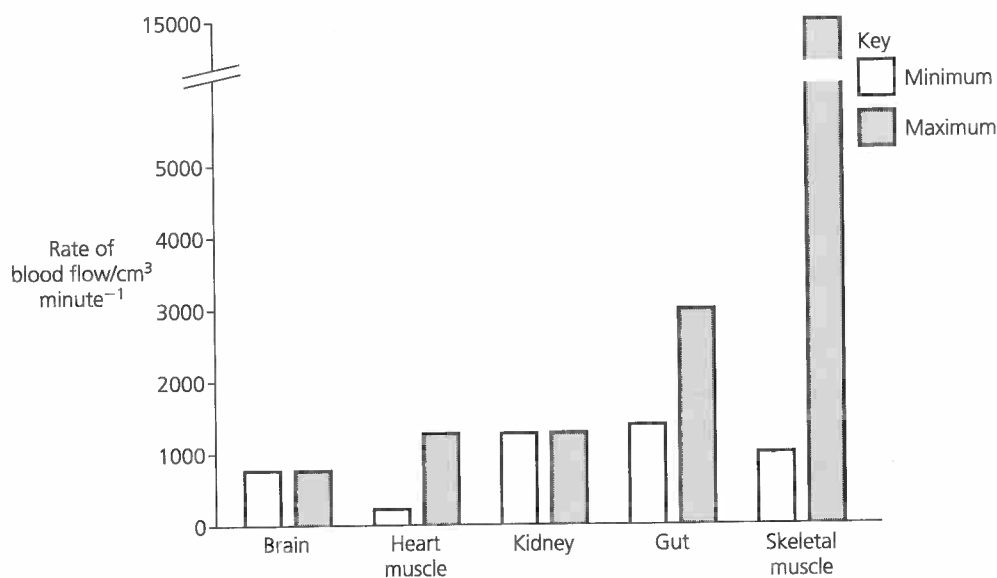


Figure 6.7 The minimum and maximum rate of blood flow through some human organs

**Exercise 6.6 continued**

5 Under what body conditions would you expect to find the maximum rate of blood flow in

(a) muscle?

(b) the gut?

(2 marks)

6 Explain why the change in blood flow to the heart muscle which takes place during strenuous exercise is important.

(2 marks)

7 The total volume of oxygen going to all the organs of the body other than the lungs in 1 minute is 5000 cm^3 . Explain why the rate of blood flow to the lungs is also $5000 \text{ cm}^3 \text{ minute}^{-1}$.

(1 mark)