Answers to SAQs

Chapter 8

1 a The fish has a single circulatory system, whereas the mammal has a double circulatory system.
In the fish, blood leaves the heart and travels to the gills, where it picks up oxygen, before continuing around the body. In the mammal, the blood returns to the heart after picking up oxygen at the lungs, and is then pumped around the body.

b Oxygenated blood can be pumped around the body at a higher pressure, and therefore faster, in a mammal than in a fish, because pressure is lost in the capillaries in the gills. This can provide a more efficient oxygen supply to mammalian cells than to fish cells.

2 Elastic fibres allow the artery to stretch and recoil as blood pulses through. Nearer the heart, the pressure changes between systole and diastole will be greater, and the maximum systolic pressure greater, than anywhere else in the circulatory system. Thus more elastic fibres are needed to cope with these large pressures and pressure changes.

3 Blood cells, and haemoglobin in red blood cells, would cause scattering and absorption of light before it reached the retina. The aqueous humour supplies the cornea with its requirements.

4 a Gravity pulls blood downwards. Normally, contraction and relaxation of leg muscles squeezes in on leg veins; valves in them ensure blood moves upwards and not downwards. When standing to attention, these muscles are still, so blood accumulates in the feet.

b As thoracic volume increases, pressure inside the thorax decreases. This decreases the pressure in the blood vessels in the thorax. The effect is very small in the arteries, but more significant in the veins. The relatively low pressure of the blood in the veins in the thorax, compared with the pressure in veins elsewhere in the body, produces a pressure difference causing blood movement towards the thorax.

5 Answers should include reference to:
- the fluctuating pressure in arteries
- why the fluctuations become gradually smaller as the blood passes through the arterial system
- the rapid drop in pressure as the blood flows along the arterioles and capillaries, and reasons for this
- the rise of pressure as blood enters the pulmonary circulation via the right-hand side of the heart, and the even higher rise in pressure in the aorta, and reasons for this.

6 a The larger the relative molecular mass of a substance, the lower the permeability of capillary walls to that substance.

b Net diffusion for glucose would be into the muscle. Respiration within the muscle requires glucose, therefore the concentration of glucose within the muscle cells is lower than in the blood plasma.

c Albumin in the blood plasma raises its solute concentration (lowers its water potential), thus helping to draw water back from the tissue fluid into capillaries. If albumin could diffuse out of capillaries into tissue fluid, more water would accumulate in the tissue fluid. (This is called oedema.)

7 a Protein in tissue fluid comes from the cells making up the tissues, many of which secrete proteins.

b If plasma protein concentrations are low, then, as explained in question **6c**, water will not be drawn back into capillaries from tissue fluid.

8 2.1×10^{11}

9 a Protein synthesis – no. There is no DNA, so no mRNA can be transcribed.

b Cell division – no. There are no chromosomes, so mitosis cannot occur, nor are there centrosomes for spindle formation.

c Lipid synthesis – no. This occurs on the smooth endoplasmic reticulum, and there is none.

d Active transport – yes. This occurs across the cell surface membrane, and can be fuelled by ATP produced by anaerobic respiration.

10 **a** 195 cm^3

b 25 cm^3

11 **a** **i** 96.5%

ii 1.25 cm^3

b **i** 24.0%

ii 0.31 cm^3

12 Less oxygen would enter the blood by diffusion, and therefore less oxygen would be carried to the body cells. The percentage saturation of haemoglobin will be only about 30% (see Figure 8.17).

13 At high altitude, the percentage saturation of the haemoglobin is relatively low. If the number of red blood cells is increased, then the number of haemoglobin molecules is also increased. Even though the percentage saturation of the haemoglobin is low, the fact that there is more of it can increase the actual quantity of oxygen carried in the blood.

14 Spending a length of time at high altitude stimulates the body to produce more red blood cells. When the athlete returns to sea level, these 'extra' red blood cells remain in the body for some time and can supply extra oxygen to muscles, enabling them to work harder and for longer than they would otherwise be able to do.

15 For the first heart beat shown: Atrial systole: between 0 and 0.125 s. Ventricular systole: between about 0.125 s and 0.325 s. Ventricular diastole: between about 0.325 s and 0.625 s.

16 The valves in the heart normally prevent backflow from the ventricles to the atria, or from the main arteries to the ventricles. If the atrioventricular valves do not close correctly, then as the ventricles contract, some blood will move back into the atria rather than into the arteries. Similarly, if the semilunar valves to not close correctly, then as the ventricles relax some blood will flow back from the arteries into the ventricles.
Both of these events will mean that less blood is pushed out of the heart and around the body, or to the lungs. This can have several effects, but the main one is likely to be that less oxygen is delivered to the tissues. The person may feel tired, as there is less oxygen available for respiration in the muscles. The heart may beat more quickly or more strongly as the body attempts to 'make up for' this lack, which – over time – may increase the risk of heart failure.