17 Cirrhosis of the liver can result from long-term liver damage. Alcohol or other toxins can cause this damage.

Scientists have suggested that cirrhosis can be detected by taking samples of body fluids and testing them for two different molecules: C-reactive protein and copeptin.

The liver produces these two molecules, and increased levels can indicate liver damage due to cirrhosis.

Different bodily fluids from a patient suspected of having cirrhosis were tested for C-reactive protein and copeptin.

Fig. 17.1 is a graph of the results.

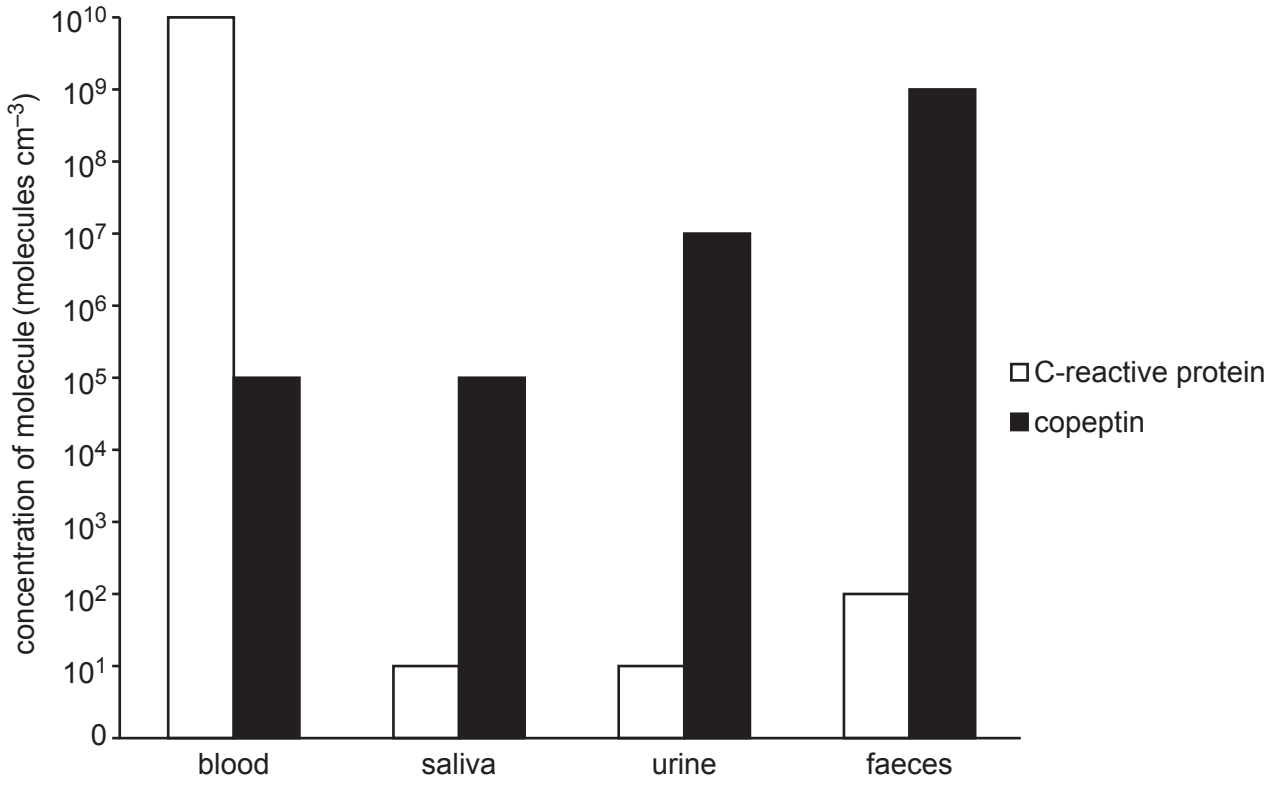

Fig. 17.1

(a) Different bodily fluids have different concentrations of the different molecules.

(i) Calculate the order of magnitude by which concentration of copeptin in the **faeces** is higher than the concentration of C-reactive protein in the **saliva**.

Show your working.

Answer = ... molecules cm^{-3} **[2]**

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(ii) Suggest why blood and faeces have the highest concentrations of C-reactive protein and copeptin.

.....

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.....

.....

..... **[2]**

(b) Fig. 17.2 is an image of a Kupffer cell from the liver.

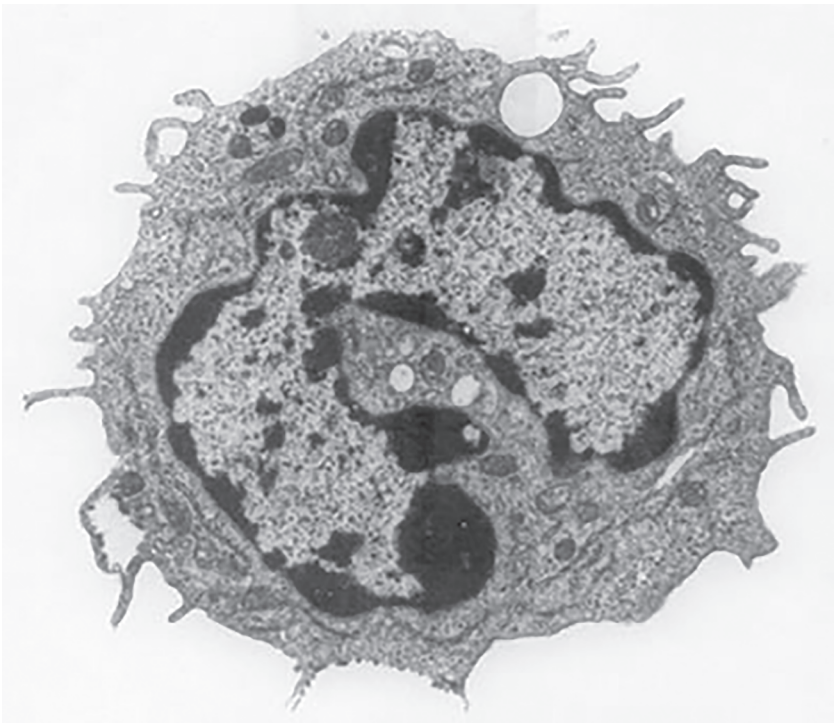

Fig. 17.2

(i) The diameter of the Kupffer cell in the image is 9.1 cm. Assuming it is spherical, calculate the actual volume of this cell.

Give your answer to **four** significant figures. Show your working.

Answer = ... **[3]**

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(ii) Which type of microscope has been used to obtain this image? Explain your answer.

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.....

.....

..... **[2]**

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23 (a) A student looked at slides of different tissues under a light microscope.

The four viewed images are labelled **W**, **X**, **Y** and **Z** in Fig. 23.1, **on the insert**.

Identify tissues **W**, **X** and **Y**.

W .....

X .....

Y .....

[3]

(b) The student wrote the following summary about the control of heart rate.

When the heart rate is too low the level of carboxylic acid in the blood becomes higher than normal. The vagus nerve sends action potentials to the AVN to increase the contraction rate of the heart muscle. The baroreceptors in the walls of the blood vessels then detect that the pH of the blood is normal, so heart rate can return to resting.

The endocrine system can also change heart rate. Release of the hormone adrenaline from the adrenal medulla causes the smooth muscle of the heart to contract more frequently.

Identify **and** correct any biological errors in the student's summary.

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..... **[4]**

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(c) Reflex actions are rapid responses that protect the body from harm.

The Moro reflex is found in babies up to five months of age, and occurs when the baby feels its head is suddenly no longer supported. The Moro reflex is made up of the following responses:

- The baby spreads out its arms then brings them together rapidly.
- The baby cries.

(i) Suggest how the Moro reflex helps to prevent harm to a newborn baby.

.....

.....

.....

.....

..... **[2]**

(ii) The Moro reflex gradually disappears and usually stops completely after babies reach nine months. Other reflexes develop as children grow older.

Describe a reflex response a 3-year-old child would make to an object moving towards their eyes **and** explain the advantage of this response.

.....

.....

.....

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.....

..... **[3]**

END OF QUESTION PAPER

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17(a). **Fig. 17.1** is a diagram of the external view of a mammalian liver.

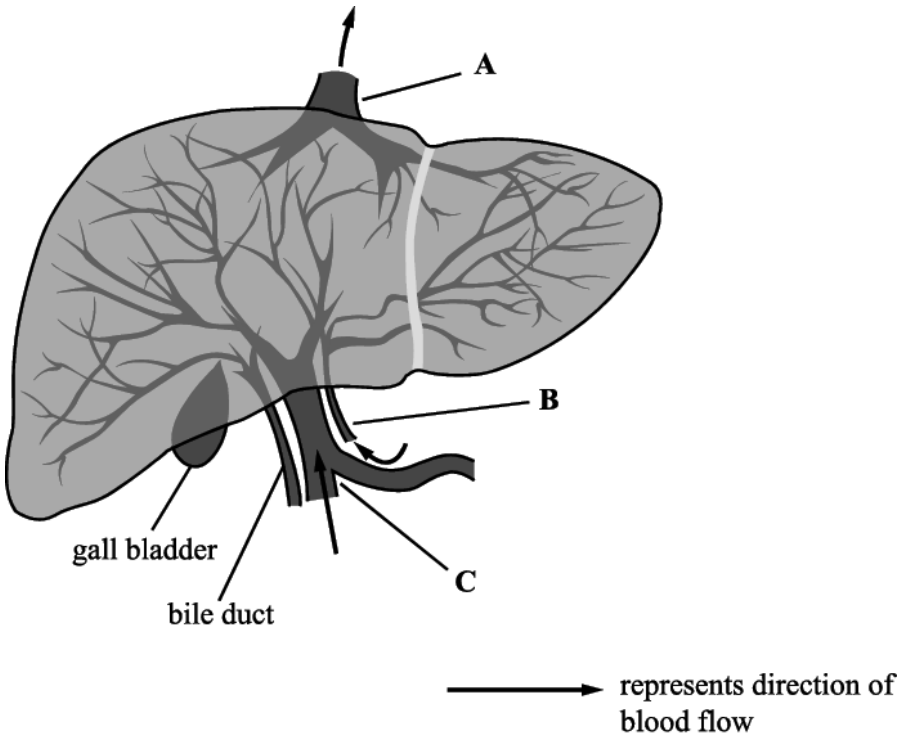

Fig. 17.1

Identify, with reasons, each of the blood vessels labelled **A** – **C** in **Fig. 17.1**.

A

B

C

---

[3]

(b). One of the main functions of the liver cells is the formation of urea by the ornithine cycle, an outline of which is shown in **Fig. 17.2**.

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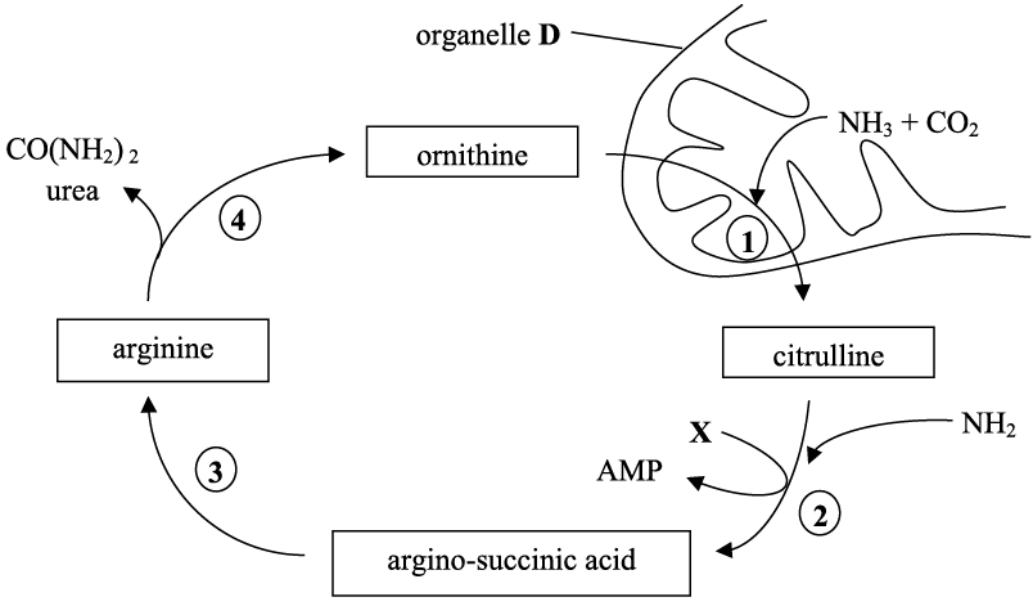

Fig. 17.2

(i) Step **1** of the cycle takes place in the organelle represented by **D**.

Identify organelle **D**.

---

[1]

(ii) During the cycle ornithine moves into organelle **D** and citrulline moves out of the organelle.

Suggest the method by which these molecules move into and out of the organelle during the cycle. Give reasons for your choice.

---

[2]

(iii) How has the ammonia that is used in step **1** been formed?

---

[1]

(iv) Identify the compound labelled **X** in **Fig. 17.2**.

---

[1]

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(c). Liver cells have a high metabolic rate. Hydrogen peroxide is a metabolic product produced in significant quantities in liver cells. It needs to be removed in order to prevent serious damage to the liver cells.

Hydrogen peroxide is detoxified by the enzyme catalase:

$$2H_2O_2 \square\ 2H_2O + O_2$$

Catalase has a very high turnover number. A single catalase molecule can catalyse the breakdown of approximately 6 million hydrogen peroxide molecules every minute. Catalase is found in peroxisomes inside the liver cells. Peroxisomes are organelles surrounded by a single membrane.

The activity of catalase was investigated in a laboratory, using chopped liver tissue and dilute hydrogen peroxide. When the chopped liver was added to the hydrogen peroxide large quantities of froth as bubbles of oxygen were produced in the liquid.

Fig. 17.3 shows the effect of increasing enzyme concentration on the rate of the reaction.

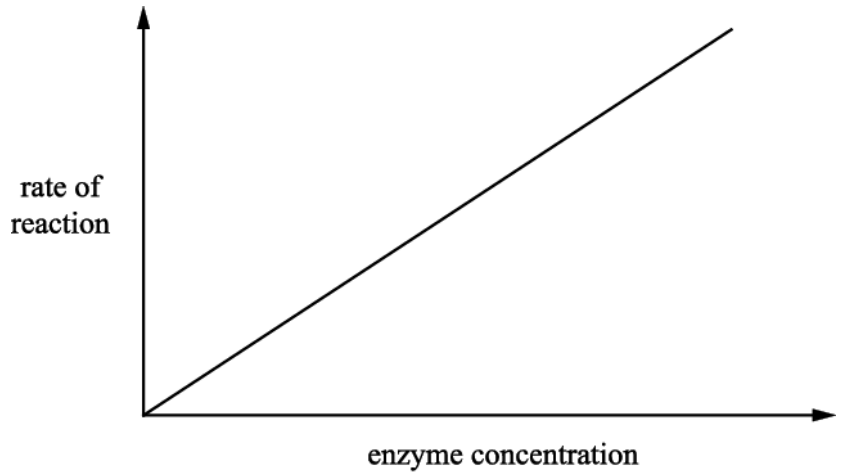

Fig. 17.3

(i) Identify **two** variables that would need to be controlled in this laboratory investigation.

1 ----------

2 ----------

[1]

(ii) How could you control **one** of the variables that you identified in **(i)** in the laboratory investigation?

----

[1]

(iii) * Using the information, deduce why and how catalase activity is regulated inside the liver cells.

[6]

22 **(a)** Fig. 22.1, **on the insert**, is a cross section of part of the cortex of a mammalian kidney.

(i) Which letter identifies the region with the highest hydrostatic pressure?

..... **[1]**

(ii) Which **two** letters identify regions that **do not** contain plasma proteins?

..... **[1]**

(b) Studies of the cell surface membranes of the **distal** convoluted tubule have provided the following evidence:

- Sodium-potassium pumps:
  - move potassium ions from the blood to the tubule fluid
  - move sodium ions from the tubule fluid to the blood
  - use ATP in these processes.

- Sodium-calcium co-transport proteins:
  - move calcium ions from the tubule fluid to the blood
  - move sodium ions into the tubule fluid
  - use the electrochemical gradient of sodium ions to drive this process.

(i) Using this information and your own knowledge, compare the processes occurring in the **proximal** and **distal** convoluted tubules.

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..... **[3]**

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(ii) Nephrogenic diabetes insipidus is a disease of the kidney that affects the regulation of water potential in the blood. One cause is lithium poisoning. Lithium ions enter the kidney tubules through sodium channels.

This prevents the cells of the collecting duct from responding to ADH in the blood.

State and explain **one** symptom you would expect to observe as a result of nephrogenic diabetes insipidus.

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.....

..... **[2]**

(c) Fig. 22.2 shows a podocyte from the kidney. The many gaps between the microscopic processes form fenestrations in the Bowman's capsule.

Fig. 22.2

(i) Explain why podocytes are usually unable to undergo mitosis.

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.....

..... **[3]**

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(ii) Studies show that after damage by infection or injury, it is possible for nephron tissues to be regenerated. Adult stem cells are involved in this process.

What features of adult stem cells make them suitable for regeneration of tissues in the kidney?

.....

.....

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.....

..... **[2]**

END OF QUESTION PAPER

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Question 6 (a)

6 The process of ultrafiltration in the kidney shares similarities with the formation of tissue fluid.

(a)* Describe the similarities and differences between ultrafiltration and the formation of tissue fluid.

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..... **[6]**

This was the more difficult of the Level of Response questions, but examiners saw the full range of marks credited. Those candidates who took the lead from the question and organised their answer into similarities and then differences gave significantly more coherent responses and were credited communication marks. Those who jumped around in their thinking, which was reflected in the poor organisation of the answers, lost the communication mark. Similarly, some listed features of the 2 systems independently and made little attempt to compare them and the communication mark was deducted.

Similarities were more common – most candidates identified high hydrostatic pressure, small molecules to leave and large molecules (e.g. proteins) held back as similarities. Hence the majority of candidates succeeded in reaching at least L1 with 2 similarities.

Correct differences were less common. The most common differences mentioned were the differences in number of filtering layers, and the location of the 2 processes. Common misconceptions seen involved misunderstanding the role of oncotic pressure in both and lack of awareness that ultrafiltration occurred at the Bowman's capsule and nowhere else in the kidney tubule.

Weaker candidates confused ultrafiltration with selective reabsorption, and/or the formation of tissue fluid with its reabsorption and therefore wrote irrelevant answers. A tip for candidates would be to use sub headings to ensure they are covering both areas of the question.

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Exemplar 3

6 The process of ultrafiltration in the kidney shares similarities with the formation of tissue fluid.

(a)* Describe the similarities and differences between ultrafiltration and the formation of tissue fluid.

Both processes rely on hydrostatic pressure to push out the contents of the capillary by mass flow. However in ultrafiltration this pressure is built by a narrower efferent capillary than afferent. Both capillary walls contain gaps or fenestrations to allow only small molecules through like glucose, ions (Na+, K+). However the process of ~~dehydration~~ ultrafiltration has a basement membrane and podocytes which means molecules bigger than a molecular mass of 69 000 cannot pass through. So, lymphocytes and small proteins can pass through to tissue fluid but not into the nephron. The leakiness of the ~~capillary~~ capillary at sites of tissue fluid formation can be altered by the production of histamine whereas the [6]
glomerulus does not. The process of ultrafiltration only occurs at the glomerulus, but tissue fluid is formed all over the body. (by the nephron)
Tissue fluid is drained into the lymphatic system but the nephron leads to the ureter then to the bladder. The formation of tissue fluid has a pressure working against hydrostatic pressure called oncotic pressure whereas, ultrafiltration does not.

L2

This candidate achieved a Level 3 for this response. It fulfilled the need for several similarities (both processes involve hydrostatic pressure and filtering of small molecules through capillary walls) and several differences (location of the processes, and what happens to the molecules following the two processes). Generally, the response is well organised, despite the incorrect statements about oncotic pressure and histamine.

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Exemplar 4

6 The process of ultrafiltration in the kidney shares similarities with the formation of tissue fluid.

(a)* Describe the similarities and differences between ultrafiltration and the formation of tissue fluid.

Ultrafiltration in the kidneys happen when substances need to be excreted and so passes through the Glomerolous which are a bundle of capillaries. It enters through the efferent arterole which is larger in diameter than the ~~small~~ afferent arteride. This creates a high blood pressure within this space. This is similar to the formation of tissue fluid, this because the pressure of blood near the arteride is too high and so it diffuses to surrounding tissue space. The difference is that the blood in the kidney is going into the Bowman's capsule ~~or~~ through different layers to prevent any large substances entering. ~~However~~ However in the tissue fluid, it just surround the tissue and not entering in substances like Red blood cells can't be diffused in ~~both cases~~ kidney as ~~is~~ too big. ~~Both~~ to pass through pores. But can in tissue fluid formation [6]

In both circumstances, ~~the~~ the blood ~~red~~ enters back into the arteriole space. In the tissue fluid, it goes toward the capillary bed whereas, after it has left Bowmans capsule in the kidney, it moves away from the bundle of capillaries towards the DCT, PCT and collecting duct.

The final product of tissue fluid is ~~the~~ material that is not sent back into the blood and surrounds tissues, and the final product of ultrafiltration is the filtrate, with no ~~substan~~ large substances within.

→ which can be sent to lymph ~~vette~~ vessels after

→ eg. red blood cells

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In this case, we have a similarity- the high pressure needed in both processes- and a difference - where the processes occur- so it achieves a Level 1. It is not easy to pick out these points as the terminology used is not clear. There is also a lot of irrelevant material and so this response loses its communication mark.

Question 6 (b) (i)

(b) A person's glomerular filtration rate (GFR) provides an indication of the health of their kidneys. The GFR is a measure of the volume of blood that can be filtered by the kidneys every minute.

GFR can be estimated by monitoring the blood concentration of creatinine, which is a breakdown product of creatine phosphate in muscles.

(i) Suggest **two** characteristics of a patient that must be taken into account when using this GFR measurement to diagnose kidney damage.

Explain why each characteristic must be considered.

1 .....

.....

.....

2 .....

.....

.....

[4]

Many candidates used age, exercise or diet as the two characteristics. These were often explained well. Less able candidates did not comprehend the question fully, and listed causes of kidney failure or other medical conditions such as high blood pressure, diabetes and heart disease as factors to consider, which were not relevant to the way in which GFR was being measured.

Question 6 (b) (ii)

(ii) If kidney damage is suspected, the patient's urine is likely to be tested for the protein albumin.

Explain why the presence of albumin in the urine indicates kidney damage.

.....

..... **[1]**

Candidates generally had the right idea, but forfeited the mark through an inability to express themselves clearly. Better answers referred to the large molecular size of albumin.

Many thought the damage was a result of a problem with reabsorbing the protein. A very common error was in using the term 'filtered out' or 'not filtered out' – and it was difficult to understand what the candidate was trying to express with this terminology.

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SECTION A

You should spend a maximum of 20 minutes on this section.

Write your answer to each question in the box provided.

Answer **all** the questions.

1 Which of the options, **A** to **D**, correctly describes how an endotherm would respond to an increase in temperature?

A dilation of arterioles near the surface of the skin

B erector muscles contract, causing hairs to stand up

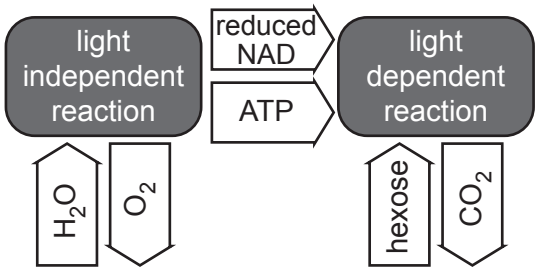
C rapid contractions of skeletal muscles

D sweat glands release less sweat

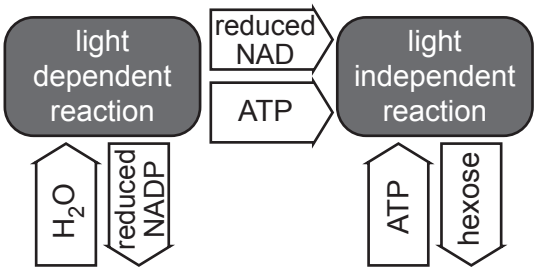
Your answer ☐ **[1]**

2 Which of the images, **A** to **D**, correctly summarises photosynthesis?

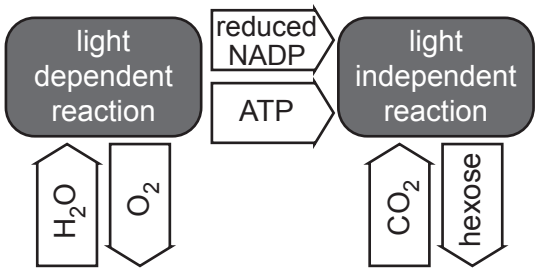
A



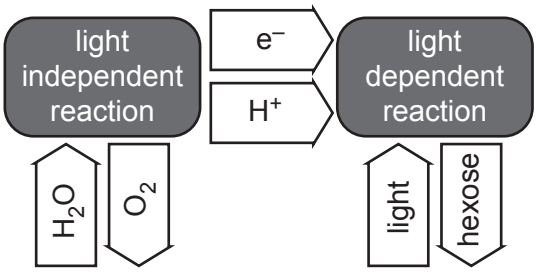
B



C



D



Your answer ☐ **[1]**

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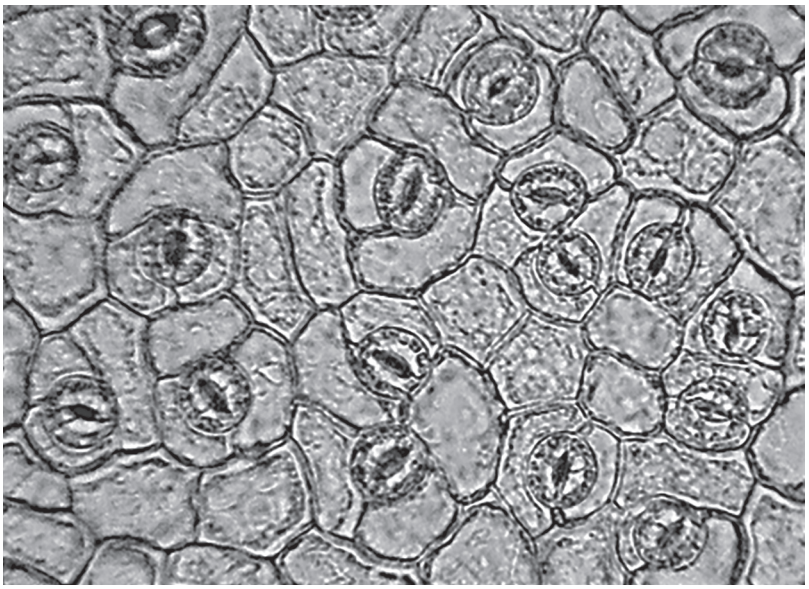
3 A student counted stomata on a leaf using a light microscope. The image below shows the stomata that were visible.

The image magnification is ×60.



Which of the options, **A** to **D**, is the correct stomatal density of this leaf?

A 7.50 stomata mm^{-2}

B 0.13 stomata mm^{-2}

C 2428 stomata mm^{-2}

D 0.21 stomata mm^{-2}

Your answer ☐ **[1]**

4 Which of the options, **A** to **D**, occurs in the nucleus of a cell?

A synthesis of enzymes

B synthesis of RNA

C modification of polypeptides

D synthesis of carbohydrates

Your answer ☐ **[1]**

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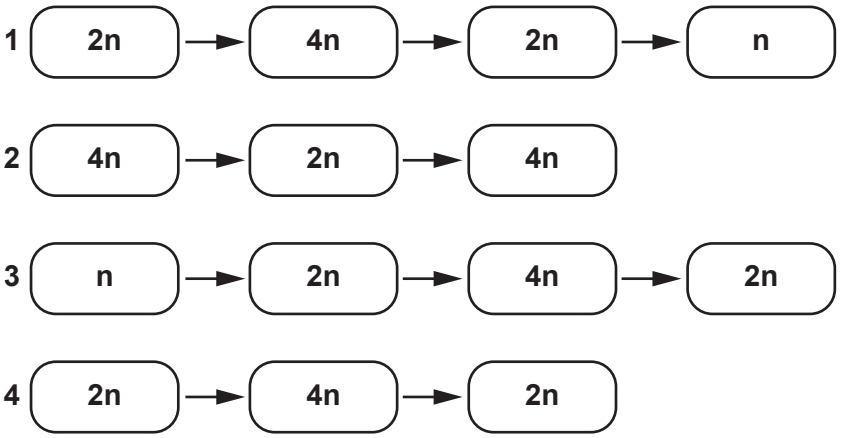
5 During cell division, the chromosome number in the cells changes.

The following sequences describe the chromosome number in cells before, during and after different types of cell division.



Which of the options, **A** to **D**, correctly describes the stages of mitosis and meiosis in human cells?

A 1 is mitosis, 2 is meiosis

B 2 is mitosis, 3 is meiosis

C 3 is mitosis, 4 is meiosis

D 4 is mitosis, 1 is meiosis

Your answer ☐ **[1]**

6 Patients with kidney failure can be treated in different ways.

Which of the following statements describes a feature of peritoneal dialysis?

1 Urea and mineral ions pass into the tissue fluid.
2 Blood is passed over an artificial membrane to remove toxins.
3 The patient receives immunosuppressant medication.

A 1, 2 and 3

B Only 1 and 2

C Only 2 and 3

D Only 1

Your answer ☐ **[1]**

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7 Bony fish absorb dissolved oxygen from the water using gills. Water is passed through the buccal cavity and over the gill lamellae. The oxygen saturation of the blood and water changes as the water passes over the gills.

Which of the statements, **A** to **D**, correctly describes the way oxygen is transferred into the blood at the gills?

A Blood and water flow in a concurrent system with a constant concentration gradient between them.

B Blood and water flow in a countercurrent system with a constant concentration gradient between them.

C Blood and water flow in a concurrent system with a greater concentration gradient between them at the start of the gill lamella.

D Blood and water flow in a countercurrent system with a greater concentration gradient between them at the start of the gill lamella.

Your answer ☐ **[1]**

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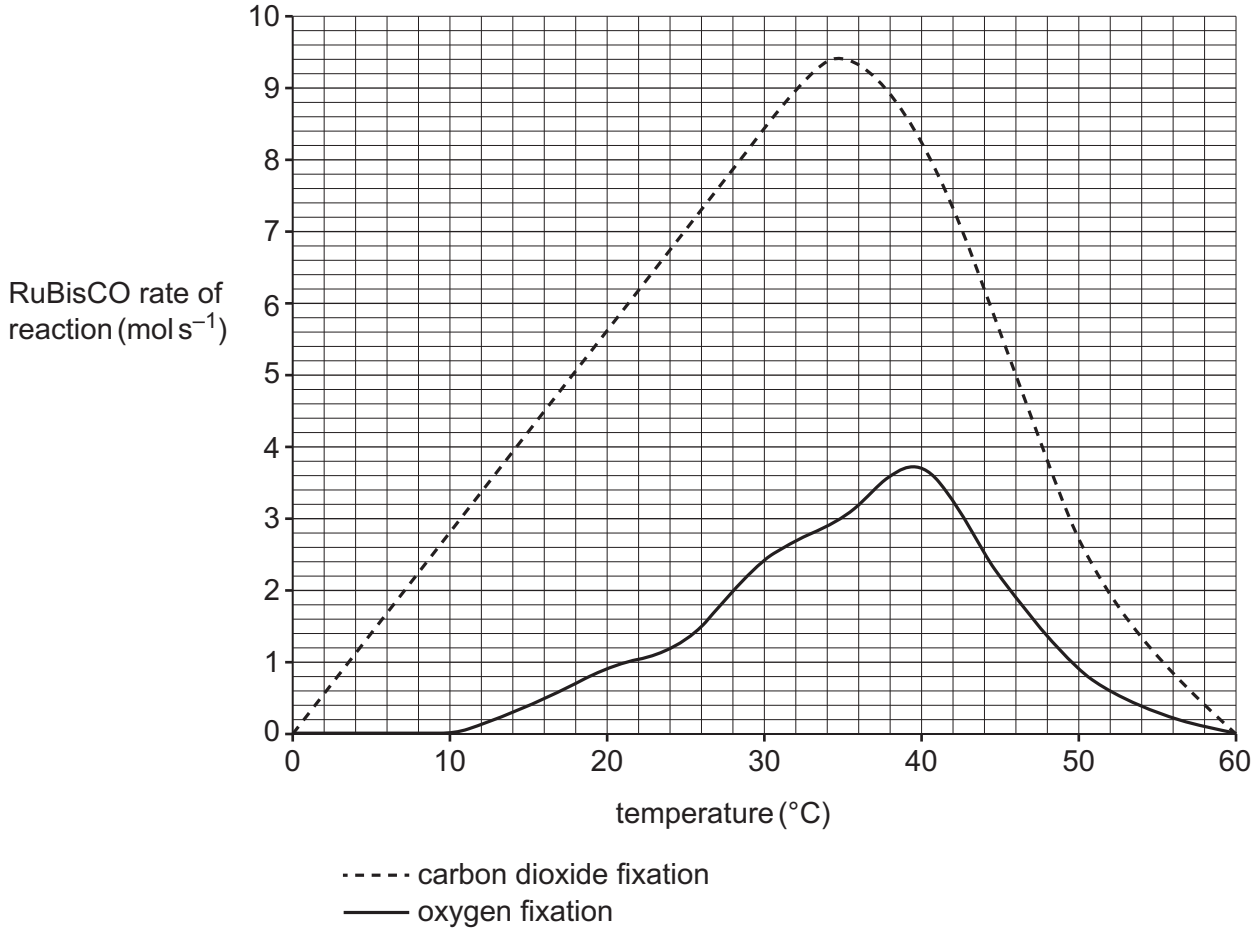
8 RuBisCO is an enzyme that fixes carbon dioxide in photosynthesis. In some conditions, RuBisCO also carries out oxygen fixation.

The graph below shows how the carbon dioxide and oxygen fixing activities of RuBisCO are affected by temperature.



What are the correct percentage changes in RuBisCO carbon dioxide and oxygen fixing activities between 30 °C and 40 °C?

A carbon dioxide fixation –12.7%, oxygen fixation 23.3%

B carbon dioxide fixation –14.6%, oxygen fixation 18.9%

C carbon dioxide fixation –2.4%, oxygen fixation 54.2%

D carbon dioxide fixation –3.6%, oxygen fixation 35.1%

Your answer ☐ **[1]**

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9 The hormone hCG can be detected in urine using pregnancy tests.

Which of the following properties of the hormone hCG allows it to be detected in urine?

A hCG is a polar molecule

B hCG has a molecular mass of less than 69,000

C hCG is a polypeptide

D hCG binds to cells using glycoproteins

Your answer ☐ **[1]**

10 The hormone ecdysone is synthesised in the prothoracic glands found in the upper thorax of some invertebrates and is released into haemolymph. It is then transported to cells near the surface of the body and causes the loss of the exoskeleton so that a new exoskeleton can form.

Which of the following statements explains how ecdysone is able to act on cells near the surface of the body?

1 Ecdysone is synthesised by specialised neurosecretory cells.
2 Ecdysone is soluble in haemolymph because it is a polar molecule.
3 Ecdysone is complementary to cell surface receptors on cells throughout the body of some invertebrates.

A 1, 2 and 3

B Only 1 and 2

C Only 2 and 3

D Only 1

Your answer ☐ **[1]**

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11 Which of the statements, **A** to **D**, correctly describes the process of adhesion?

A attraction of water molecules to the impermeable walls of xylem tissue

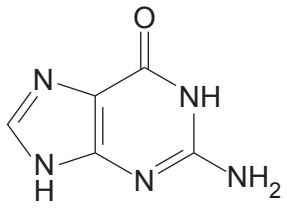
B attraction of water molecules to other water molecules in the xylem tissue

C active transport of water molecules into phloem tissue

D attraction of water molecules to other water molecules in the phloem tissue

Your answer ☐ **[1]**

12 The image below shows the structure of the nucleotide base guanine.



Bird droppings are known as *guano* because they contain a high proportion of guanine. Unlike mammals, birds excrete nitrogenous waste as guanine instead of urea. Guanine is synthesised from ammonia in the liver.

The following statements relate to guanine:

1 ammonia is more toxic than guanine
2 urea is more soluble in water than guanine
3 guanine has a high proportion of nitrogen

Which of the statements correctly explains why birds excrete guanine?

A 1, 2 and 3

B Only 1 and 2

C Only 2 and 3

D Only 1

Your answer ☐ **[1]**

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13 Different sized mammals have different surface area to volume ratios.

The table shows the surface areas and volumes of four different groups of mammals.

Mammal genus	Surface area (m^2)	Volume (m^3)
Oryctolagus	0.48	2.0×10^{-2}
Equus	18.26	2.24
Mus	1.9×10^{-3}	7.2×10^{-5}
Rattus	0.32	1.6×10^{-2}

Which of the options, **A** to **D**, is the correct order of surface area to volume ratios for the different mammals, arranged from the largest to the smallest?

A *Oryctolagus, Rattus, Equus, Mus*

B *Mus, Rattus, Oryctolagus, Equus*

C *Mus, Oryctolagus, Rattus, Equus*

D *Equus, Mus, Oryctolagus, Rattus*

Your answer ☐ **[1]**

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14 The commercially grown tobacco plant, *Nicotiana rustica*, has many pests. One such insect pest is *Manduca sexta*, which causes damage to the stems and leaves of *N. rustica*.

The tiny wasp *Cotesia congregata* lays its eggs inside the body of *M. sexta*. When the larvae develop they feed on the body of the host, eventually killing it.

N. rustica produces a volatile organic compound called volicitin when its leaves are damaged.

Volicitin attracts *C. congregata* at high concentrations.

Which of the following explains why *N. rustica* releases volicitin?

1 volicitin release reduces herbivory in *N. rustica*
2 volicitin release increases *M. sexta* growth rate
3 volicitin release reduces parasitism of *M. sexta* by *C. congregata*

A 1, 2 and 3

B Only 1 and 2

C Only 2 and 3

D Only 1

Your answer ☐ **[1]**

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15 Mistletoe is a plant parasite that lives on the stems of other plants. It survives by removing water and assimilates from the host plant.

The mistletoe binds to the stem of the host plant and grows a specialised root-like tissue called a haustorium that attaches to different tissues in the stem.

One species of mistletoe, *Viscum minimum*, contains no chloroplasts.

Which of the options, **A** to **D**, explains why *V. minimum* does not need chloroplasts?

A the haustorium of *V. minimum* attaches to sieve tube elements

B the haustorium of *V. minimum* attaches to xylem vessels

C the haustorium of *V. minimum* attaches to meristem cells

D the haustorium of *V. minimum* attaches to cambium tissue

Your answer ☐ **[1]**

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Question			Answer	Marks	Guidance
17	(a)	(i)	10^8 **OR** 1×10^8 **OR** 100 000 000 ✓✓	2	**If answer is incorrect ALLOW one mark** *For evidence of correct working* i.e.$10^9 \div 10^1$
	(a)	(ii)	liver has , large / good / AW , blood supply ✓ released / secreted / AW , into bile ✓	2	**IGNORE** reference to C-reactive protein and copeptin throughout **ALLOW** liver has sinusoids
17	(b)	(i)	3157 $\underline{\mu m^3}$ / 3.157 x10^3 $\underline{\mu m^3}$ **OR** 3155 $\underline{\mu m^3}$ / 3.155 x10^3 $\underline{\mu m^3}$ *(3.14 used for value of π)* **OR** 3158 $\underline{\mu m^3}$ / 3.158 x10^3 $\underline{\mu m^3}$ *(22/7 used for value of π)* **OR** 3.157 / 3.155 / 3.158 , $\times10^{-15}$ $\underline{m^3}$ *(answer using SI units)* ✓✓✓	3	**ALLOW for two marks** *correctly calculated value not given to 4SF* e.g. 3156.55 μm^3 3157.82 μm^3 (22/7used) 3154.95 μm^3 (3.14 used) **OR** *correctly calculated value without units* e.g. 3157 / 3.157 **OR** *correctly calculated value with inappropriate units* e.g. $3.157\text{x}10^{-6}$ mm^3 $3.157\text{x}10^{-9}$ cm^3 ***If two or three marks were not awarded for the correct answer or calculated value:*** *for **one mark** look for evidence of use of the formula:* $(4/3) \times \pi \times r^3$

Question			Answer	Marks	Guidance
17	(b)	(ii)	(transmission) electron (microscope) ✓ **AND ONE** of the following: 2D image ✓ internal details visible ✓ (named) organelles / ultrastructures , visible ✓ high <u>magnification</u> ✓ high <u>resolution</u> ✓	**2 max**	**ALLOW** TEM **DO NOT ALLOW** scanning electron microscope / SEM **IGNORE** black and white / colour e.g. mitochondria **IGNORE** nucleus (as visible under a light microscope)
			Total	**9**	

Question			Answer	Marks	Guidance
23	(a)		**W** liver / hepatic ✓ **X** pancreas / pancreatic ✓ **Y** skeletal / striated , muscle ✓	3	**IGNORE** cells **ALLOW** Islet of Langerhans / acini
	(b)		*carboxylic acid* should be carbonic acid / H_2CO_3 ✓ *vagus* (nerve) should be , accelerator / sympathetic / accelerans , (nerve) ✓ *AVN* should be , SAN / sinoatrial node ✓ *baroreceptors* should be chemoreceptors **OR** *pH* should be pressure ✓ *smooth muscle* should be cardiac muscle ✓	max 4	*Error* and correct term must be clearly identified. **ALLOW** copied statements where correct terms replace errors. **IGNORE** carbon dioxide **ALLOW** specialised striated
	(c)	(i)	allows baby to , (try to) hold on / grasp ✓ (crying) draws attention (to the baby) ✓	2	**ALLOW** alerts parent / encourages someone to pick baby up
		(ii)	*description:* (rapid) blinking / shutting / closing (of eyes) ✓ *explanation:* involuntary ✓ prevents , damage to / objects entering , eyes ✓	3	**ALLOW** references to , ducking / raising hands / flinching **ALLOW** unconscious / automatic / innate / instinctive **ALLOW** protects the eyes
			Total	12	

Question			Answer/Indicative content	Marks	Guidance
17	a		**A** hepatic vein as blood leaving liver (1) **B** hepatic artery as blood entering liver through narrow vessel (1) **C** hepatic portal vein as blood (from gut) entering liver through branched vessel (1)	3	
	b	i	mitochondrion	1	**ALLOW** mitochondria.
		ii	*either* facilitated diffusion (1) conversion of ornithine into citrulline creates concentration gradients **or** (molecules are not lipid soluble so) require protein channels to cross membrane (1) ***or*** active transport (1) ornithine and citrulline need to be moved into and out of **D** more quickly than would be met by diffusion (1)	2	
		iii	deamination / removal of NH_2 group from amino acid (1)	1	
		iv	ATP (1)	1	
	c	i	*two from* pH temperature substrate / hydrogen peroxide concentration (1)	1	Two answers required for 1 mark. **DO NOT ALLOW** an answer that includes mass of liver / enzyme concentration.
		ii	*pH* take pH reading / ensure hydrogen peroxide is same pH for all enzymes concentrations tested (1) *temperature* use liver tissue and hydrogen peroxide at room temperature / same temperature for all enzyme concentrations tested (1) *substrate concentration* use same concentration and volume of hydrogen peroxide for all enzyme concentrations tested (1)	1	

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Question			Answer/Indicative content	Marks	Guidance
		iii	* **Level 3 (5–6 marks)** Deduction includes coherent interpretation of the evidence, clearly linking all ideas to explain why and how activity is regulated. *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** Deduction includes clear use of some evidence to support conclusion but ideas may not be clearly linked for both how and why. *There is a line of reasoning presented with some structure. The information presented is in the most-part relevant and supported by some evidence.* **Level 1 (1–2 marks)** A simple deduction about how or why based on a limited interpretation of the evidence. *The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear.* **0 marks** No response or no response worthy of credit.	6	**Relevant points include:** *Why* • large quantities of hydrogen peroxide and high turnover number of catalase would mean vigorous reaction and lots of oxygen produced very quickly. *How* • isolation of catalase in peroxisomes • released in small quantities • cells can limit expression of catalase • this effectively limits enzyme concentration and therefore reduces reaction rate • cells have no control over temperature or substrate concentration so enzyme concentration is the only method of control.
			Total	**16**	

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Question			Answer	Marks	Guidance
22	(a)	(i)	**A** ✓	1	*mark the first letter only* **IGNORE** name unless contradicts a stated letter
	(a)	(ii)	**B** , **D** ✓	1	*If more than two letters given, 0 mark* **IGNORE** names unless contradicts a stated letter
22	(b)	(i)	*similarities* **S1** both use <u>active transport</u> ✓ **S2** both involve , co-transport / described ✓ **S3** both involve <u>selective</u> reabsorption ✓ **S4** both involve use of , sodium ions / Na^+ ✓ *differences* **D1** DCT involves use of , calcium ions / Ca^{2+} ✓ **D2** (co-transport in) DCT involves ions only ✓ **D3** PCT involves ions and (named) molecules ✓	3 max	*maximum two marks for similarities or differences* **IGNORE** sodium / Na **IGNORE** calcium / Ca **e.g.** glucose / amino acid(s)
	(b)	(ii)	*symptom* high volume of / excess , urine **OR** always thirsty / AW ✓ *explanation* fewer / AW , aquaporins in the (plasma) membrane (of collecting duct cells) ✓	2	**ALLOW** large amount / lots , of urine **IGNORE** reference to , dilute urine / water potential / frequency of urination **ALLOW** <u>protein</u> water channels for aquaporins

Question			Answer	Marks	Guidance
22	(c)	(i)	**1** have already / are , differentiated / specialised (so cannot divide) ✓ **2** are in , G_0 (phase of cell cycle) / resting phase ✓ **3** *idea that* shape is (too) , irregular / asymmetrical (so cannot divide) ✓ **4** cytoskeleton cannot function / spindle (fibres) cannot form✓ **5** (if mitosis occurred) it would alter , number / size , of the , gaps / fenestrations ✓ **6** *idea that it* would alter an aspect of ultrafiltration ✓	**3 max**	**ALLOW** cannot pass G1 checkpoint / cannot go into S phase / remains in G_1 e.g. (podocyte) has projections (so cannot divide) **ALLOW** for aspect of ultrafiltration e.g. different sized molecules can pass through e.g. no / less , ultrafiltration e.g. changes rate of ultrafiltration e.g. changes composition of filtrate
	(c)	(ii)	(adult stem cells) are <u>multipotent</u> ✓ (differentiate to) become any <u>cell</u> type within , kidney / nephron (tissue) ✓	**2**	**DO NOT ALLOW** totipotent / pluripotent **ALLOW** (adult stem cells) can , differentiate / specialise
			Total	**12**	

Question			Answer	Marks	Guidance
			or systematic sampling / place quadrats at, set / pre-determined, intervals along the transect **or** random sampling using quadrats in, selected areas / strata ✓		(N.B. only allow random sampling in context of stratified sampling)
			pooter / sweep nets / pitfall traps / light traps / tree-beating ✓		**ALLOW** any suitable method of trapping insects **IGNORE** capture mark recapture
		iii	Woodland = (k)g m^{-2} yr^{-1} / (k)J m^{-2} yr^{-1} **AND** Lake = (k)g m^{-3} yr^{-1} / (k)J m^{-3} yr^{-1} ✓	**1**	**ALLOW** (k)g h^{-1} yr^{-1} / (k)J h^{-1} yr^{-1} / tonnes h^{-1} yr^{-1} / (k)g (k)m^{-2} yr^{-1} / (k)J (k)m^{-2} yr^{-1} **ALLOW** (k)g (d)m^{-3} yr^{-1} / (k)J (d)m^{-3} yr^{-1} / (k)g (k)m^{-3} yr^{-1} / (k)J km^{-3} yr^{-1} **ALLOW** hectare $^{-1}$ for h^{-1} **ALLOW** y for yr **DO NOT ALLOW** 'per' **ALLOW** '/' instead of $^{-1}$
6	**a**		**Level 3 (5-6 marks)** Correctly describes similarities **and** differences between the processes *There is a well-developed line of reasoning, which is clear and logically-structured and uses scientific terminology at an appropriate*	**6**	**Indicative scientific points may include** *Similarities:* • Small molecules are filtered from/diffuse out of the blood.

Question			Answer	Marks	Guidance
			level. All the information presented is relevant and forms a continuous narrative. **Level 2 (3-4 marks)** Correctly describes a similarity **and** a difference between the processes *There is a line of reasoning presented with some structure and use of appropriate scientific language. The information presented is mostly relevant.* **Level 1 (1-2 marks)** Correctly describes similarities **or** differences between the processes *The information is communicated with only a little structure. Communication is hampered by the inappropriate use of technical terms.* **0 marks** No response or no response worthy of credit.		• Both processes occur in capillaries. • Large molecules/proteins/ cells, remain in the blood. • High (hydrostatic) pressure in both processes. • Many molecules (e.g. water, sugars, ions) are reabsorbed back into capillaries. • Blood vessels become narrower to maintain (hydrostatic) pressure • Hydrostatic pressure greater than oncotic pressure in both • Neutrophils / lymphocytes, can pass through in both • Both involve basement membranes *Differences:* • Filtrate enters the Bowman's capsule and then the PCT in the kidney, but tissue fluid bathes cells/enters intercellular space. • Molecules that are not reabsorbed by capillaries form urine in the kidney, but molecules that are not reabsorbed from

Question			Answer	Marks	Guidance
					tissue fluid will, enter cells / form lymph. • Blood filtered through 3(named) layers in ultrafiltration, but only 1 (named) layer in formation of tissue fluid • knot of capillaries in ultrafiltration but a network of capillaries in formation of tissue fluid
6	b	i	age ✓ (because) GFR / kidney function , declines with age ✓ gender ✓ (because) men and women have different muscle mass ✓ exercise / muscle activity / muscle mass / fitness / pregnancy / body mass ✓ (because this will) alter, metabolism of creatine (phosphate) / production of creatinine ✓ diet ✓ (because this will) affect levels of, creatine (phosphate) / creatinine (in the blood) ✓ ethnicity / genetic make up ✓ different alleles, affect metabolism of creatine (phosphate)	4 max	**Mark first two characteristics given** **Only award mark for explanation if correctly linked to characteristic** **IGNORE** chances of kidney failure increase with age **ALLOW** 'more / less, creatinine / product (in blood)' **ALLOW** 'more / less, creatine (in muscle) **ALLOW** use of creatine supplements

Question			Answer	Marks	Guidance
			/ production of creatinine ✓		
		ii	*idea that* large proteins, should remain in the blood / not enter, Bowman's capsule / nephron ✓	1	e.g. 'proteins / albumin, too large to cross the basement membrane' ' proteins are too large to be filtered and be present in the urine'
			Total	**70**	

Question			Answer	Marks	Guidance
1			A ✓	1	
2			C ✓	1	
3			A ✓	1	
4			B ✓	1	
5			D ✓	1	
6			D ✓	1	
7			B ✓	1	
8			C ✓	1	
9			B ✓	1	
10			C ✓	1	
11			A ✓	1	
12			A ✓	1	
13			C ✓	1	
14			D ✓	1	
15			A ✓	1	
			Total	**15**	