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]*.

Pages 53-55: More Exchange and Transport Systems — 3

1.1 They prevent the backflow of blood ***[1 mark]*** into the atria when the ventricles contract ***[1 mark]***.

1.2 They open when pressure is greater below the valve / in the ventricle than in the artery ***[1 mark]***.

1.3

	Standing up	Lying down
Mean heart rate / bpm	74	57
Mean cardiac output / cm^3 min^{-1}	4700	4700
Mean stroke volume / cm^3	63.5 (3 s.f.)	82.5 (3 s.f.)

[1 mark]

Stroke volume = cardiac output ÷ heart rate, so when standing up it's 4700 ÷ 74 = 63.5, and when lying down it's 4700 ÷ 57 = 82.5.

1.4 It gives the heart rate time to stabilise, as the act of changing position could cause it to increase ***[1 mark]***.

1.5 Heart rate is lower when lying down as blood does not have to be pumped above the level of the heart / against gravity ***[1 mark]***.

The heart has to work harder when a person is standing up, because blood has to flow against gravity. When you're lying down, the force of gravity is evenly distributed across the body.

1.6 Taking multiple measurements and calculating the mean reduces the effect of random error, so makes the results more precise ***[1 mark]***.

2.1 60 ÷ 0.55 = 109.0909...
109 beats per minute ***[1 mark]***

2.2 0.13 seconds or 0.68 seconds ***[1 mark]***

The left atrium contracts before the left ventricle in the cardiac cycle, so you need to find a point on the graph where the pressure of the atrium increases before the pressure of the ventricle increases.

2.3 Any six from: at point A, pressure in the left ventricle exceeds pressure in the left atrium ***[1 mark]***, because the left ventricle is contracting and the left atrium is relaxing ***[1 mark]***. This causes the atrioventricular valve/the valve between the left atrium and left ventricle to close, preventing the backflow of blood into the left atrium ***[1 mark]***.
At point B, pressure increases in the left ventricle to above that of the aorta ***[1 mark]***, which forces the semi-lunar valve/the valve between the left ventricle and aorta open ***[1 mark]***.
At point C, the left ventricular pressure falls below that of the aorta ***[1 mark]***, because blood has moved into the aorta from the ventricle and the left ventricle is relaxing ***[1 mark]***. As a result, the semi-lunar valve/the valve between the left ventricle and the aorta closes ***[1 mark]***.
Finally, at point D, pressure has been increasing in the left atrium as blood has been returning to the atrium from the body ***[1 mark]***. As the atrial pressure exceeds ventricular pressure ***[1 mark]***, the atrioventricular valve/valve between the left atrium and left ventricle opens, allowing blood to flow into the left ventricle ***[1 mark]***.
[Maximum of 6 marks available]

2.4 The left ventricle has a higher maximum pressure than the left atrium because it has a thicker muscle wall and so is able to generate more force when it contracts ***[1 mark]***.

2.5 The wall of the aorta is thick and muscular / the wall of the aorta contains elastic tissue to stretch and recoil / the inner lining of the aorta is folded so it can stretch ***[1 mark]***, which helps to maintain the high pressure of the blood coming out of the left ventricle ***[1 mark]***.

Pages 56-58: More Exchange and Transport Systems — 4

1.1 Water on the leaves would reduce the water potential gradient between inside the leaf and outside ***[1 mark]***, reducing water loss/transpiration ***[1 mark]***.

1.2 The higher the temperature, the faster the rate of transpiration ***[1 mark]***. At higher temperatures, water molecules have more kinetic energy so they evaporate more quickly from the cells inside the leaf ***[1 mark]***. This increases the water potential/concentration gradient between the inside and outside of the leaf, so water diffuses out of the leaf faster ***[1 mark]***.

2.1 Light intensity is higher at 12:00, so more stomata are open ***[1 mark]***, which increases the transpiration rate ***[1 mark]***. This draws water molecules up the xylem at a quicker rate, due to cohesion and tension ***[1 mark]***.

At 00:00, it would be dark, whereas there is sunlight at 12:00.

2.2 To prevent the plant tissue from drying out ***[1 mark]***.

2.3 Dyeing the tissue with a stain/named stain ***[1 mark]***.

3.1 Translocation requires energy/ATP ***[1 mark]***. If metabolism stops, respiration cannot occur so ATP is not produced / energy is not released ***[1 mark]***.

3.2 The level of pressure at point A is higher than that at point B ***[1 mark]***. This is because, at point A, the water potential is being lowered by the solutes entering from the companion cell, causing water to enter from the xylem and companion cell ***[1 mark]***, and raising the pressure ***[1 mark]***.

3.3 The concentration of solutes at point A would increase because the solutes are still being loaded from the companion cell and can't flow down the phloem ***[1 mark]***, as phloem is removed when a ring of bark is taken ***[1 mark]***.

3.4 E.g. in a tracer experiment, a leaf could be supplied with radioactively labelled CO_2 ***[1 mark]***, which would then be incorporated into the organic substances produced by the leaf ***[1 mark]***. The movement of these substances around the plant could then be tracked by detecting the radioactively labelled carbon ***[1 mark]***.

Topic Four — Genetic Information and Variation

Pages 59-62: DNA, RNA and Protein Synthesis

1.1 The DNA is wound around histone proteins ***[1 mark]*** and then tightly coiled into compact chromosomes ***[1 mark]***.

1.2 Any one from: e.g. prokaryotic DNA is not associated with proteins ***[1 mark]***. / Prokaryotic DNA is condensed by supercoiling ***[1 mark]***.

1.3 The total length of DNA is 2 m.
1.5% of the DNA encodes proteins.
Therefore, (1.5 ÷ 100) × 2 = 0.03 m of DNA corresponds to protein-encoding genes.
There are 20 000 protein-encoding genes.
Therefore, the average length of a gene is:
0.03 ÷ 20 000 = **0.0000015 m** or **1.5×10^{-6} m**
[2 marks for the correct answer, 1 mark for 0.03 m]

1.4 genome ***[1 mark]***

1.5 proteome ***[1 mark]***