3.1 E.g. the monoclonal antibodies bind to the (beta-amyloid) proteins in the plaque and form antigen-antibody complexes ***[1 mark]***. This labels the proteins for destruction by phagocytosis, which breaks down the plaque ***[1 mark]***.

3.2 The vehicle acted as a control ***[1 mark]*** so that the scientists could ensure that the drug caused the observed effect on plaque number and not the vehicle itself ***[1 mark]***.

3.3 Any one from: e.g. gantenerumab cleared plaques that were less than 300 μm^2 in size. / Compared to the vehicle/control, gantenerumab reduced the number of plaques formed that were less than 600 μm^2 in size. / Gantenerumab had no effect on plaques that were greater than 600 μm^2 in size. ***[1 mark]***

If the number of plaques in treated mice was less than the baseline, then you can conclude that the drug prevented plaque formation and removed some plaques. If it was less than the control but not the baseline, then the drug reduced the number of new plaques formed but didn't remove any.

3.4 Any four from: e.g. because the study was carried out in mice, not humans, so you don't know how effective the drug would be in humans ***[1 mark]***. The data shows how the drug affected the number of beta-amyloid plaques, not how it affected the symptoms of Alzheimer's ***[1 mark]***. Scientists don't know for certain that amyloid plaques cause Alzheimer's ***[1 mark]***. The gantenerumab did not remove all the plaques in the mice's brains ***[1 mark]***. The data does not record any side effects experienced by the mice, which might make the drug a less effective medical treatment ***[1 mark]***. ***[Maximum of 4 marks available]***

4.1 Different blood types have red blood cells with different antigens ***[1 mark]***. The immune system of someone receiving the wrong blood type would not recognise the antigens on the donated red blood cells / would view the antigens on the donated red blood cells as foreign ***[1 mark]***. This would stimulate an immune response, destroying the blood cells ***[1 mark]***.

4.2 Any six from: e.g. phagocytes recognise foreign antigens on type B red blood cells and engulf them ***[1 mark]***. They present the antigens on their surface ***[1 mark]***. Receptors on helper T-cells bind to these antigens ***[1 mark]***. This stimulates the helper T-cells to activate more phagocytes/ cytotoxic T-cells to kill the type B red blood cells ***[1 mark]***. The helper T-cells also activate B-cells ***[1 mark]*** which divide to produce plasma cells that secrete antibodies against the type B antigens ***[1 mark]***. The antibodies bind to the type B antigens causing the type B blood cells to clump together/agglutinate ***[1 mark]***, labelling them for destruction by phagocytosis ***[1 mark]***. ***[Maximum of 6 marks available.]***

4.3 Blood type O has no antigens, so no immune response will be triggered ***[1 mark]***.

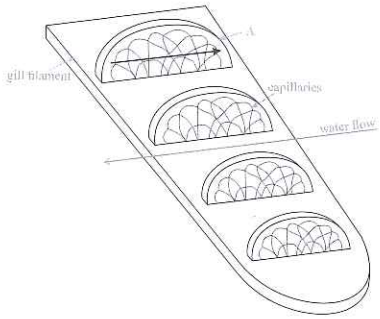
4.4 E.g. monoclonal antibodies specific to the antigen(s) of one blood type could be added to a sample of the person's blood ***[1 mark]***. If agglutination is observed, then it can be concluded that the person has that blood type ***[1 mark]***.

Topic Three — Exchange and Transport

Pages 39-42: Exchange and Transport Systems — 1

1.1 lamella ***[1 mark]***

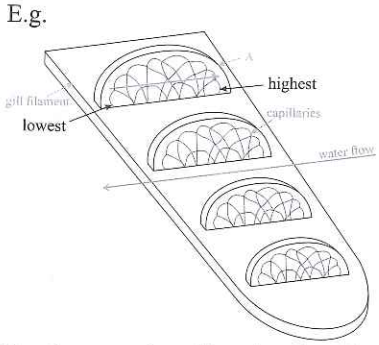
1.2 An arrow drawn across structure A in the opposite direction to the arrow showing water flow across the gill filament, e.g.



[1 mark]

Fish gills have a counter-current system, meaning the blood flows in the opposite direction to the water.

1.3 E.g.



[1 mark]

1.4 E.g. the many lamellae give the gill a large surface area ***[1 mark]***, increasing the rate of diffusion of gases ***[1 mark]***.

2.1 E.g. dissecting scissors ***[1 mark]***

2.2 A: spiracle ***[1 mark]***
B: tracheae ***[1 mark]***

2.3 E.g. pipette a drop of water onto a slide ***[1 mark]***. Use tweezers to place a section of structures B/the tracheae onto the drop of water ***[1 mark]***. Stand a cover slip upright on the slide, next to the water drop, then carefully tilt and lower it so it covers the specimen ***[1 mark]***.

2.4 Any two from: e.g. it is able to close its spiracles when it is losing too much water ***[1 mark]***. / It has a waterproof, waxy cuticle all over its body ***[1 mark]***. / It has tiny hairs around the spiracles ***[1 mark]***.

3.1 Mean number of stomata per 0.025 mm^2 =
$(5 + 6 + 7 + 4 + 3 + 8 + 5 + 5 + 3 + 4) \div 10 =$
$50 \div 10 = 5$
$150\ mm^2 \div 0.025\ mm^2 = 6000$
Number of stomata you'd expect to find in 150 mm^2 =
$5 \times 6000 =$ **30 000 stomata**
[2 marks for correct answer, otherwise 1 mark for mean per 0.025 mm^2 = 5, or 1 mark for multiplying mean by 6000]

3.2 E.g. it is based on data from the lower epidermis only and stomata might not be evenly distributed across a leaf ***[1 mark]***. It is based on a small sample size ***[1 mark]***.

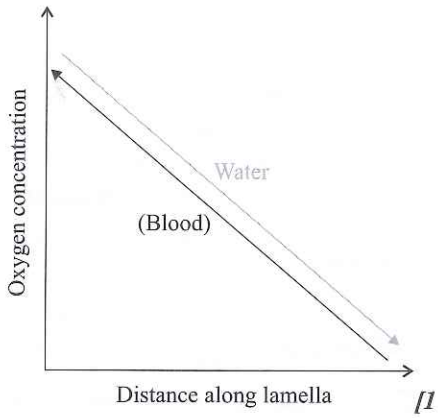
3.3 Mesophyll ***[1 mark]***

3.4 The stoma is sunken in a pit ***[1 mark]***, which traps moist air, reducing the concentration gradient of water between the leaf and the air ***[1 mark]***. This reduces the diffusion and evaporation of water from the leaf ***[1 mark]***.

4.1 *Lepus othus*. Having shorter ears gives the hare a smaller surface area to volume ratio ***[1 mark]***, which means it loses heat less easily ***[1 mark]***. This makes the hare better adapted to surviving at low temperatures ***[1 mark]***.

4.2 Alaskan hares are likely to have a higher metabolic rate than polar bears because hares are smaller ***[1 mark]***, so they have a higher surface area compared to their volume ***[1 mark]***. This means they lose heat more easily, so need a high metabolic rate in order to generate enough heat to stay warm ***[1 mark]***.

5.1



[1 mark]

5.2 In the parallel flow system, the oxygen concentration gradient between the water and the blood decreases with distance along the lamella ***[1 mark]***, which will mean that the rate of oxygen diffusion will also decrease with distance along the lamella ***[1 mark]***. This means that less oxygen diffuses into the blood than with a counter-current system, where the concentration gradient (and therefore rate of diffusion) is maintained ***[1 mark]***.

Pages 43-45: Exchange and Transport Systems — 2

1 Bacterium B: $84 \div 22 = 3.8181...$, so $84 : 22 = 3.81 : 1$
Bacterium C: $15.75 \div 3.5 = 4.5$, so $15.75 : 3.5 = 4.5 : 1$
Bacterium with fastest gas exchange: Bacterium **A**
[1 mark for bacterium A, 1 mark for correct conversion of ratios]

Converting all the ratios into the form n : 1 makes it easier to see that Bacterium A has a bigger surface area compared to its volume, which means there is a larger surface for gases to diffuse across. This means the rate of gas exchange can be faster.

2.1 diaphragm ***[1 mark]***, external intercostal muscles ***[1 mark]***

You must specify the external intercostal muscles to get the mark here. The internal intercostal muscles only contract during forced expiration.

2.2 0-2 seconds ***[1 mark]*** because this is when the pressure inside the lungs/the intrapulmonary pressure is negative ***[1 mark]***. Air travels down a pressure gradient, so air must be being taken into the lungs at this point ***[1 mark]***.

2.3 3 seconds ***[1 mark]***

Lung volume will be smallest when the pressure is highest (and the person is expiring).

3.1 Any two from: e.g. the alveolar epithelium is only one cell thick ***[1 mark]***. / Alveolar epithelial cells are flat ***[1 mark]***. / Alveoli have a large surface area for gas exchange to take place over ***[1 mark]***.

3.2 Air flow into the emphysema patient's lungs is not restricted, so the inspiration line is relatively normal ***[1 mark]***. The alveoli of the person with emphysema cannot recoil to expel air as well as those of the healthy person however, because of the loss of elastin in the alveoli walls ***[1 mark]***. This limits/slows the flow of air out of the lungs, so the expiration line is lower and more concave ***[1 mark]***.

3.3 $1\ dm^3 = 1000\ cm^3$
So $7.60\ dm^3 = 7.60 \times 1000 = 7600\ cm^3$
Volume of air in each breath = PVR ÷ breaths per minute
$= 7600 \div 16$
$= \mathbf{475\ cm^3}$
[2 marks for the correct answer, otherwise 1 mark for $4.75\ dm^3$ or for a correct conversion from dm^3 to cm^3.]

4.1 E.g. the scar tissue means that the lungs are less able to expand, so they can't hold as much air ***[1 mark]***. To take in enough oxygen, the person has to breathe more quickly ***[1 mark]***.

4.2 Any four from: e.g. the number of annual deaths from asbestosis increased after the ban in 1999, suggesting that the ban was not very effective ***[1 mark]***. (However) it cannot be concluded that the ban was unsuccessful ***[1 mark]***. We don't know whether the increase in deaths would have been greater without the ban ***[1 mark]***. Asbestosis might not develop until many years after exposure / people might have asbestosis for a long time without dying ***[1 mark]***. (Therefore) the annual death rate from asbestosis might be rising while the people who had already been exposed to asbestos before the ban die ***[1 mark]***. Another explanation for the increase could be that doctors are getting better at diagnosing asbestosis or identifying it as a cause of death ***[1 mark]***.
[Maximum of 4 marks available]

Pages 46-49: More Exchange and Transport Systems — 1

1.1 Any of the peptide bonds that are not at the end of the protein, e.g.

[1 mark]

1.2 Name: exopeptidases ***[1 mark]***
Function: they hydrolyse peptide bonds at the ends of proteins ***[1 mark]***.
Name: dipeptidases ***[1 mark]***
Function: they hydrolyse peptide bonds in dipeptides ***[1 mark]***.

1.3 E.g. amino acids are absorbed into the ileum epithelial cells by co-transport ***[1 mark]***. This involves sodium ions being actively transported from the ileum epithelial cells into the bloodstream ***[1 mark]***. This builds up a concentration gradient of sodium ions, with a higher concentration of sodium ions in the lumen of the ileum than in the ileum epithelial cells ***[1 mark]***. Sodium ions then diffuse into the ileum epithelial cells through sodium-dependent transporter proteins ***[1 mark]*** carrying amino acids with them ***[1 mark]***.

1.4 Without enteropeptidase, trypsin is not produced ***[1 mark]***, which means that proteins cannot be fully digested ***[1 mark]***. This may mean that not enough amino acids can be absorbed into the blood and used by body cells to keep the person healthy ***[1 mark]***.

2.1 Lipase A is an enzyme with an active site that has a specific shape ***[1 mark]*** that is more complementary to the shape of Type B oil molecules than Type A or Type C oil molecules ***[1 mark]***.

2.2 17.3 (Type B) ÷ 7.4 (Type C) = 2.3378...
2.3 : 1 ***[1 mark]***

When a calculation gives you a number with a lot of decimal places, give your answer to the lowest number of significant figures that was used in the measurements for the calculation.

2.3 bile salts ***[1 mark]***

2.4 monoglycerides ***[1 mark]***
fatty acids ***[1 mark]***

2.5 Micelles move the monoglycerides and fatty acids/products of lipid digestion towards the epithelial lining of the small intestine ***[1 mark]***. As micelles break up, they release the monoglycerides and fatty acids/products of lipid digestion ***[1 mark]***. Both monoglycerides and fatty acids/the products of lipid digestion are then able to freely diffuse across the epithelial cell membrane ***[1 mark]***.

3.1 E.g. by setting up the equipment in the same way, but using the same volume of distilled water in the Visking tubing instead of amylase ***[1 mark]***.

3.2 Any two from: e.g. In a real gut there are transporters/protein channels for active transport of food molecules across the gut wall ***[1 mark]***. / Visking tubing doesn't have as large a surface area as the real gut ***[1 mark]***. / The real gut is surrounded by blood that maintains a concentration gradient ***[1 mark]***.

3.3 At the start of the experiment, the iodine test was positive for the Visking tubing contents, showing starch was present ***[1 mark]*** because it hadn't been digested by amylase yet ***[1 mark]***. The iodine test was negative for the beaker contents because the starch molecules were too big to fit through the Visking tubing membrane and move into the beaker ***[1 mark]***. At the end of the experiment, the iodine test was negative for the Visking tubing and the beaker contents because all the starch had been digested ***[1 mark]***.

3.4 At the start of the experiment, the Benedict's test was negative for both the Visking tubing and beaker contents showing there was no sugar present ***[1 mark]*** because the starch hadn't been digested into maltose yet ***[1 mark]***. At the end of the experiment, the Benedict's test was positive for the Visking tubing contents because the starch had been broken down into maltose ***[1 mark]***. The Benedict's test was also positive for the beaker contents because the maltose molecules were small enough to move through the Visking tubing membrane and into the beaker ***[1 mark]***.

Pages 50-52: More Exchange and Transport Systems — 2

1.1 Any five from: at low partial pressures of oxygen, the percentage saturation of haemoglobin with oxygen is low ***[1 mark]*** because the four polypeptide chains that make up haemoglobin are tightly bound, making it difficult for oxygen to bind ***[1 mark]***. The curve rises steeply at medium partial pressures, as more haemoglobin is carrying oxygen ***[1 mark]***. This is because once the first oxygen has bound, haemoglobin changes shape, making it easier for additional oxygen molecules to bind ***[1 mark]***. At high partial pressures, the curve levels off/plateaus because more haemoglobin is saturated with oxygen ***[1 mark]***, so it gets harder for oxygen molecules to bind ***[1 mark]***. ***[Maximum of 5 marks available]***

1.2 Llamas live at high altitudes where there is less oxygen ***[1 mark]***, which means their haemoglobin has to have a higher affinity for oxygen than humans ***[1 mark]***. This puts the llama oxygen dissociation curve to the left of the human curve, because their haemoglobin loads more oxygen at lower partial pressures ***[1 mark]***.

1.3 The respiration rate increases during exercise, which increases the partial pressure of carbon dioxide in the blood ***[1 mark]***. Higher concentrations of carbon dioxide increase the rate of oxygen unloading and the saturation of blood with oxygen is lower for a given pO_2 ***[1 mark]***. This is called the Bohr effect ***[1 mark]***.

2.1 Name of X = aorta ***[1 mark]***
Name of Y = pulmonary vein ***[1 mark]***

2.2 Any three from: e.g. wear gloves ***[1 mark]*** / wear a lab coat ***[1 mark]*** / disinfect the area and equipment afterwards ***[1 mark]*** / take care with the use of sharp equipment ***[1 mark]***.

2.3 Any one from: e.g. use clear, continuous lines/no overlaps in lines ***[1 mark]*** / no shading ***[1 mark]*** / draw different components in proportion ***[1 mark]*** / include a scale ***[1 mark]*** / include relevant labels ***[1 mark]***.

3.1 Inflammation and thrombosis in small and medium arteries would lead to reduced blood flow to the fingers and toes ***[1 mark]***. Without an adequate supply of oxygen/glucose/nutrients etc., the tissue in the fingers and toes may die ***[1 mark]***.

3.2 At the start of a capillary bed, the hydrostatic pressure inside the capillaries is higher than outside ***[1 mark]***, so fluid is forced out of the capillaries, forming tissue fluid ***[1 mark]***. At the venule end of the capillary bed, the loss of fluid means the water potential inside the capillaries is lower than in the tissue fluid ***[1 mark]***, so some of the water in the tissue fluid re-enters the capillaries ***[1 mark]*** by osmosis ***[1 mark]***.

3.3 E.g. capillaries have walls that are only one cell thick, which shortens the diffusion pathway ***[1 mark]***.