CAMBRIDGE INTERNATIONAL AS & A LEVEL BIOLOGY · 9700

BIOLOGY



EXAM QUESTION PACK

14 HOMEOSTASIS

SCORE	PERCENTAGE
/	%

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Homeostasis – 2018 Biology A2 9700

1. Nov/2018/Paper_41/No.10

(a) Describe how the structure of the nephron and its associated blood vessels are adapted to the process of ultrafiltration. [8]

(b) Describe the effects of insulin on its main target tissues **and** explain how this leads to changes in blood glucose concentration. [7]

[Total: 15]

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2. Nov/2018/Paper_43/No.10

(a) Describe how the structure of the nephron and its associated blood vessels are adapted to the process of ultrafiltration. [8]

(b) Describe the effects of insulin on its main target tissues **and** explain how this leads to changes in blood glucose concentration. [7]

[Total: 15]

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1. Nov/2019/Paper_41/No.1

(a) ADH is a hormone that is released into the blood of a mammal when changes occur in the internal environment.

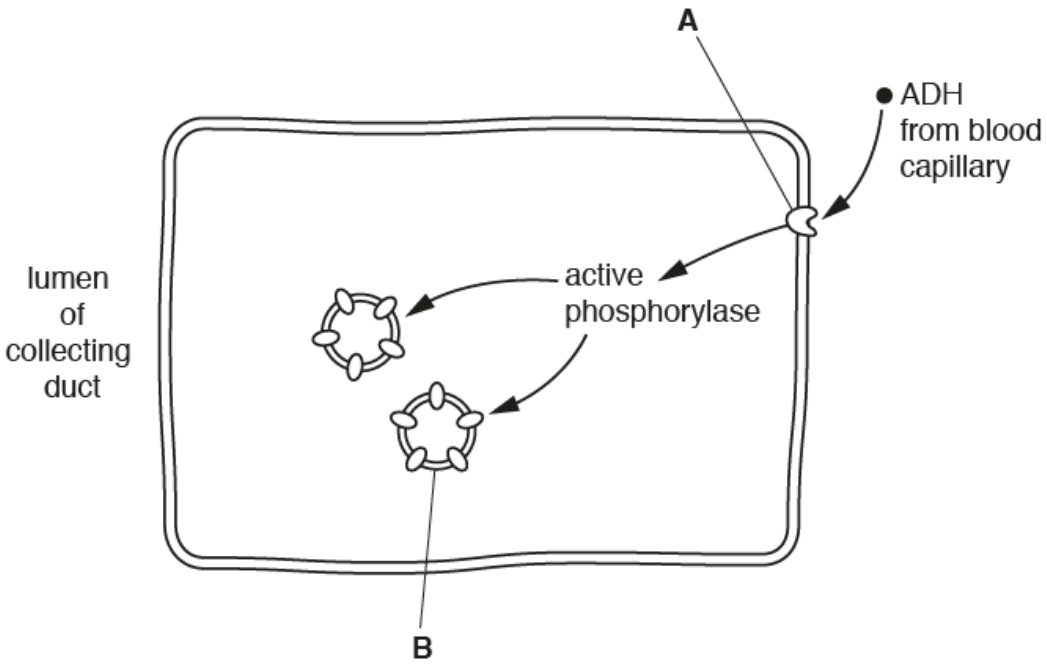
(i) State **one** change in the internal environment of a mammal that leads to the release of ADH.

..... [1]

(ii) Name the part of the body that releases ADH into the blood.

..... [1]

(b) Fig. 1.1 shows a cell of one of the collecting ducts of the kidney.



not to scale

Fig. 1.1

Name membrane protein **A** and cell structure **B**.

A .....

B ..... [2]

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(c) The phosphorylase enzyme stimulates structure **B**.

Describe the response of structure **B** to this stimulation **and** describe the consequences of this response.

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..... [4]

[Total: 8]

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2. Nov/2019/Paper_42/No.1

(a) ADH is a hormone that is released into the blood of a mammal when changes occur in the internal environment.

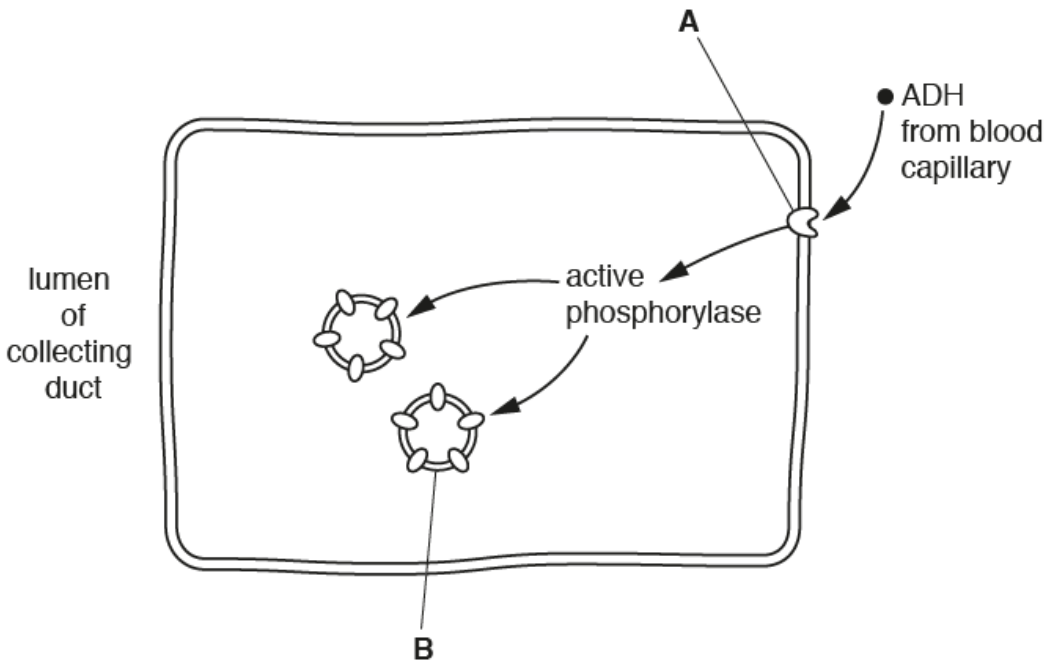
(i) State **one** change in the internal environment of a mammal that leads to the release of ADH.

..... [1]

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..... [1]

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not to scale

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Describe the response of structure **B** to this stimulation **and** describe the consequences of this response.

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..... [4]

[Total: 8]

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3. Nov/2019/Paper_43/No.1

(a) Fig. 1.1 shows part of a guard cell.

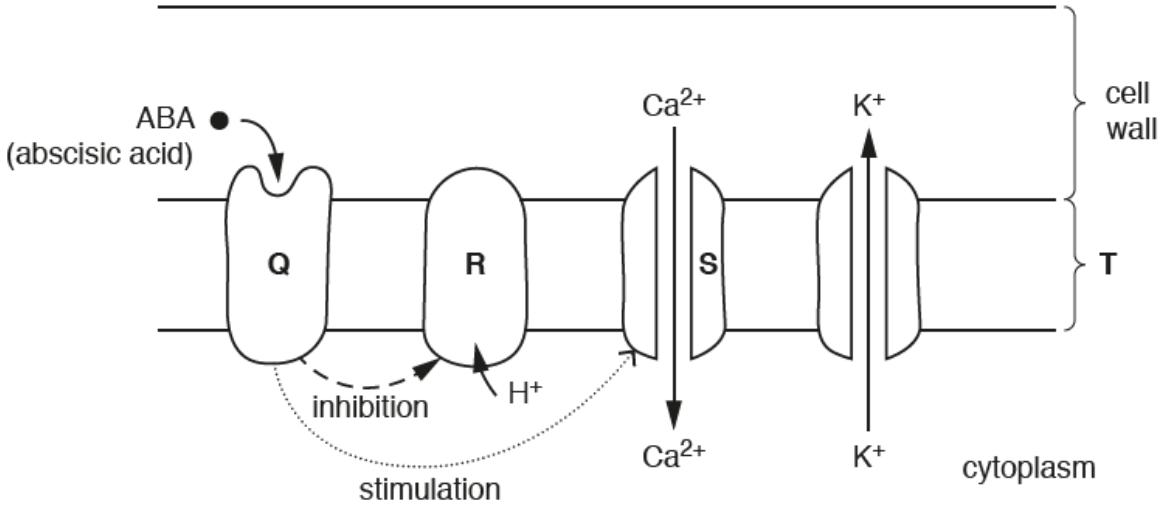


Fig. 1.1

(i) State the **type** of protein represented by **Q**.

..... [1]

(ii) Proteins **R** and **S** are transport proteins.

Identify **R** and **S**.

R.....

S..... [2]

(iii) Name cell structure **T**.

..... [1]

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(b) With reference to Fig. 1.1, outline the events that occur in a guard cell during times of water stress.

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..... [5]

[Total: 9]

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4. June/2019/Paper_41/No.7

(a) Some people have a condition called diabetes. In type 1 diabetes the pancreas does not produce enough insulin.

Fig. 7.1 shows the blood glucose concentrations of a type 1 diabetic person and a non-diabetic person, at regular intervals after drinking a glucose drink.

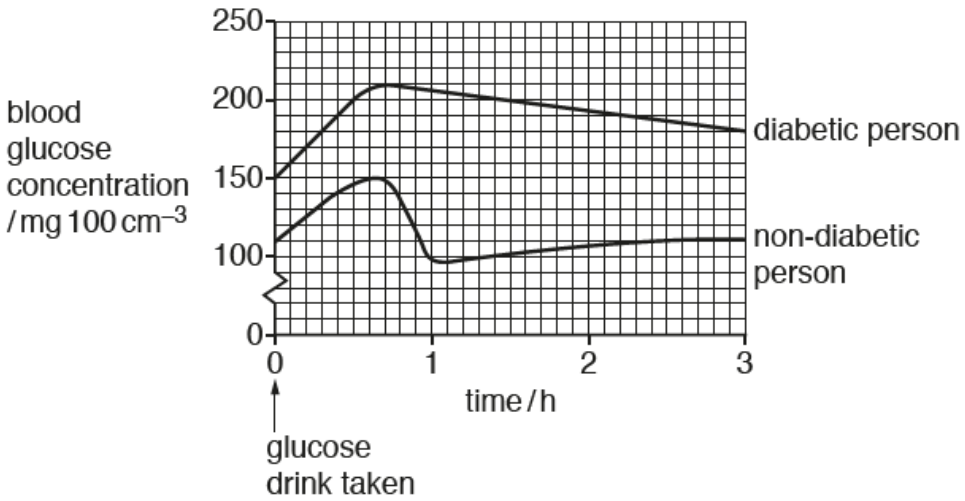


Fig. 7.1

(i) Describe the results shown in Fig. 7.1.

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..... [3]

(ii) Name the location of the receptors in a non-diabetic person that detect a change in blood glucose concentration.

..... [1]

(iii) Name the homeostatic mechanism by which blood glucose concentration is maintained.

..... [1]

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(b) The urine of a non-diabetic person does not contain glucose. A person with type 1 diabetes will excrete glucose in urine.

A reading of the concentration of glucose in the urine can be estimated using a dipstick.

Fig. 7.2 outlines how a dipstick works.

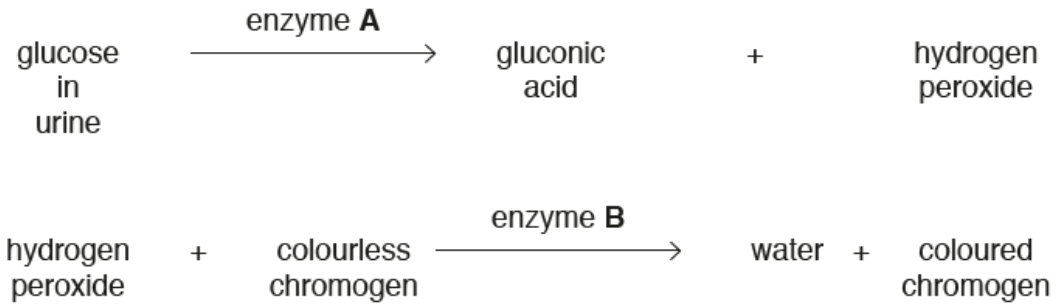


Fig. 7.2

The higher the concentration of glucose in the urine, the darker the colour on the dipstick.

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

A .....

B .....

[2]

(ii) An electronic biosensor can be used to measure the glucose concentration in a drop of blood.

Suggest **one** advantage of using a biosensor and **one** advantage of using a dipstick to measure glucose concentration.

biosensor .....

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dipstick .....

.....

[2]

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(c) Describe the role played by insulin in the control of blood glucose concentration.

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..... [5]

[Total: 14]

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5. June/2019/Paper_42/No.5

(a) Fig. 5.1 is a photomicrograph of part of the cortex of a kidney.

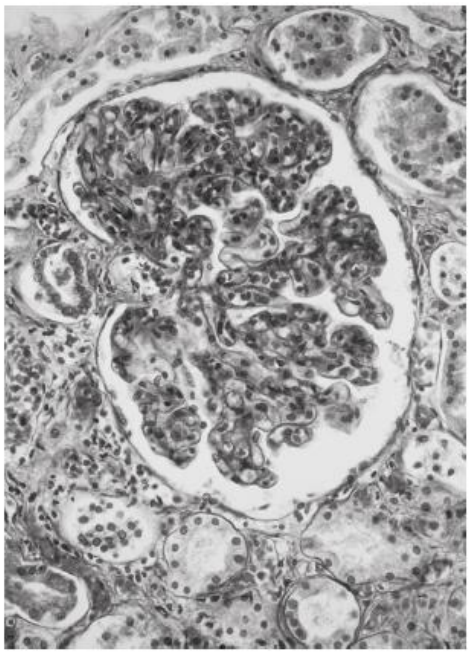


Fig. 5.1

(i) On Fig. 5.1, use label lines and letters to label:

G – the glomerulus

L – the lumen of the Bowman's (renal) capsule.

[2]

(ii) During ultrafiltration, components of blood in the glomerulus with a relative molecular mass greater than 68 000 are prevented from passing into the Bowman's capsule.

Name the structure that acts as this filtration barrier.

..... [1]

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(b) The glomerular filtration rate (GFR) is the rate of flow of filtered fluid through the kidneys per unit time.

The afferent arterioles supply blood to the glomerulus of each nephron within the kidney and the efferent arterioles take blood away from each glomerulus. The lumen diameters of the afferent and efferent arterioles have a large effect on the GFR. Normally the lumen diameters of the afferent and efferent arterioles are different, but they can change to increase or decrease the normal GFR in response to changing conditions.

Complete Table 5.1 to indicate whether the GFR is normal, increased, or decreased for each combination of arteriole diameters shown.

The first row has been completed for you.

Table 5.1

afferent arteriole lumen diameter	efferent arteriole lumen diameter	GFR
normal	normal	normal
decreased	normal	.....
normal	increased	.....

[2]

(c) After leaving the Bowman's capsule, the glomerular filtrate passes through the proximal convoluted tubule, where selective reabsorption occurs.

Describe **and** explain how all of the glucose in the glomerular filtrate is reabsorbed back into the blood.

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..... [5]

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(d) State **and** explain **three** features of a proximal convoluted tubule cell that adapt it to its function.

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..... [3]

[Total: 13]

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6. June/2019/Paper_43/No.5

(a) Fig. 5.1 is a photograph of a section through a kidney.

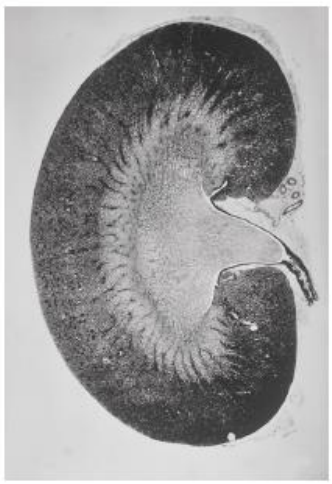


Fig. 5.1

On Fig 5.1, use label lines and letters to label the regions of the kidney where the following are located:

L – loop of Henlé

D – distal convoluted tubule

P – podocyte cells.

[3]

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(b) In a cold environment, people urinate more frequently. This condition is called cold diuresis.

In a cold environment, homeostatic mechanisms keep heat loss to a minimum. Blood is diverted away from the skin so that more blood circulates around the main body organs, including the kidney.

Suggest **and** explain why cold diuresis occurs.

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..... [4]

(c) The water potential of the blood is maintained at a constant level by a mechanism called negative feedback.

With reference to the maintenance of the water potential of the blood, explain what is meant by negative feedback.

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..... [5]

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(d) ADH affects the number of water channel proteins, aquaporins, in the cell surface membranes of the cells of the distal convoluted tubule.

State what happens to the water potential **and** volume of the urine if cells in the distal convoluted tubule have more aquaporins in their cell surface membranes.

water potential .....

volume of urine .....

[1]

[Total: 13]

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7. Feb/2019/Paper_42/No.2

(a) The hormone glucagon is an example of a cell signalling molecule. Table 2.1 lists the mair events that occur when the blood glucose concentration decreases below the set point.

The events are **not** listed in the correct order.

Table 2.1

event	description of event
A	adenylyl cyclase enzyme is activated
B	cyclic AMP activates an enzyme cascade
C	glycogen stored in liver cells is broken down to glucose
D	blood glucose concentration increases
E	glucagon is secreted by α cells in the pancreas
F	conformational change to glucagon receptor causes G-protein activation
G	active adenylyl cyclase acts on ATP to produce second messenger
H	glucagon signal is amplified
I	glucose diffuses out of liver cells through GLUT transporter proteins
J	glucagon binds to receptors in the cell surface membranes of liver cells
K	cyclic AMP is formed

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Complete Table 2.2 to show the correct order in which these events occur.

Three of the events have already been placed in their correct order.

Table 2.2

correct order	letter of event
1	E
2	
3	
4	
5	
6	K
7	
8	
9	
10	
11	D

[4]

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(b) An investigation was carried out to measure the rate at which glucose is provided for respiration from three different sources of glucose:

- a meal
- glycogenolysis – the breakdown of glycogen
- gluconeogenesis – production of glucose from non-carbohydrate molecules.

After a person ate a meal, the rates at which glucose was provided for respiration from the three different sources were measured at regular intervals over a 24-hour period. During this period, no food was eaten.

Fig. 2.1 shows the results of this investigation.

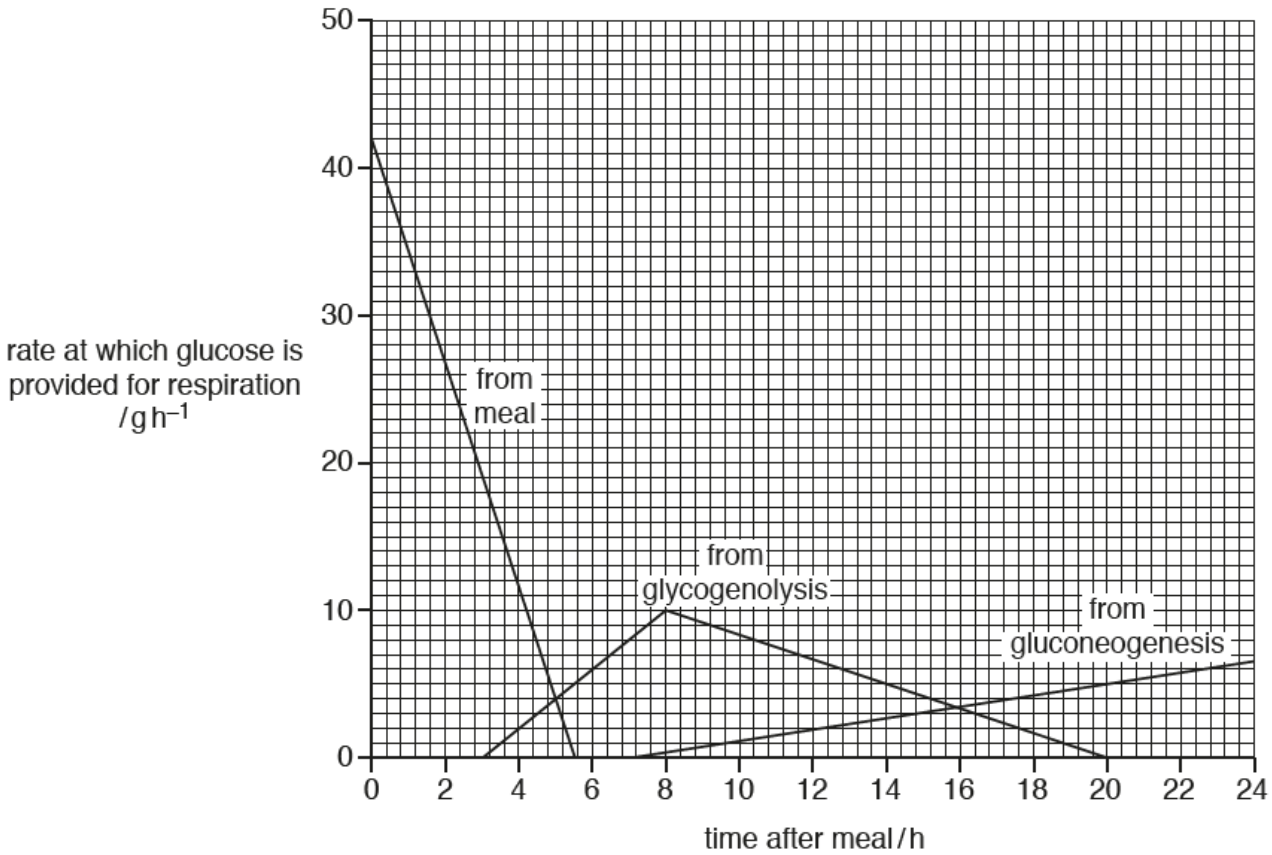


Fig. 2.1

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(i) State the time after the meal when the rate at which glucose was provided from the meal for respiration was the same as the rate at which glucose was provided from glycogenolysis for respiration.

..... [1]

(ii) State the first time after the meal when **all** of the glucose for respiration was provided by gluconeogenesis.

..... [1]

(iii) Name the homeostatic mechanism by which blood glucose concentration is maintained at a set point.

..... [1]

(iv) In humans, carbohydrates such as glucose are not the only respiratory substrates.

Name **two** non-carbohydrate respiratory substrates in humans.

.....

..... [2]

[Total: 9]

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1. Nov/2021/Paper_41/No.1

(a) Fig. 1.1 is a diagram of a kidney nephron and some of its blood vessels.

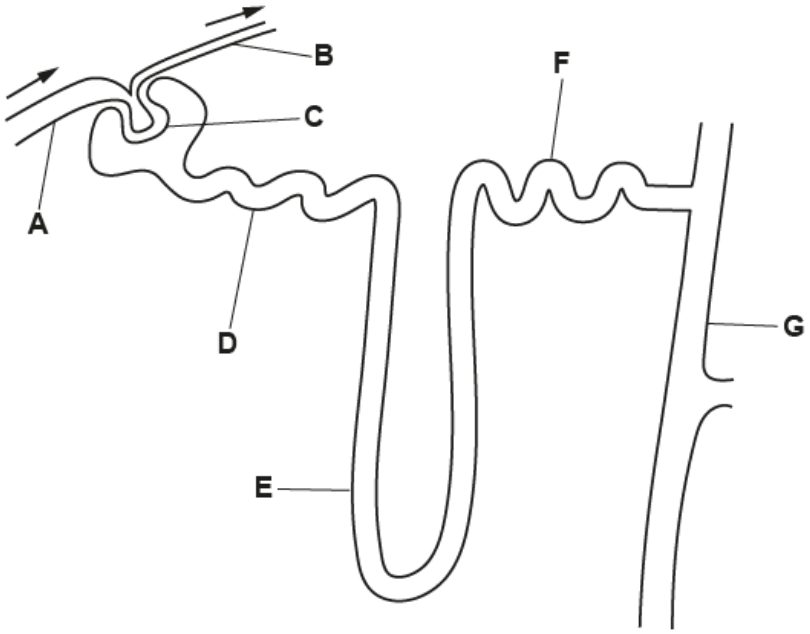


Fig. 1.1

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

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

Table 1.1

description	letter
efferent blood vessel	.....
part of nephron containing cells that respond to ADH	.....
part of nephron where podocyte cells are located	.....
part of nephron containing cells that are located in the medulla	.....

[4]

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(b) Describe **and** explain how the cells of the proximal convoluted tubule are adapted to carry out selective reabsorption.

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..... [5]

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(c) Fig. 1.2 shows the concentrations of ADH in the blood at different percentage changes in water potential of the blood.

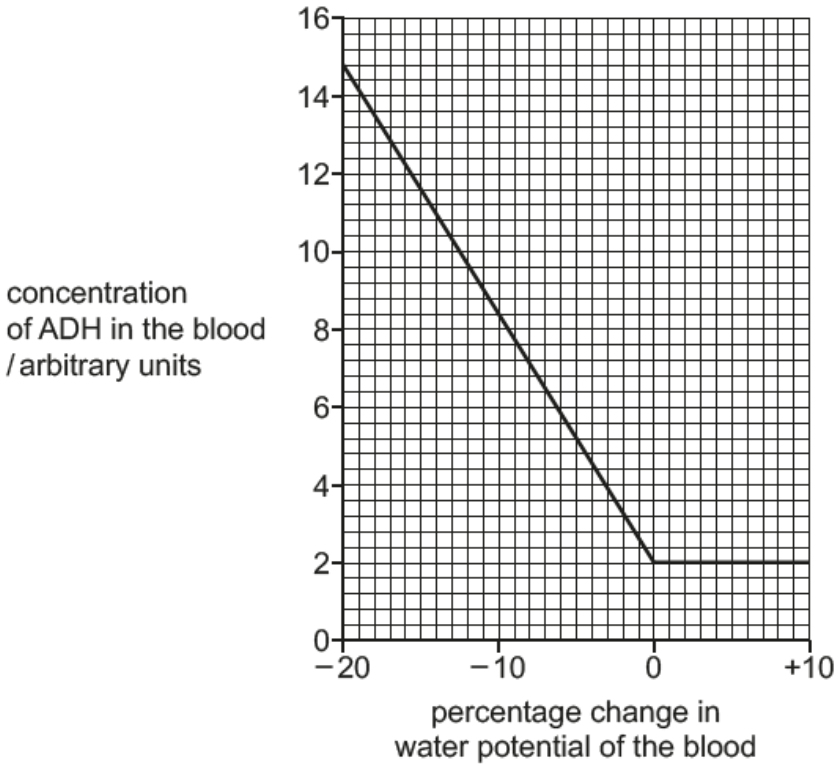


Fig. 1.2

(i) Describe the trend shown in Fig. 1.2.

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..... [2]

(ii) Sometimes a person will have a low concentration of ADH in the blood even though there is a change in the water potential.

Suggest **one** effect on the circulatory system of a low concentration of ADH in the blood.

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.....

..... [1]

[Total: 12]

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2. Nov/2021/Paper_42/No.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.

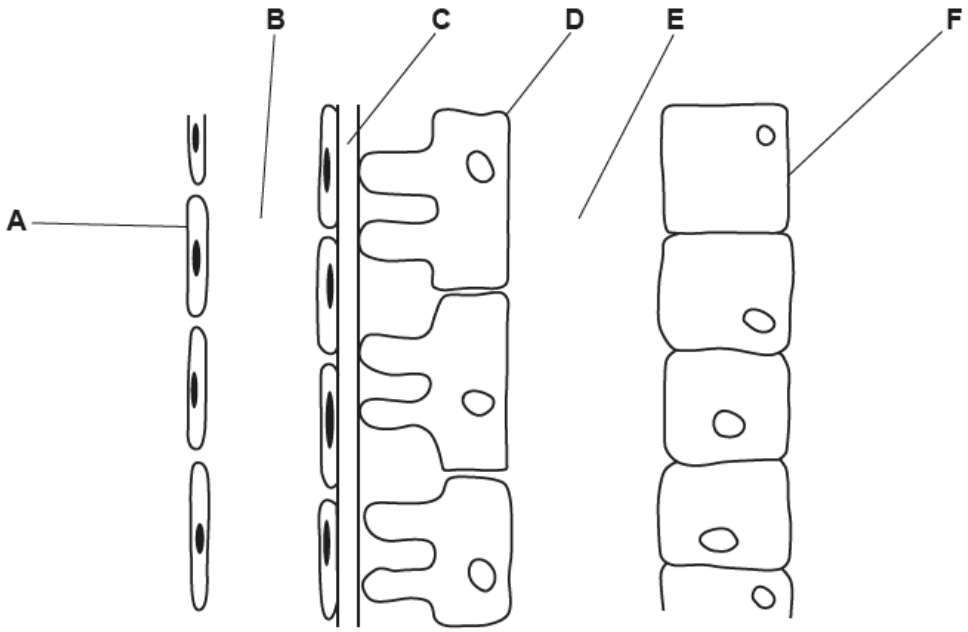


Fig. 1.1

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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(b) Describe **and** explain how the structures in the Bowman's capsule and its associated blood supply are adapted to allow ultrafiltration to take place.

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..... [5]

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(c) The glomerular filtration rate (GFR) is the rate at which blood plasma is filtered in the Bowman's capsule.

Fig. 1.2 shows the relationship between GFR and mean renal arterial blood pressure.

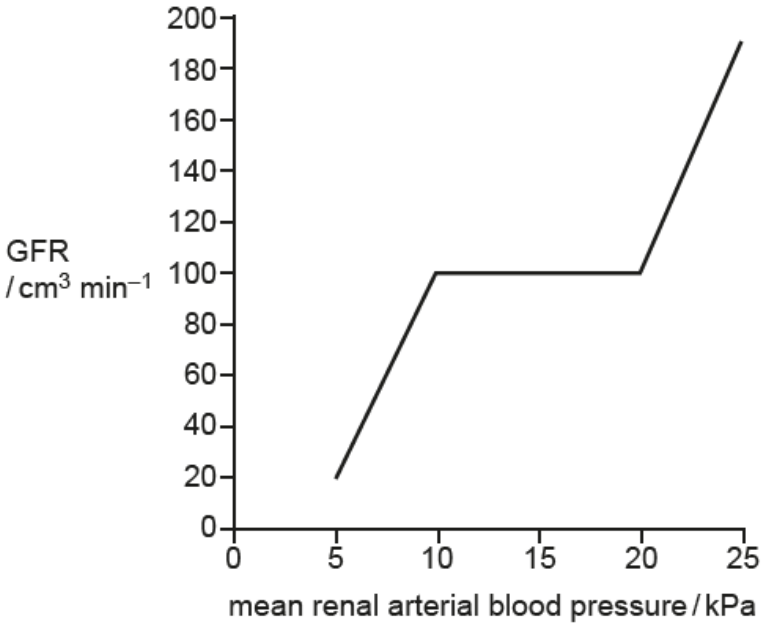


Fig. 1.2

(i) Comment on the relationship between GFR and mean renal arterial blood pressure.

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..... [2]

(ii) Suggest **one** reason why the GFR of a person might decrease.

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..... [1]

[Total: 12]

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3. Nov/2021/Paper_42/No.9(a)

(a) Describe the roles of ADH **and** the collecting ducts in osmoregulation. [9]

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1. June/2022/Paper_41/No.6

(a) In mammals, the blood glucose concentration must be maintained within narrow limits so that the body cells can function efficiently.

Name the mechanism by which the blood glucose concentration is maintained within narrow limits.

..... [1]

(b) Glucagon is released by the alpha (α) cells of the pancreas when the blood glucose concentration decreases below the set point.

Fig. 6.1 outlines the response of liver cells to glucagon.

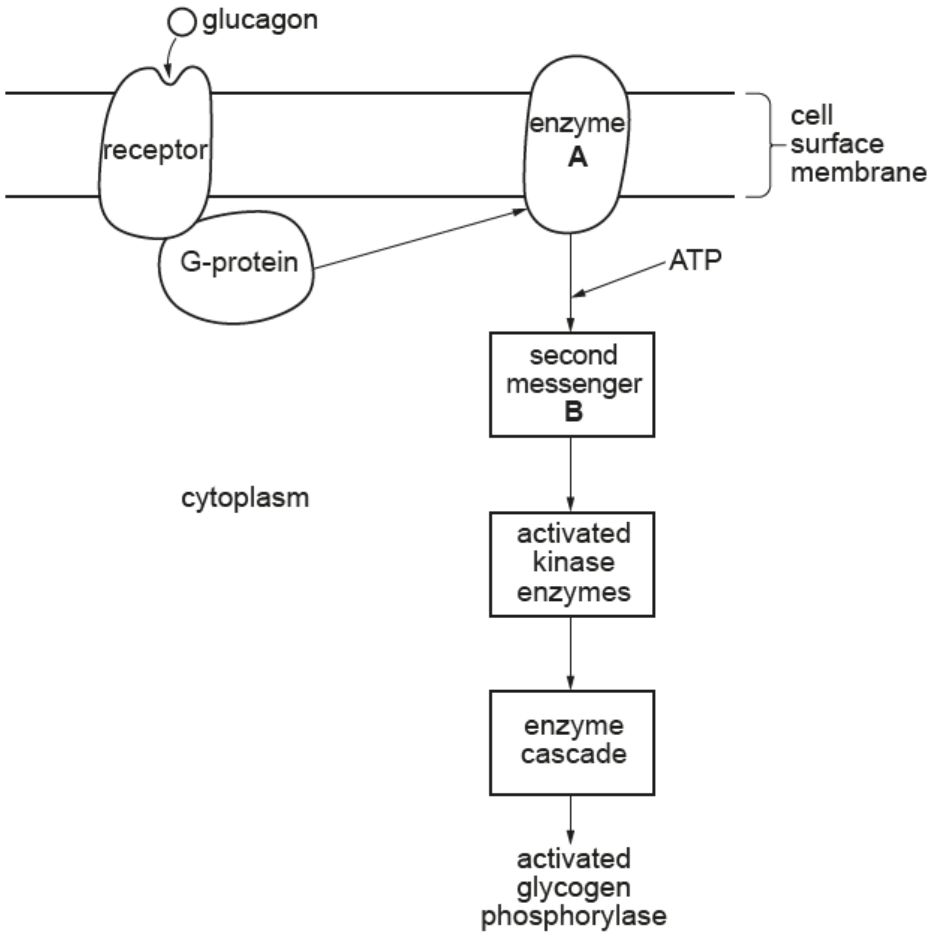


Fig. 6.1

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(i) State how glucagon reaches the liver cells.

..... [1]

(ii) With reference to Fig. 6.1, name enzyme **A** and second messenger **B**.

A .....

B .....

[2]

(iii) State the role of the enzyme cascade.

.....

..... [1]

(iv) State the function of the final enzyme in the pathway, glycogen phosphorylase.

..... [1]

(c) A biosensor is used to measure blood glucose concentration to check that it is within the normal range.

Describe how a glucose biosensor works.

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..... [4]

[Total: 10]

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2. June/2022/Paper_42/No.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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..... [2]

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

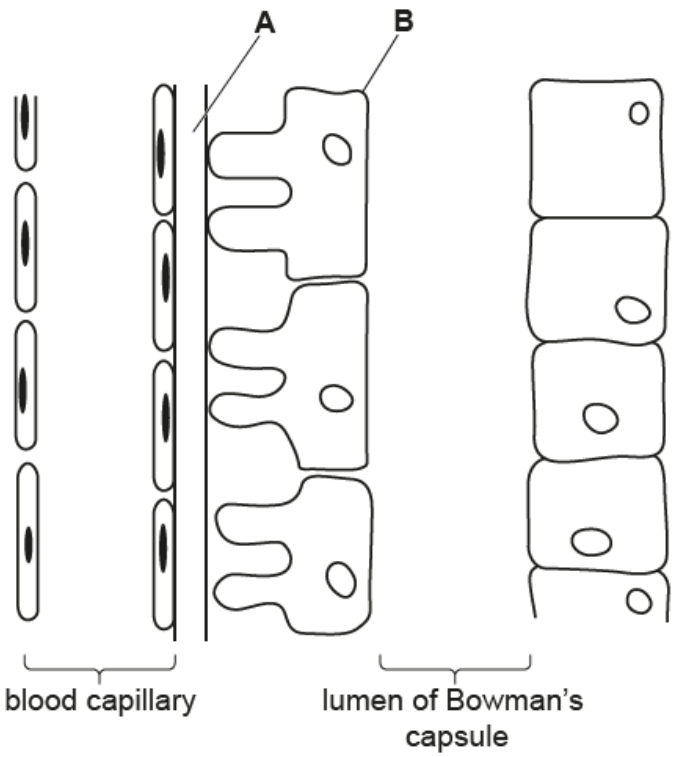


Fig. 9.1

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

A .....

B .....

[2]

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

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..... [3]

[Total: 7]

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3. June/2022/Paper_43/No.1(a, b,)

(a) The water potential of mammalian blood needs to be maintained within narrow limits so that cells function efficiently. This process is called osmoregulation.

The relative medullary thickness (RMT) indicates the proportion of a kidney that is composed of medullary tissue.

$$\text{RMT} = \frac{\text{thickness of medulla}}{\text{kidney size}} \times 10$$

Table 1.1 shows the relationship between the RMT and the concentration of urine produced by four mammals from different habitats.

Table 1.1

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mammal	habitat	RMT	urine concentration / arbitrary units
beaver	rivers and lakes	1.4	0.90
warthog	savannah	2.8	2.35
human	variable	3.2	2.50
kangaroo rat	desert	8.6	10.50

(i) Name the parts of the nephron that are located in the medulla.

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..... [2]

(ii) Name a hormone involved in osmoregulation.

..... [1]

(iii) Describe the relationship between the RMT and the concentration of urine produced **and** explain the differences between the data for the beaver and the kangaroo rat.

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..... [4]

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(b) The warthog, *Phacochoerus africanus*, is a member of the pig family. The warthog lives in dry savannah areas of sub-Saharan Africa.

Fig. 1.1 shows a warthog.



Fig. 1.1

A warthog and a human have similar values of RMT and concentration of urine. A human can survive only a few days without drinking water, whereas a warthog can live for several months without drinking water.

Suggest how a warthog is able to survive several months without drinking water.

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..... [2]

[Total: 9]

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4. June/2022/Paper_43/No.10

(a) Insulin has an important role in the maintenance of blood glucose concentration.

An investigation measured how blood glucose concentration and blood insulin concentration changed after a glucose-rich meal had been eaten.

The results are shown in Fig. 10.1.

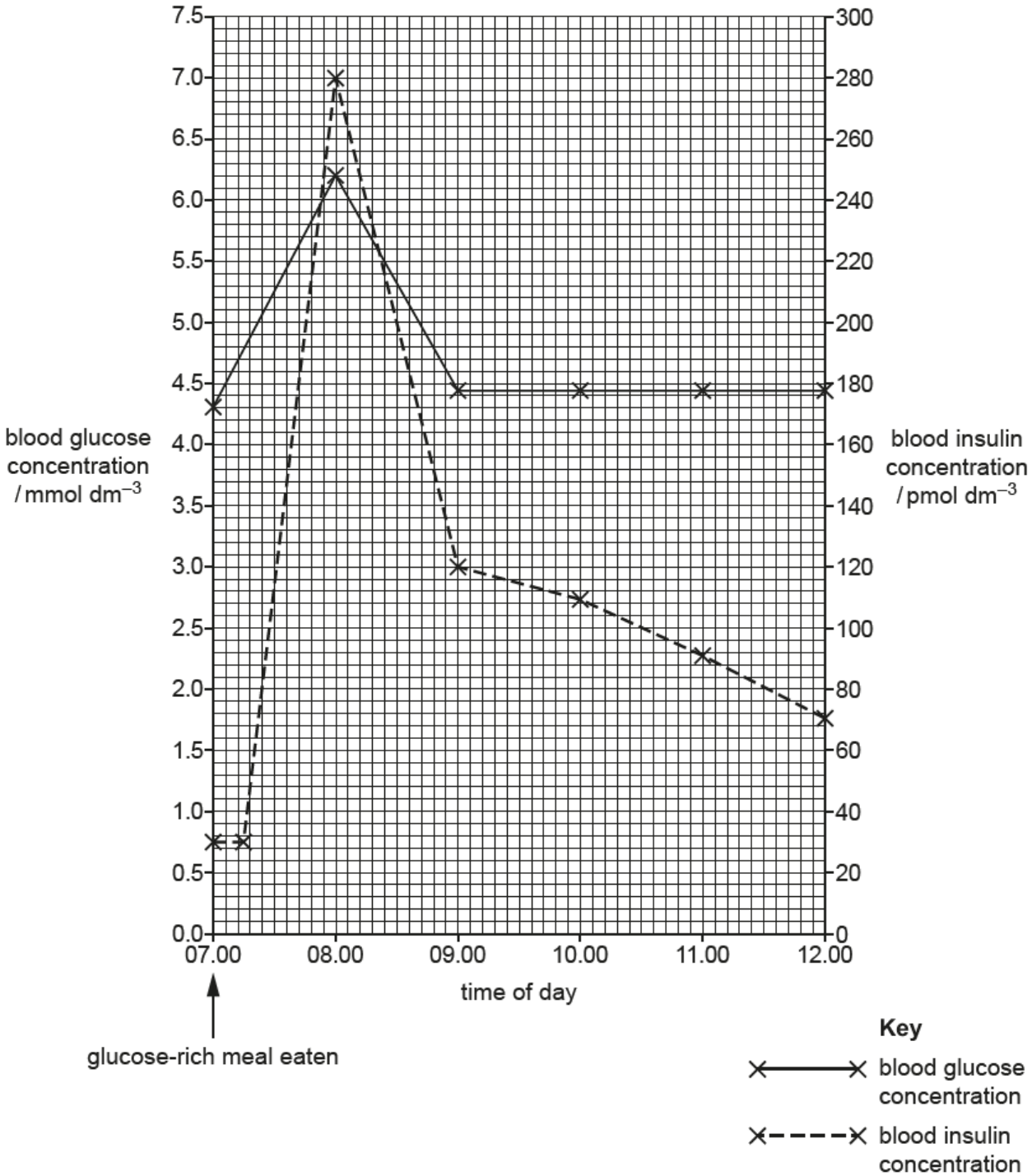


Fig. 10.1

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(i) Describe **and** explain how the results shown in Fig. 10.1 indicate a relationship between blood glucose concentration and blood insulin concentration after the consumption of a glucose-rich meal.

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..... [3]

(ii) Suggest **and** explain how the results shown in Fig. 10.1 would change if the meal was mostly starch rather than glucose.

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..... [3]

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(b) Glucagon is synthesised by cells in the pancreas known as alpha (α) cells. Glucagon binds to G-protein-coupled receptors in the cell surface membrane of liver cells. This results in the activation of G-proteins.

Outline the sequence of events occurring within the cell after the activation of G-proteins that helps to restore the blood glucose concentration to its set point.

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..... [4]

[Total: 10]

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1. Nov/2022/Paper_41/No.8

(a) Fig. 8.1 is a diagram of a kidney nephron.

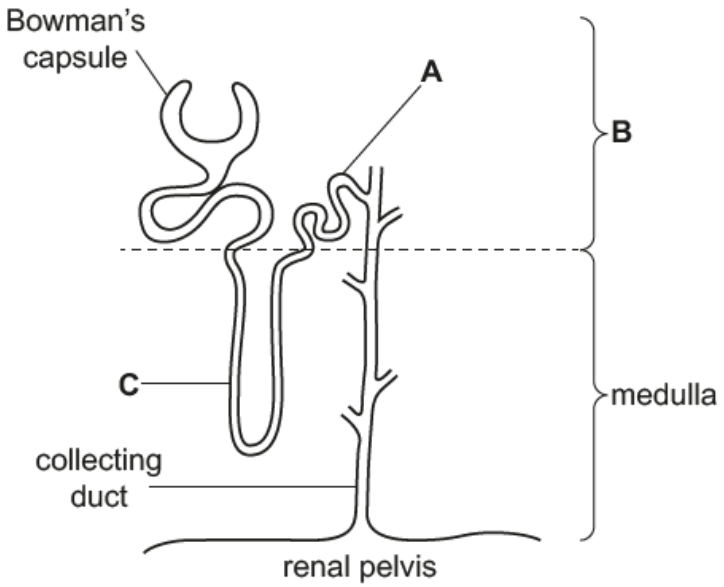


Fig. 8.1

With reference to Fig. 8.1, name **A**, **B** and **C**.

A .....

B .....

C .....

[3]

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(b) Antidiuretic hormone (ADH) is involved in the maintenance of the water potential of the blood.

Fig. 8.2 shows the relationship between blood ADH concentration, urine concentration and the flow rate of urine.

The flow rate of urine is the rate of production of urine by the kidneys.

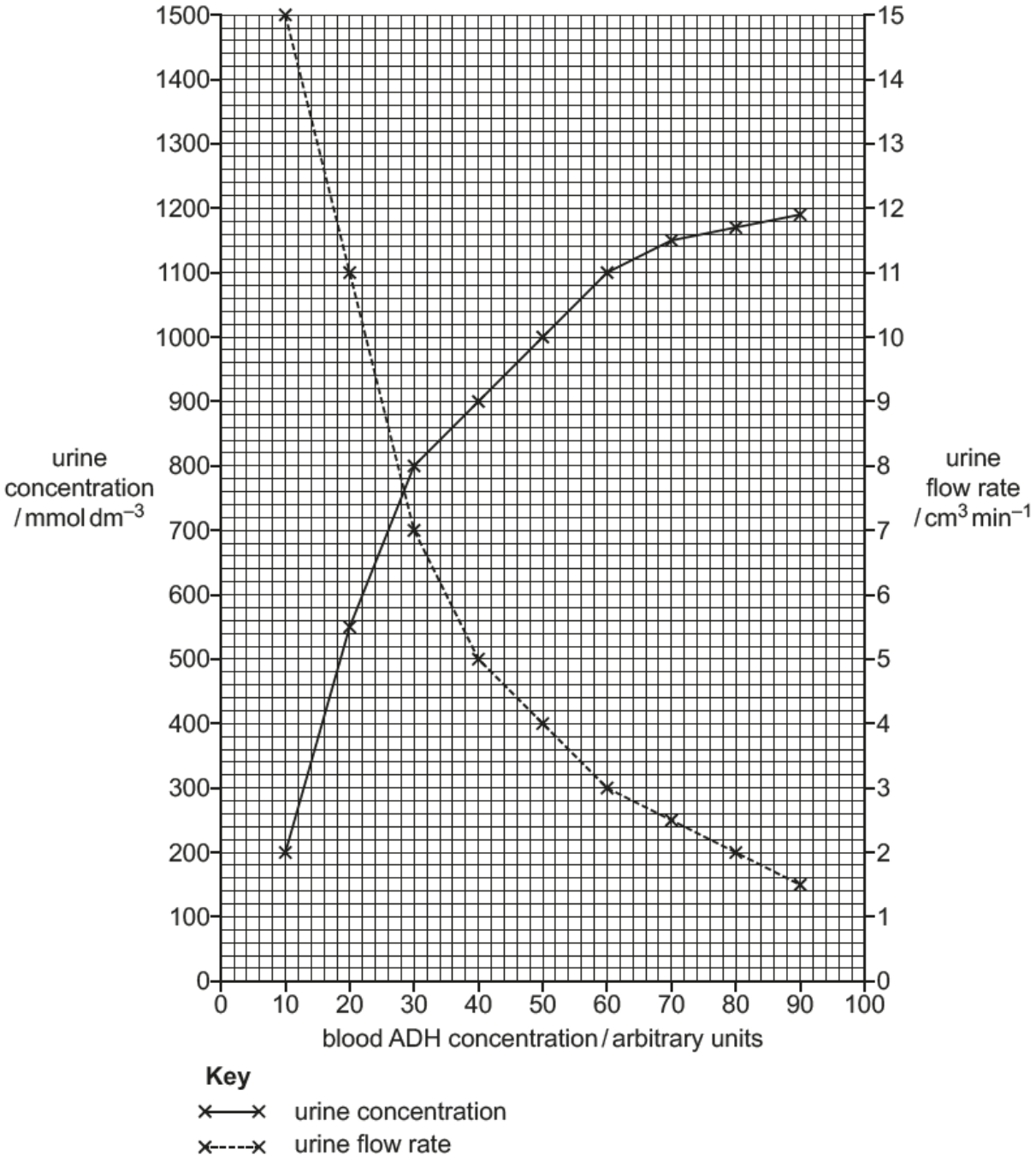


Fig. 8.2

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Describe the relationships shown in Fig. 8.2.

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..... [3]

(c) Describe **and** explain the action of ADH on the cells of the collecting duct when the water potential of the blood decreases.

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..... [5]

[Total: 11]

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2. Nov/2022/Paper_41/No.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.

[Total: 5]

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3. Nov/2022/Paper_42/No.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.

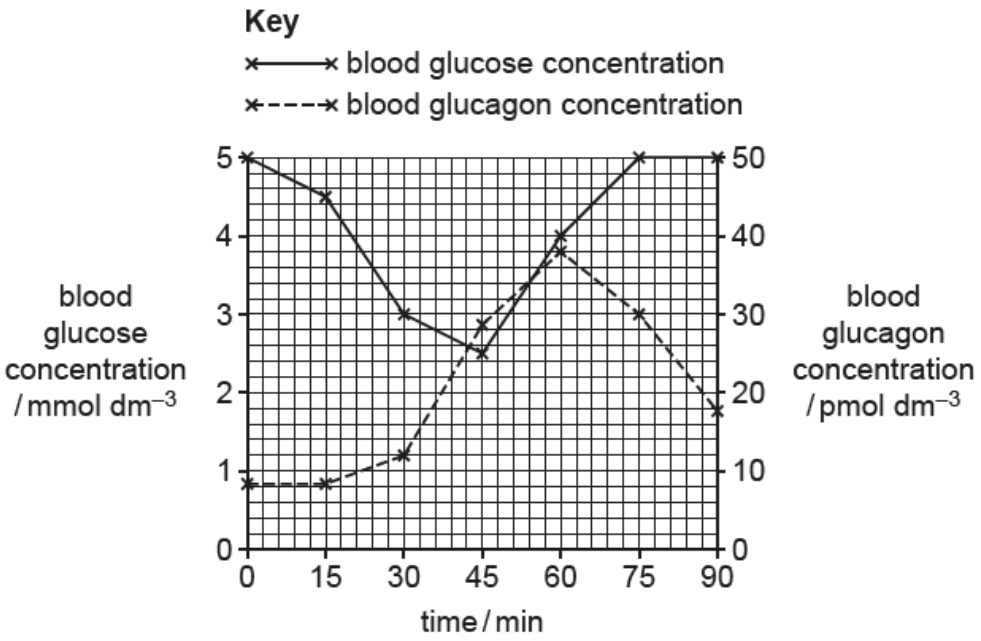


Fig. 10.1

Explain the relationship shown in Fig. 10.1.

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..... [4]

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(b) The passage below outlines cell signalling.

Complete the passage by using the most appropriate scientific terms.

Cells need to interact with their environment and other cells around them. This is called cell signalling. Cells in mammals are involved in a complex system of communication with each other. For example, liver cells detect signals using receptors in their cell surface membranes. Glucagon binds to the receptors because its shape is ..... . This binding activates a ..... , leading to stimulation of the enzyme ..... . [3]

[Total: 7]

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1. March/2023/Paper_ 9700/42/No.1

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

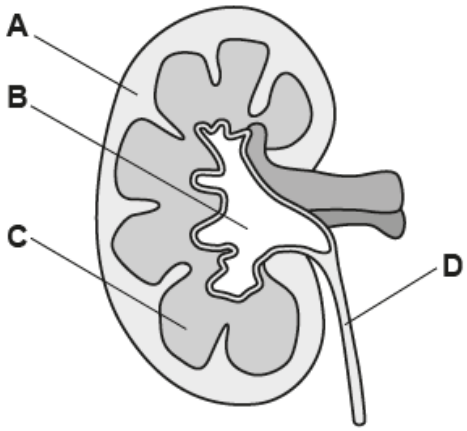


Fig. 1.1

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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(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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..... [3]

(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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..... [3]

[Total: 10]

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2. June/2023/Paper_ 9700/41/No.5

The kidney is an important organ of homeostasis. One role of the kidney is osmoregulation.

(a) Fig. 5.1 is a photomicrograph of part of a kidney nephron.

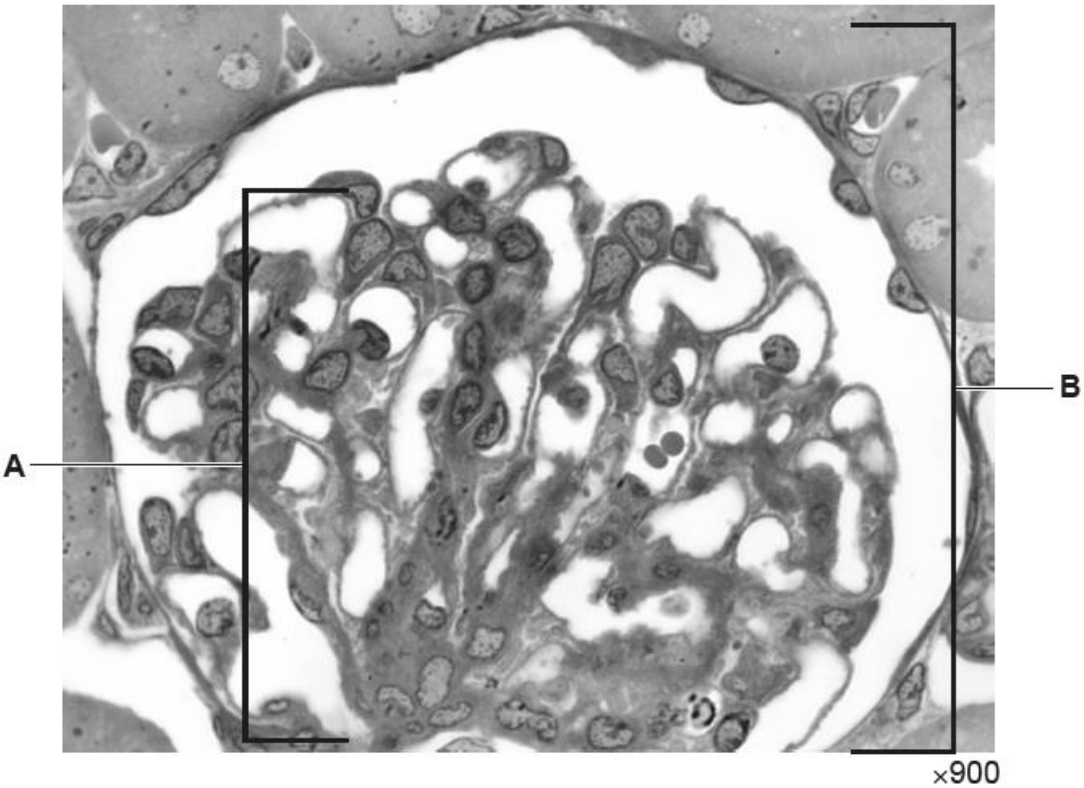


Fig. 5.1

(i) Identify the structures labelled **A** and **B** in Fig. 5.1.

A .....

B .....

[2]

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(ii) Describe how blood is filtered by the part of the kidney nephron shown in Fig. 5.1.

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..... [4]

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(b) The cell surface membranes of kidney cells have receptors for many molecules, including glucagon and antidiuretic hormone (ADH).

(i) Glucagon binds to G-protein-coupled receptors on kidney cells.

The binding of glucagon to kidney cells activates a cell signalling pathway that is similar to the cell signalling pathway activated when glucagon binds to liver cells.

Fig. 5.2 is an outline of the cell signalling pathway activated when glucagon binds to kidney cells.

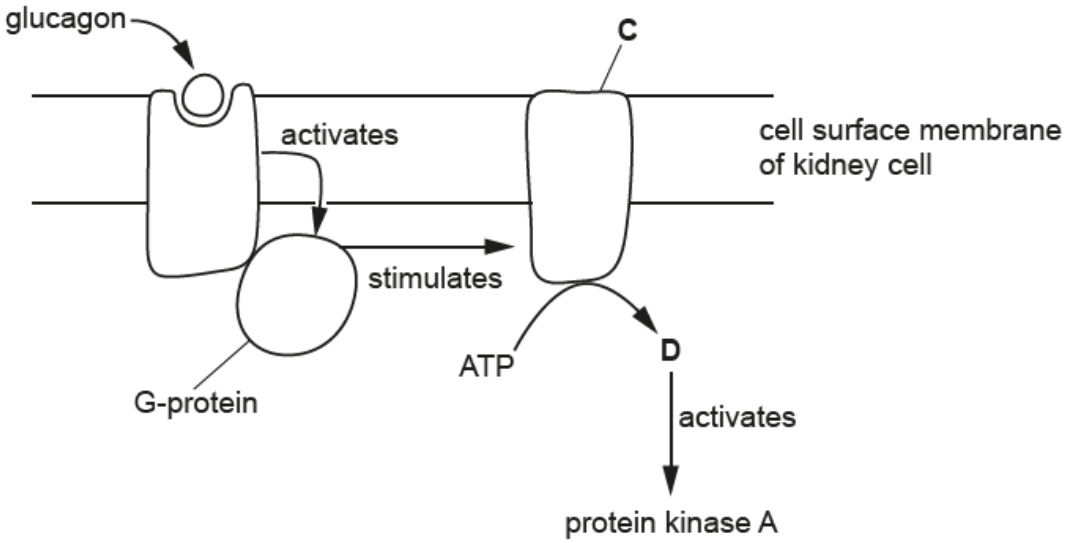


Fig. 5.2

Name the molecules labelled **C** and **D** in Fig. 5.2.

C .....

D .....

[2]

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(ii) Syndrome of inappropriate antidiuresis (SIAD) is a condition that affects osmoregulation in the kidney.

Fig. 5.3 shows how sodium ion concentration in the blood affects the ADH concentration in the blood in:

- people with normal homeostasis
- people with one type of SIAD, known as type C SIAD.

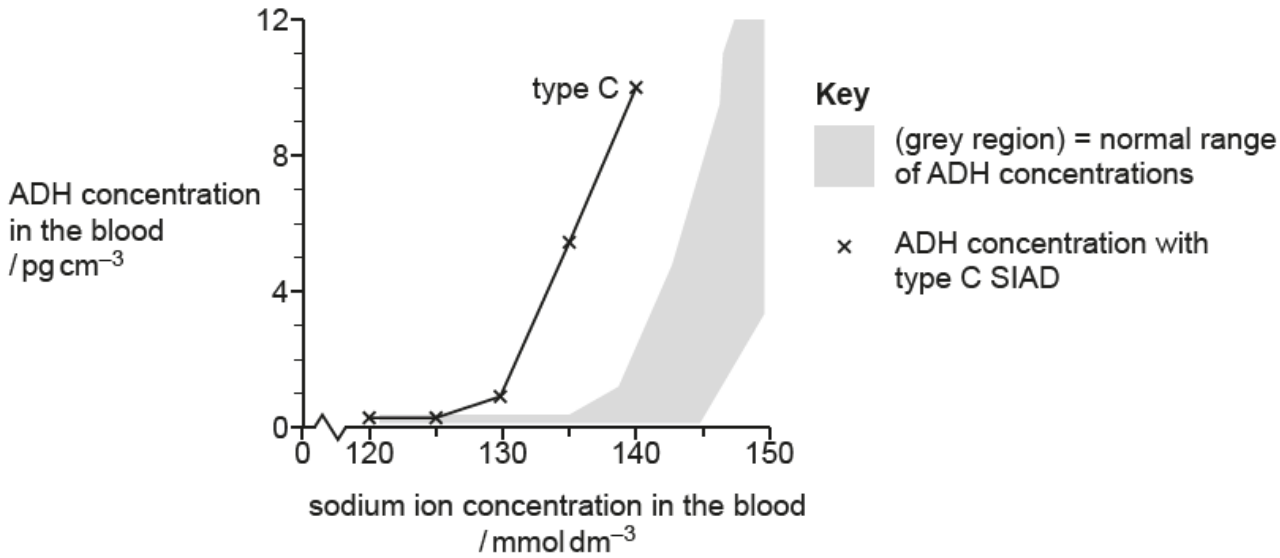


Fig. 5.3

Describe the results shown in Fig. 5.3 **and** explain the effect of type C SIAD on osmoregulation.

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..... [4]

[Total: 12]

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3. June/2023/Paper_ 9700/42/No.6

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

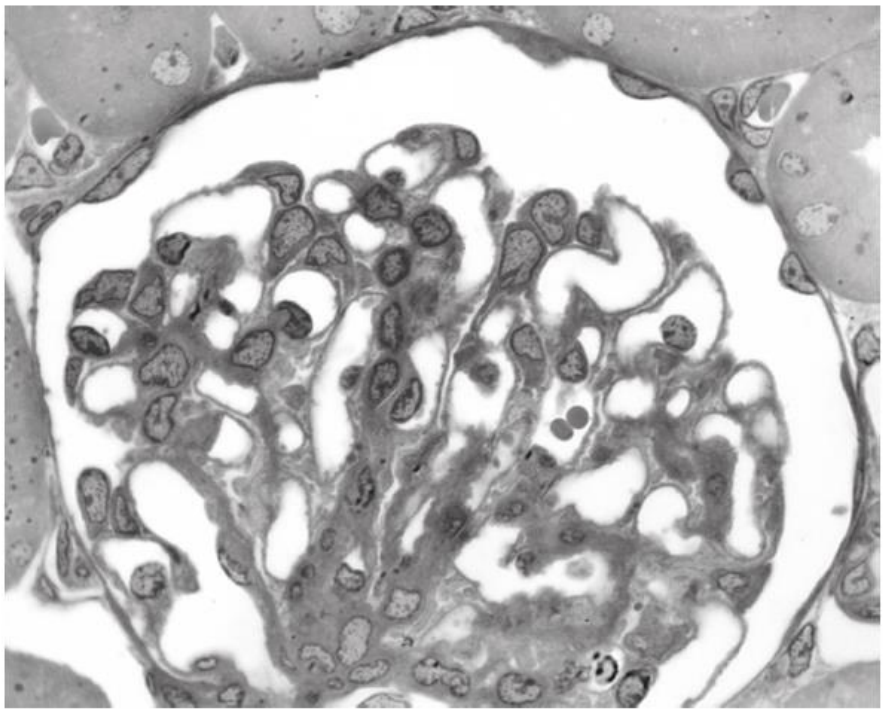


Fig. 6.1

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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(b) The glomerular filtration rate (GFR) is the rate at which fluid filters from the blood in the glomerulus into the Bowman's capsule.

Fig. 6.2 shows the mean GFR values for healthy males and females of different age groups.

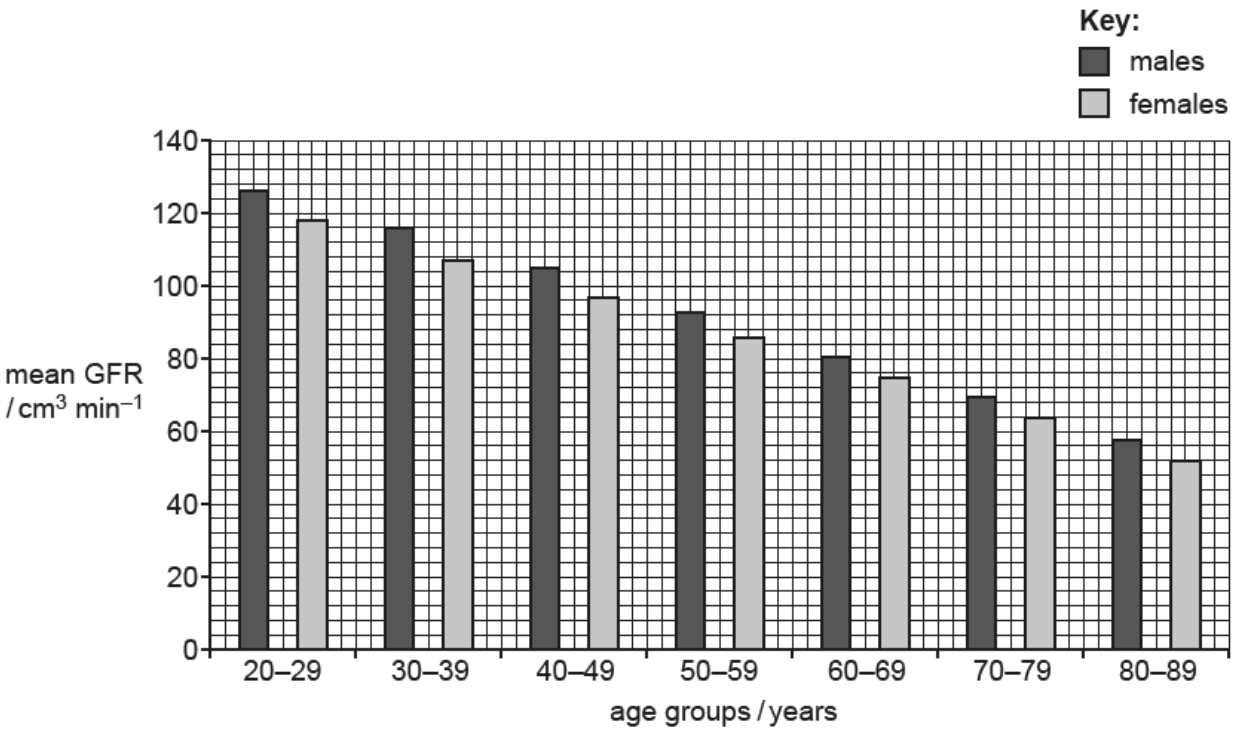


Fig. 6.2

(i) Use Fig. 6.2 to calculate the yearly rate of decrease in mean GFR from the 20–29 age group to the 80–89 age group for **females**.

Show your working.

Give your answer to **one** decimal place and include units.

answer ..... [3]

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(ii) The age of a person and whether they are male or female can affect GFR.

Suggest **and** explain other factors that can affect GFR.

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..... [3]

(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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..... [7]

[Total: 15]

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4. June/2023/Paper_ 9700/43/No.6

(a) Fig. 6.1 shows part of the Bowman's capsule of a kidney nephron.

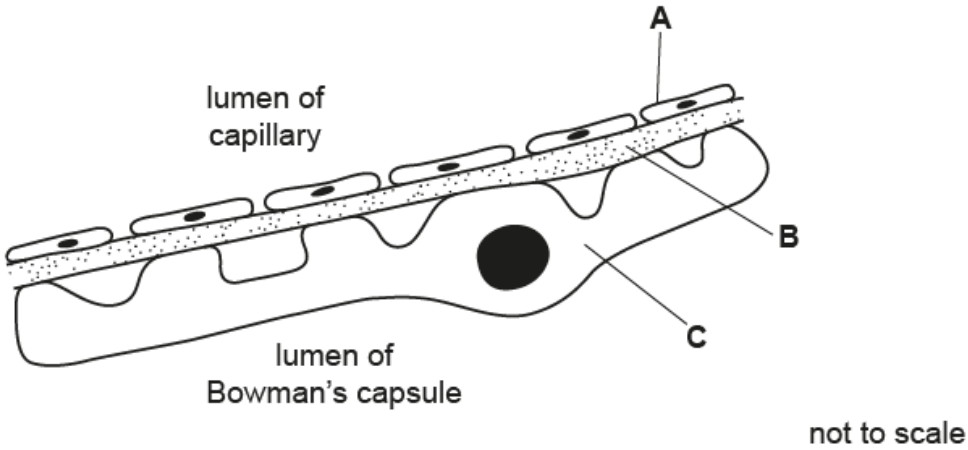


Fig. 6.1

Name structures **A**, **B** and **C**.

A .....

B .....

C .....

[3]

(b) Fluid is forced into the Bowman's capsule by ultrafiltration to form the glomerular filtrate.

Describe the role of structure **B** in ultrafiltration.

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..... [2]

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(c) The main component of the glomerular filtrate formed in the Bowman's capsule is water. Most of this water is reabsorbed as the filtrate passes along the nephron.

- 180 dm^3 of water forms part of the glomerular filtrate each day.
- 1.4 dm^3 of water leaves the body in urine each day.

Calculate the percentage of water in the glomerular filtrate that is reabsorbed as the glomerular filtrate passes along the nephron.

Show your working and give your answer to **one** decimal place.

answer ..... % [2]

(d) Describe how the action of antidiuretic hormone (ADH) on the cells of the collecting duct leads to the reabsorption of water in the glomerular filtrate.

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..... [7]

[Total: 14]

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