Homeostasis in Mammals (14.1): Cambridge (CIE) A Level Biology 9700 Exam Questions by Topic

22 questions · 79 marks · about 95 minutes. Answer in the spaces, then check the mark schemes at the end.

Question 1 · Paper 4 · October/November 2022 (41) · Q10 · 5 marks

10 The passage below outlines homeostasis.

Complete the passage by using the most appropriate scientific terms.

Homeostasis, in mammals, is the process of keeping the ..... environment of the body in optimum conditions so that cells can function efficiently. Blood water potential, core temperature and blood glucose concentration are all factors that need to be kept at optimum values or set-point.

When a condition deviates from its set-point, a corrective mechanism is triggered. An increase in blood glucose concentration triggers processes to decrease it and vice versa. This corrective mechanism is called ..... .

The pancreas is involved in the control of blood glucose concentration. Glucose binds to ..... on the cell surface membrane of pancreatic cells. These are ..... cells, which secrete hormones such as insulin and glucagon. The two hormones have opposite effects on the blood glucose concentration. For example the action of one hormone stimulates the uptake of glucose by cells for respiration and the action of the other hormone stimulates the breakdown of ..... to glucose in the liver.

Question 2 · Paper 4 · May/June 2024 (42) · Q10(a) · 1 mark

10 (a) In mammals, blood glucose concentration is maintained around a set point so that the mammal can function efficiently. This is an example of homeostasis.

Name the mechanism that maintains blood glucose concentration around a set point.

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Question 3 · Paper 4 · May/June 2021 (42) · Q6(d) · 3 marks

(d) GLP-1 inhibits the emptying of the stomach. This is an example of negative feedback.

Explain what is meant by negative feedback.

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Question 4 · Paper 4 · October/November 2024 (41) · Q6(a)(i) · 2 marks

6 The mammalian kidney is responsible for:

- the excretion of urea
- osmoregulation (the homeostatic control of the water potential of the blood).

(a) (i) Outline how **and** where the excretory product urea is made in the body.

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1 (a) Fig. 1.1 is a drawing of a longitudinal section (LS) of a human kidney.

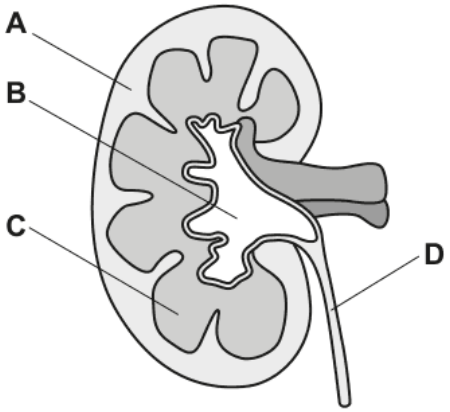


Fig. 1.1

Use the letters **A**, **B**, **C** and **D** in Fig. 1.1 to complete Table 1.1.

Each letter may be used once, more than once or not at all.

For each description, list **all** the letters that are correct.

Table 1.1

description	region of kidney
location of loops of Henle	.....
location of Bowman's capsules	.....
location of glomeruli	.....
contains urine at final concentration	.....

[4]

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6 (a) Fig. 6.1 is a photomicrograph of a section through a Bowman's capsule and a glomerulus.

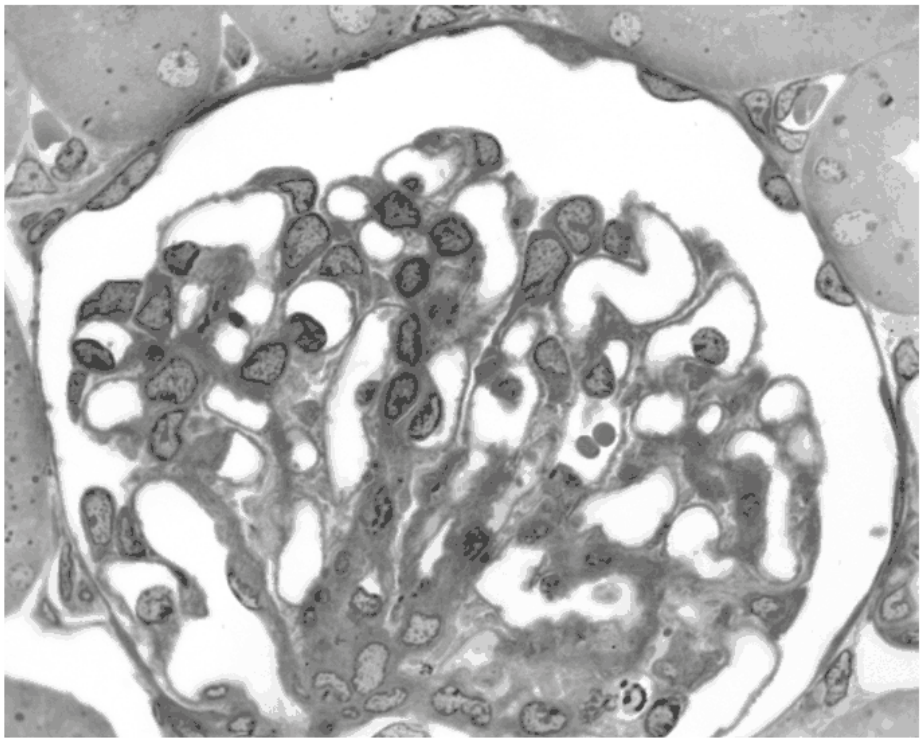


Fig. 6.1

On Fig. 6.1, use label lines and letters to label:

F – the location of the glomerular filtrate

P – the location of the blood plasma. [2]

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1 (a) The Bowman's capsule of a nephron is involved in ultrafiltration.

Fig. 1.1 is a diagram of part of a Bowman's capsule and glomerulus.

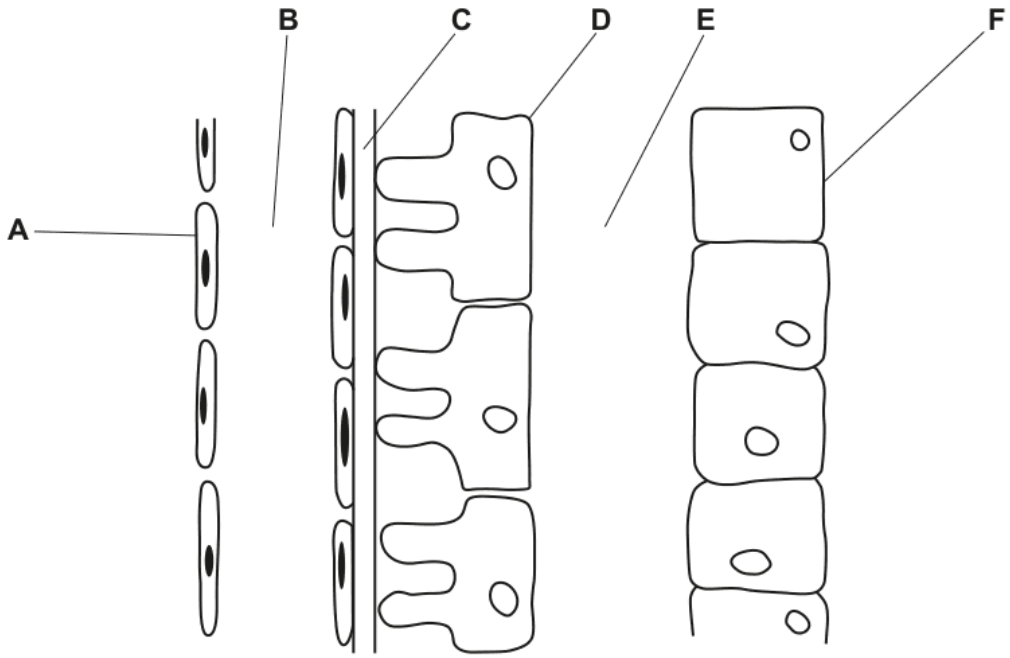


Fig. 1.1

With reference to Fig. 1.1, complete Table 1.1 using the letters **A** – **F**.

Each letter may be used once, more than once or not at all.

Table 1.1

feature	letter
glomerular filtrate	.....
basement membrane	.....
podocyte cell	.....
capillary endothelial cell	.....

[4]

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Question 8 · Paper 4 · May/June 2022 (42) · Q9(a) · 2 marks

9 **(a)** Ultrafiltration in the kidney takes place between the glomerulus and the Bowman's capsule. The afferent blood vessel carrying blood to the glomerulus has a wider lumen than the efferent blood vessel.

Explain why the lumen of the afferent blood vessel needs to be wider than the lumen of the efferent blood vessel.

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Question 9 · Paper 4 · May/June 2022 (42) · Q9(b)(i) · 2 marks

(b) Fig. 9.1 is a diagram of part of the glomerulus and Bowman's capsule.

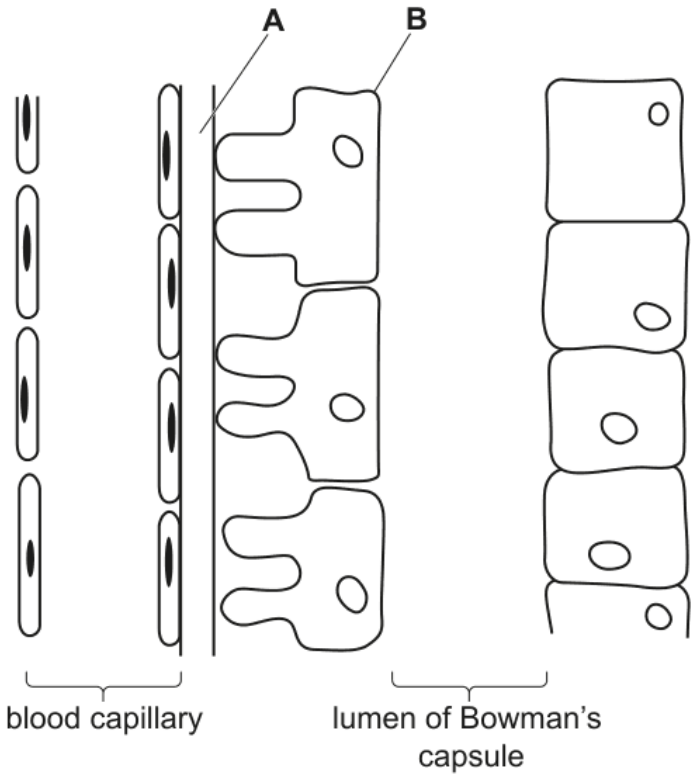


Fig. 9.1

(i) Name **A** and **B**.

A .....

B .....

[2]

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Question 10 · Paper 4 · May/June 2022 (42) · Q9(b)(ii) · 3 marks

(ii) Describe the roles of **A** and **B** in the formation of the glomerular filtrate.

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Question 11 · Paper 4 · May/June 2023 (42) · Q6(c) · 7 marks

(c) The glomerular filtrate passes from the Bowman's capsule to the proximal convoluted tubule, where selective reabsorption takes place.

Describe the process of selective reabsorption.

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Question 12 · Paper 4 · October/November 2022 (42) · Q8(a) · 2 marks

8 **(a)** Selective reabsorption takes place in the proximal convoluted tubule of a kidney nephron.

Fig. 8.1 is a diagram of two cells of the proximal convoluted tubule and part of the adjacent blood capillary.

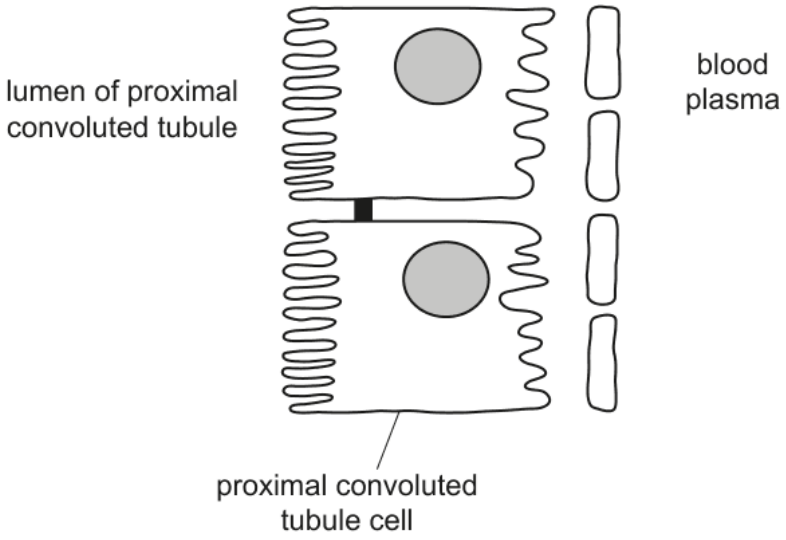


Fig. 8.1

The cells of the proximal convoluted tubule are adapted to carry out selective reabsorption.

On Fig. 8.1, use label lines and letters to indicate:

- **C**, where cotransporter proteins are located
- **P**, where sodium-potassium pumps are located. [2]

Question 13 · Paper 4 · October/November 2022 (42) · Q8(b) · 5 marks

(b) Explain how the cells of the proximal convoluted tubule are adapted to carry out selective reabsorption.

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9 (a) Antidiuretic hormone (ADH) is involved in the maintenance of a constant blood water potential.

A student drank 0.5 dm^3 of water and the concentration of ADH in their blood was measured every 30 minutes for 3 hours.

Fig. 9.1 shows the results of this investigation.

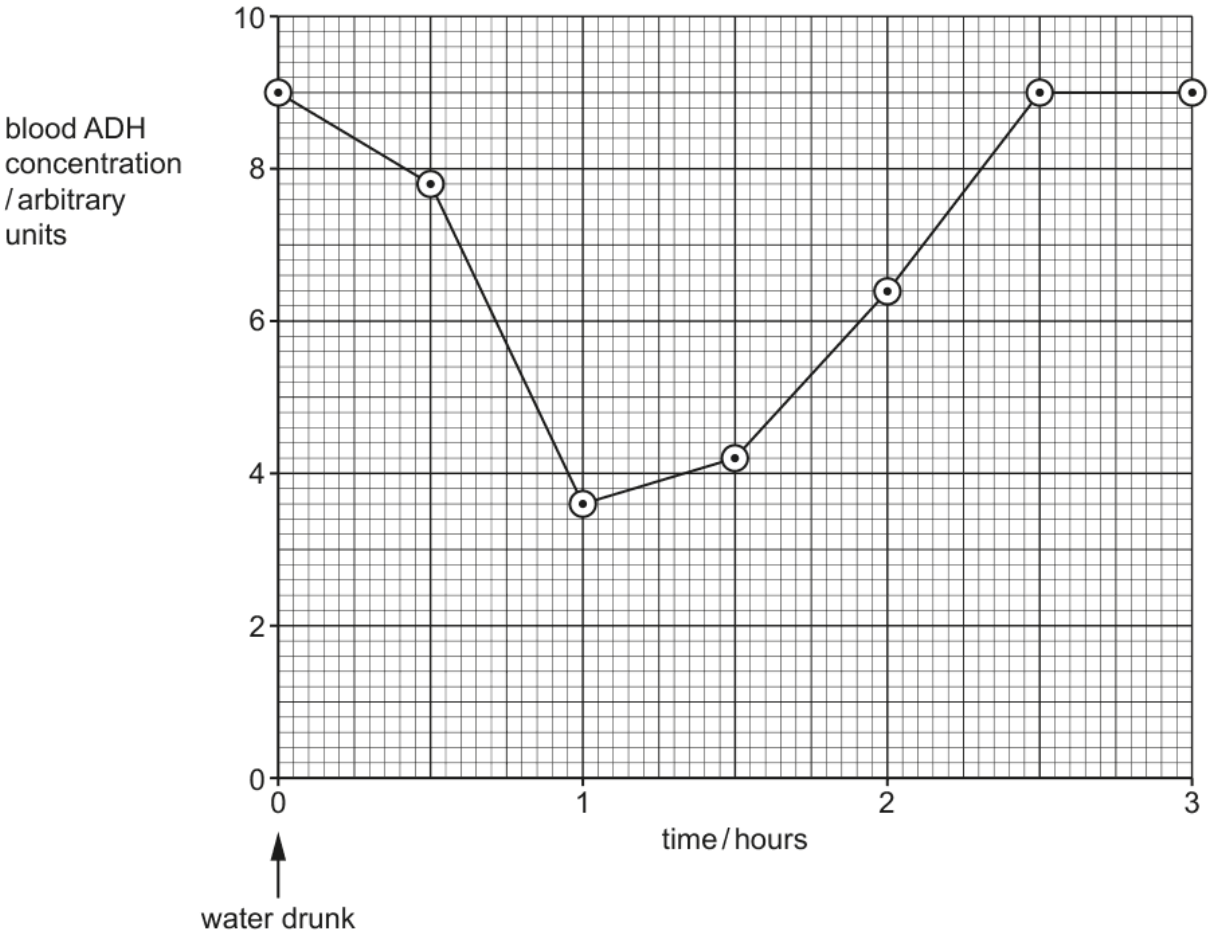


Fig. 9.1

Explain the results shown in Fig. 9.1.

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Question 15 · Paper 4 · February/March 2023 (42) · Q1(b) · 3 marks

(b) The volume and water potential of the urine produced by the kidney vary according to the water potential of the blood. This is a result of osmoregulation.

Describe the role of aquaporins in osmoregulation.

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Question 16 · Paper 4 · February/March 2023 (42) · Q1(c) · 3 marks

(c) Describe the role of the brain in osmoregulation when the water potential of the blood **increases** above the set point.

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6 (a) (i) When blood glucose concentration decreases, glucagon is released by the pancreas into the blood and is transported to the cells.

Fig. 6.1 outlines the effect of glucagon on liver cells.

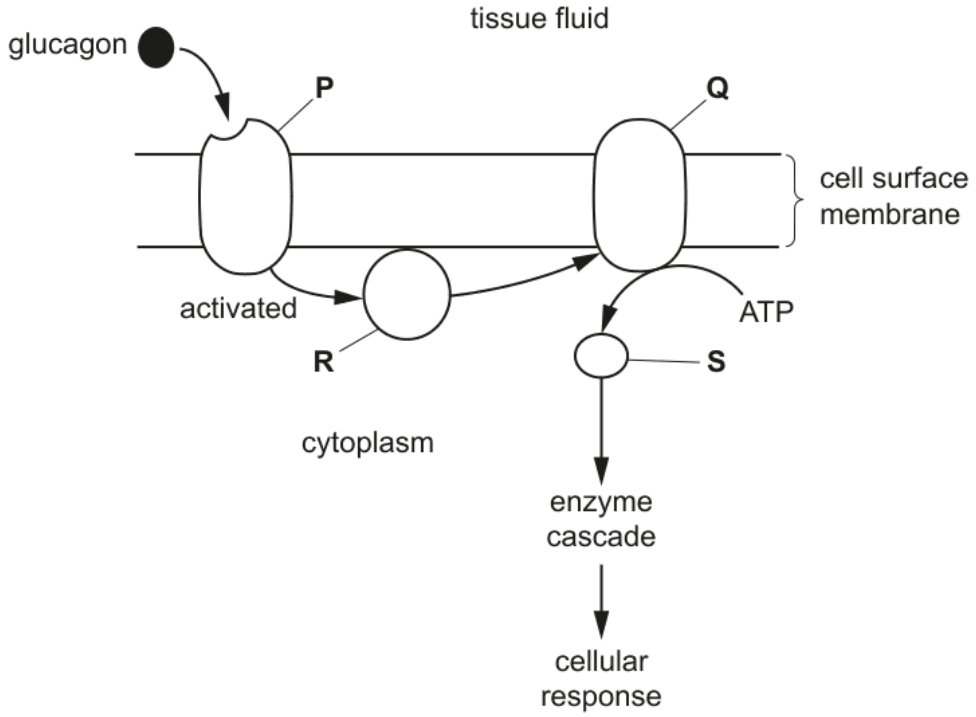


Fig. 6.1

Identify **P**, **Q**, **R** and **S** shown in Fig. 6.1.

P .....

Q .....

R .....

S .....

[4]

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Question 18 · Paper 4 · February/March 2025 (42) · Q6(b) · 7 marks

(b) When the blood glucose concentration decreases **below** the set point, a hormone is released from the pancreas.

Describe how the release of this hormone leads to the blood glucose concentration returning to the set point.

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(b) The blood glucose concentration of a person was measured at regular intervals after the ingestion of a meal rich in glucose.

Fig. 9.1 shows the results of this investigation.

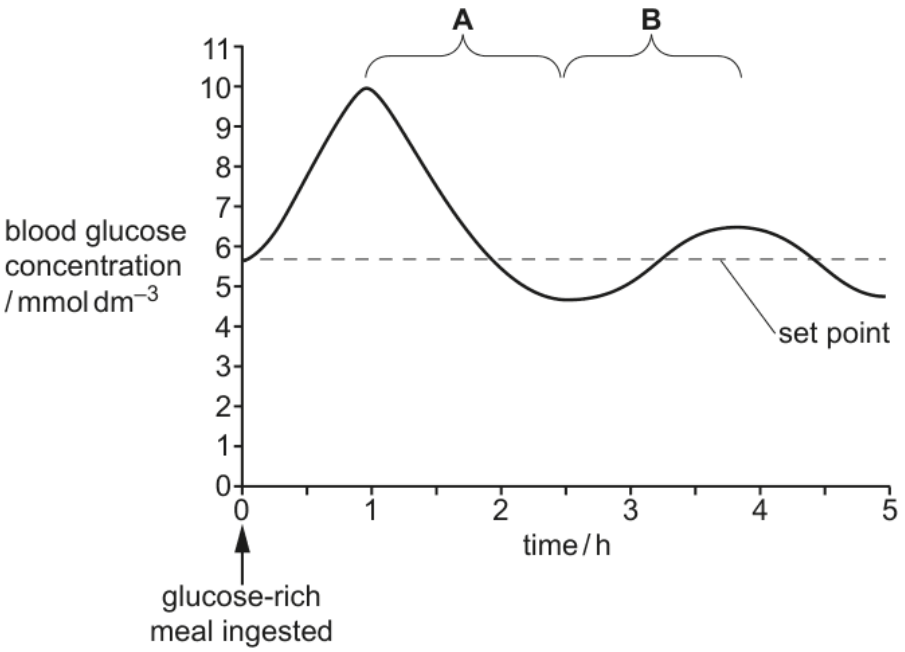


Fig. 9.1

(i) Explain how the blood glucose concentration is reduced during phase **A** of the curve.

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10 (a) Glucagon has a role in the maintenance of blood glucose concentration.

Fig. 10.1 shows the relationship between blood glucose concentration and blood glucagon concentration, measured over 90 minutes in a healthy person. The person did not have any food in the three hours before the measurements were taken.

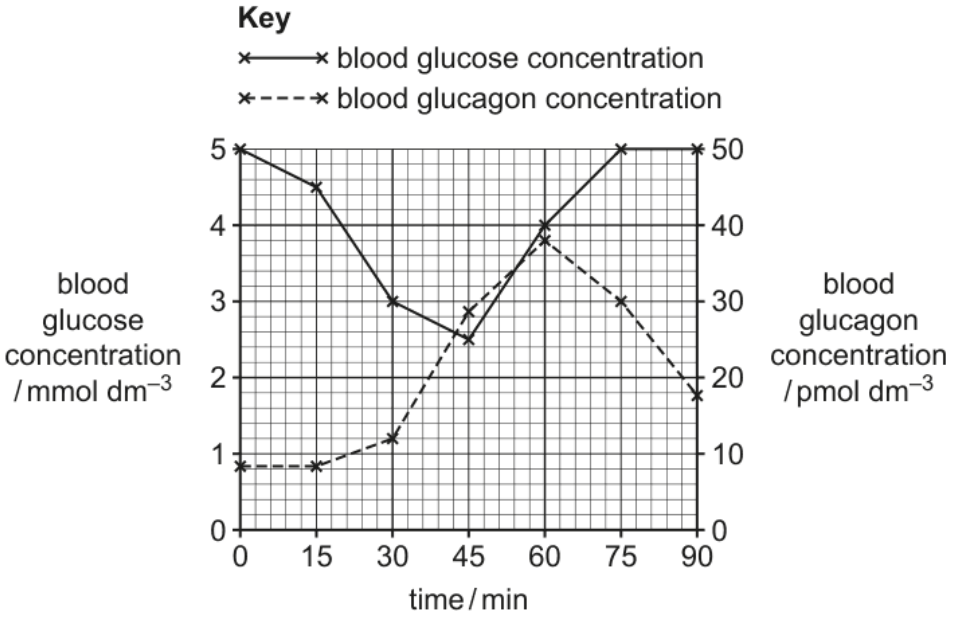


Fig. 10.1

Explain the relationship shown in Fig. 10.1.

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(c) Type 1 diabetes in humans is a condition where the pancreas does not produce enough insulin to control blood glucose concentration.

Test strips are used to measure the concentration of glucose in a sample of urine. Two reactions take place on the test strip and a colour change occurs if glucose is present in the urine.

The equations for these reactions are:

$$\text{glucose} + \text{oxygen} \xrightarrow{\text{glucose oxidase}} \mathbf{A} + \text{hydrogen peroxide}$$

$$\text{hydrogen peroxide} + \mathbf{B} \xrightarrow{\text{peroxidase}} \text{oxidised } \mathbf{B} + \text{water}$$

(i) Identify compound **A** and the type of substrate represented by **B**.

A .....

B .....

[2]

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Question 22 · Paper 4 · October/November 2023 (42) · Q6(b) · 7 marks

(b) Type 2 diabetes is a condition affecting the homeostatic control of blood glucose concentration. In type 2 diabetes, target cells have a much lower response to insulin and some glucose is excreted in the urine.

Test strips can be used to measure the concentration of glucose in a sample of urine, but many people with type 2 diabetes measure blood glucose concentration using a biosensor.

Explain the principles of operation of a test strip for glucose **and** suggest advantages for a person with type 2 diabetes of using a biosensor instead of a test strip.

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Mark schemes

Question 1 · Paper 4 · October/November 2022 (41) · Q10 · 5 marks

10	1	internal ;	5
	2	negative feedback ;	
	3	receptor(s) ;	
	4	endocrine / islets of Langerhans / α and β ;	
	5	glycogen ;	

Question 2 · Paper 4 · May/June 2024 (42) · Q10(a) · 1 mark

10(a)	negative feedback ;	1

Question 3 · Paper 4 · May/June 2021 (42) · Q6(d) · 3 marks

6(d)	*any **three** from:*		3
	1	change in a parameter ;	
	2	detected by receptor ;	
	3	coordination / described ;	
	4	(corrective) action taken by effector ;	
	5	return to, set point / norm / optimum ;	

Question 4 · Paper 4 · October/November 2024 (41) · Q6(a)(i) · 2 marks

6(a)(i)	**1**	(excess) amino acids, deaminated / have amino group removed ;	2
	2	in the liver ;	

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Question 5 · Paper 4 · February/March 2023 (42) · Q1(a) · 4 marks

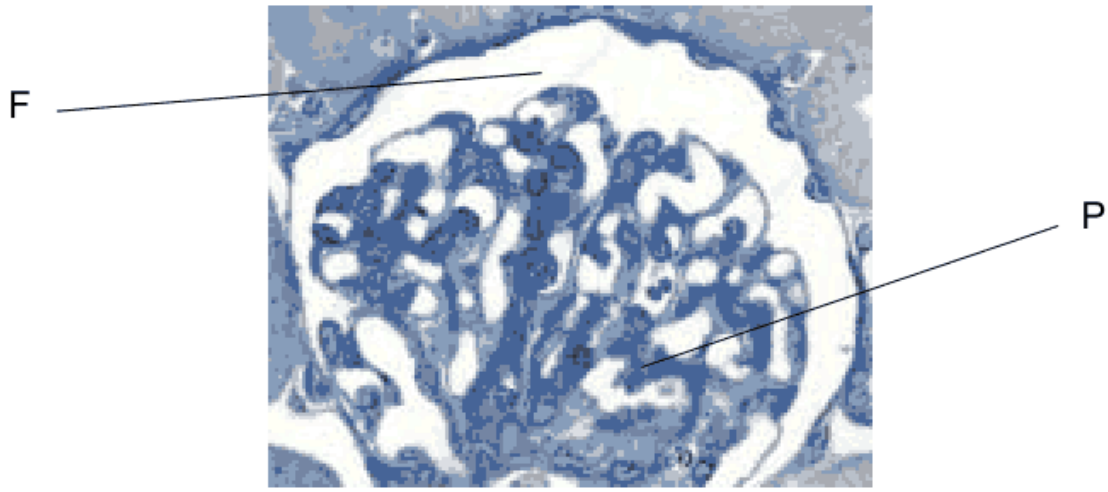
1(a)

	region of kidney	
location of loops of Henle	**C**	;
location of Bowman's capsules	**A**	;
location of glomeruli	**A**	;
contains urine at final concentration	**B + D**	;

4

Question 6 · Paper 4 · May/June 2023 (42) · Q6(a) · 2 marks

6(a)



2

Question 7 · Paper 4 · October/November 2021 (42) · Q1(a) · 4 marks

1(a)

feature	letter
glomerular filtrate	**E** ;
basement membrane	**C** ;
podocyte cells	**D** ;
capillary endothelial cell	**A** ;

4

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Question 8 · Paper 4 · May/June 2022 (42) · Q9(a) · 2 marks

9(a)	to generate a high, blood pressure / hydrostatic pressure ; **Ignore** to increase the blood pressure to force, plasma / fluid / water, through basement membrane / into the Bowman's capsule / into lumen ; **R** osmosis / diffuse **Ignore** named substance e.g. glucose	**2**

Question 9 · Paper 4 · May/June 2022 (42) · Q9(b)(i) · 2 marks

9(b)(i)	**A** – basement membrane ; **B** – podocyte ;	**2**

Question 10 · Paper 4 · May/June 2022 (42) · Q9(b)(ii) · 3 marks

9(b)(ii)	*any **three** from:* **A** basement membrane 1 acts as a, filter / filtration barrier ; 2 only, named molecules / ions / molecules less than 68 000–70 000 (R)MM, can pass through **or** red blood cells / large proteins, cannot pass through ; **B** podocyte 3 has, gaps / slits / projections / pores ; 4 allows, fluid / water / filtrate, to pass into the, lumen / Bowman's capsule ; 5 produces, **A** / basement membrane ;	**3**

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Question 11 · Paper 4 · May/June 2023 (42) · Q6(c) · 7 marks

6(c)	*any **seven** from:* 1 Na^+, actively transported / pumped, out of cells ; 2 Na^+ enter blood ; 3 Na^+ concentration in cells decreases **or** Na^+ concentration gradient (between pct lumen and cytoplasm) / described ; 4 Na^+ enter cells from, filtrate / lumen ; 5 by facilitated diffusion ; 6 cotransport of, glucose / amino acids ; **I** secondary active transport 7 water potential of cells decreases ; 8 water enters cells from (filtrate / lumen) by, osmosis / down the water potential gradient ; 9 glucose / amino acids, leave cells by, (facilitated) diffusion / described ; 10 glucose / amino acids, reabsorbed **or** move into , tissue fluid / blood ; 11 AVP ; e.g. other named ions reabsorbed	**7**

Question 12 · Paper 4 · October/November 2022 (42) · Q8(a) · 2 marks

8(a)	**C** pointing to the microvilli adjacent to the proximal convoluted tubule lumen ; **P** pointing to the basal membrane adjacent to the blood capillary ; *label line must touch a membrane (not a space)*	**2**

Question 13 · Paper 4 · October/November 2022 (42) · Q8(b) · 5 marks

8(b)	*any **five** from:* 1 microvilli for large surface area (for reabsorption) ; 2 (large surface area) for **many**, cotransporters / carrier proteins ; 3 cotransporter (proteins) to absorb sodium ions with, glucose / amino acids ; **A** idea of secondary active transport 4 tight junctions between cells so substances have to pass through the cells / AW ; 5 **many** mitochondria to produce ATP ; 6 (ATP) for the sodium (potassium) pumps **or** (ATP) to pump / actively transport, sodium ions (into the blood) ; 7 folded basal membrane for **many** sodium (potassium) pumps ;	**5**

Question 14 · Paper 4 · October/November 2023 (42) · Q9(a) · 4 marks

9(a)	*any **four** from:* 1 (drink of water causes) increase in blood water potential / AW ; 2 detected by, osmoreceptors / hypothalamus ; 3 causes decrease in release of ADH (into blood in first hour) ; 4 less water reabsorbed (from collecting ducts) ; 5 (so) decrease in blood water potential / blood water potential returns to set point ; 6 causes increase in release of ADH ; 7 negative feedback ;	**4**

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Question 15 · Paper 4 · February/March 2023 (42) · Q1(b) · 3 marks

1(b)	*any **three** from:* 1 (aquaporins are) water channel (proteins) ; 2 (more) aquaporins increase (cell surface) membrane permeability (to water) ; **ora** 3 of collecting duct (cells) ; **I** distal convoluted tubule cells 4 allow water to, be reabsorbed / move into tissue fluid or blood ;	**3**

Question 16 · Paper 4 · February/March 2023 (42) · Q1(c) · 3 marks

1(c)	*any **three** from:* 1 detected by osmoreceptors ; 2 in hypothalamus ; 3 (osmoreceptors send) fewer impulses to posterior pituitary ; **I** signals 4 less ADH, released / produced ; **I** no ADH released	**3**

Question 17 · Paper 4 · October/November 2023 (42) · Q6(a)(i) · 4 marks

6(a)(i)	**P**: receptor ; **Q**: adenyl(yl) cyclase ; **R**: G-protein ; **S**: cyclic AMP / cAMP ;	**4**

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Question 18 · Paper 4 · February/March 2025 (42) · Q6(b) · 7 marks

6(b)	*any **seven** from:*	**7**
	1 glucagon ;	
	2 binds to receptor on cell surface membrane (of liver cell) ;	
	3 G-protein activated ;	
	4 adenyl(yl) cyclase activated ;	
	5 ATP converted to cAMP ;	
	6 second messenger ;	
	7 enzyme cascade / described ;	
	8 enzymes activated by phosphorylation ;	
	9 signal amplified ;	
	10 glycogen broken down into glucose / glycogenolysis ;	
	11 glucose enters blood ;	
	12 gluconeogenesis / described ;	

Question 19 · Paper 4 · May/June 2023 (42) · Q9(b)(i) · 3 marks

9(b)(i)	1	insulin, produced / released ;	**3**
	2	increase in uptake of glucose into cells ;	
	3	detail of uptake ; e.g. increase permeability of cell surface membrane (to glucose) / GLUT added to cell surface membrane	
	4	increase / stimulates, respiration of glucose (in cells) / phosphorylation of glucose ;	
	5	(stimulates) glycogenesis / conversion of glucose to lipids ;	

Question 20 · Paper 4 · October/November 2022 (42) · Q10(a) · 4 marks

10(a)	*any **four** from:*		**4**
	1	decreasing / low, blood glucose concentration **causes**, increase in glucagon concentration / glucagon secretion ;	
	2	glucagon acts on liver cells ;	
	3	glycogenolysis / described ; **R** is glucagon breaks down glycogen	
	4	gluconeogenesis / described ;	
	5	**so**, glucose is released into the blood / blood glucose concentration increases ;	
	6	*ref. to* negative feedback ;	

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Question 21 · Paper 4 · May/June 2024 (42) · Q10(c)(i) · 2 marks

10(c)(i)	**A** – gluconic acid / gluconolactone ;	**2**
	B – chromogen ;	

Question 22 · Paper 4 · October/November 2023 (42) · Q6(b) · 7 marks

6(b)	*any **four** from:*	**7**
	1 strip contains glucose oxidase and peroxidase ; 2 strip dipped into urine ; 3 glucose (and oxygen) reacts with glucose oxidase to produce hydrogen peroxide ; 4 hydrogen peroxide reacts with peroxidase to produce a colour change ; 5 colour is matched with a colour chart to give, reading / estimate, of glucose concentration ;	
	*any **three** from:*	
	6 quick(er) ; 7 (more) sensitive / accurate / precise ; 8 gives immediate reading ; 9 results can be stored electronically / can be connected to smart phone / AW ; 10 numerical / digital / quantitative / objective ; 11 reusable ;	

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