

1. Question part 1/2 | 9700 Feb-March 2016 P4 V2 Q5

- 5 (a) Fig. 5.1 outlines how two hormones, **A** and **B**, are involved in the regulation of blood glucose concentration.

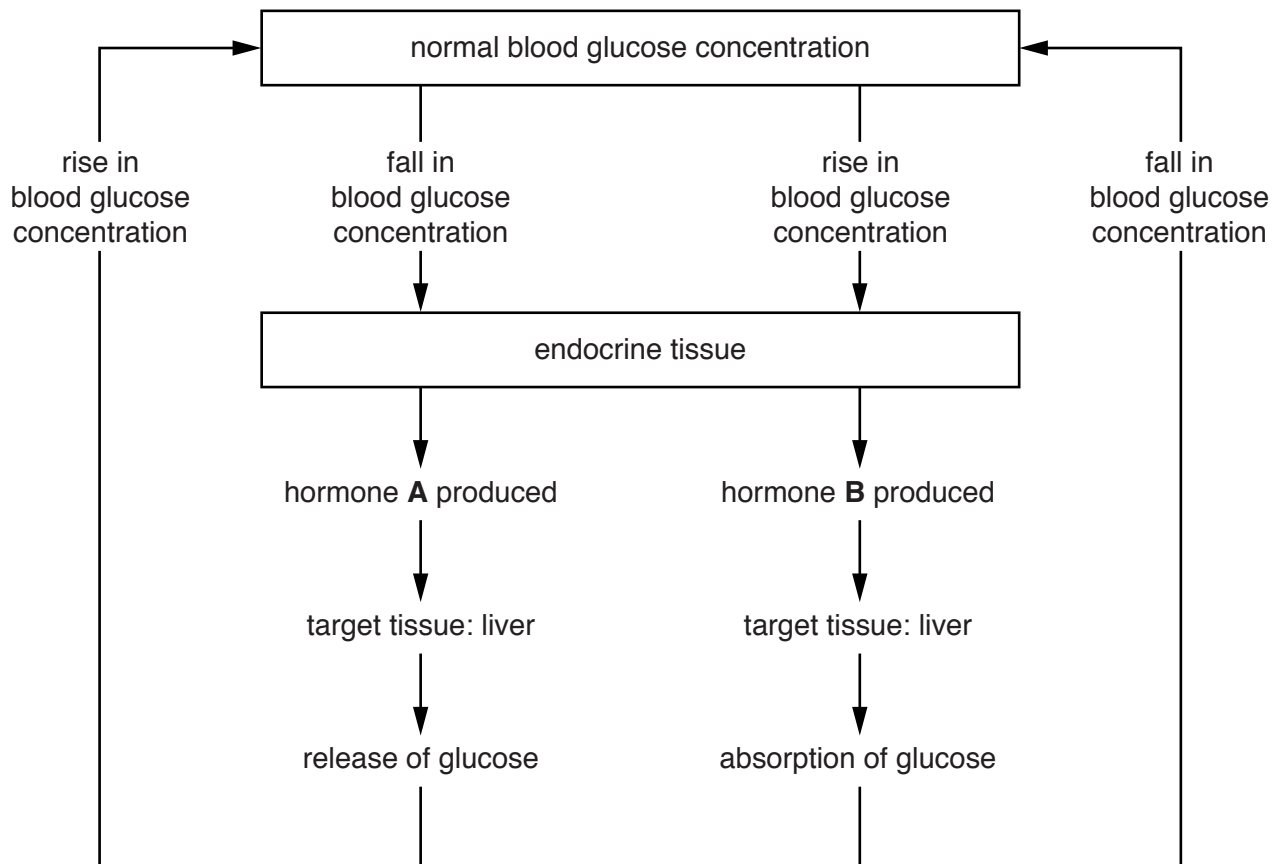


**Fig. 5.1**

With reference to Fig. 5.1, name:

- (i) the control mechanism that regulates blood glucose concentration

.....[1]

- (ii) hormone **A**.

.....[1]

The graph plots the activity of two enzymes, glycogen phosphorylase and glycogen synthetase, against time after a glucose meal. The y-axis represents enzyme activity in arbitrary units, ranging from 0 to 400. The x-axis represents time in minutes, ranging from 0 to 210. Glycogen phosphorylase activity (dashed line) starts at approximately 390 units at time 0 and decreases steadily, reaching about 35 units by 120 minutes and remaining constant thereafter. Glycogen synthetase activity (solid line) starts at approximately 25 units at time 0 and increases steadily, reaching about 320 units by 210 minutes.

| Time after glucose meal (min) | Glycogen phosphorylase activity (arbitrary units) | Glycogen synthetase activity (arbitrary units) |
|-------------------------------|---------------------------------------------------|------------------------------------------------|
| 0                             | 390                                               | 25                                             |
| 30                            | 280                                               | 30                                             |
| 60                            | 150                                               | 40                                             |
| 90                            | 70                                                | 50                                             |
| 120                           | 35                                                | 100                                            |
| 150                           | 35                                                | 150                                            |
| 180                           | 35                                                | 190                                            |
| 210                           | 35                                                | 320                                            |

Describe and suggest an explanation for the changes in the activity of the enzymes glycogen synthetase and glycogen phosphorylase.

.....[5]

2. Question part 1/2 | 9700 Feb-March 2016 P4 V2 Q6

- 6 *Paramecium* is a ciliated, unicellular protist. The cilia are similar in structure to those found in the trachea of a human. The cilia beat to move *Paramecium* through the water in which it lives.

Fig. 6.1 shows *Paramecium*.



**Fig. 6.1**

- (a) *Paramecium* has anterior and posterior ends. Generally the cilia beat so that the organism is moved forwards. Sometimes reverse movement is needed, for example when the *Paramecium* meets an obstacle.
- The direction of beating of the cilia is linked to the difference in concentration of calcium ions inside and outside the cell.
  - There is usually a higher concentration of calcium ions outside than inside the cell.
  - When *Paramecium* touches an object, its cell surface membrane becomes deformed.
  - The membrane potential becomes more positive inside the cell.
  - The organism moves backwards for a short time.
- (i) Suggest the sequence of events that occurs to cause the *Paramecium* to move backwards when it touches an object.

.....

.....

.....

.....

..... [2]

(ii) Suggest how *Paramecium* ensures that there is usually a higher concentration of calcium ions in the surrounding water than inside the cell.

.....

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.....

.....

..... [2]

(b) *Paramecium* has a contractile vacuole that fills up with water. When it is full, the contractile vacuole contracts to expel the water. The rate of contraction of the vacuole depends on the water potential of the surrounding water.

(i) Name the process by which water enters *Paramecium*.

..... [1]

(ii) Suggest the relationship between the rate of contraction of the contractile vacuole and the water potential of the surrounding water.

.....

.....

..... [1]

(c) Describe how the DNA of *Paramecium* differs from that of a prokaryotic cell.

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.....

.....

.....

..... [2]

[Total: 8]

3. Question part 1/2 | 9700 May-June 2016 P4 V1 Q7

- 7 (a)** An important function of control systems in mammals is homeostasis.

Explain what is meant by the term *homeostasis*.

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

- (b)** Insulin plays a part in homeostasis. It affects muscle and liver cells to bring about a decrease in blood glucose concentration, particularly after a meal.

- (i)** Insulin is composed of two polypeptides which are made in  $\beta$  cells in the pancreas.

State precisely where in  $\beta$  cells polypeptide molecules are synthesised.

..... [1]

- (ii)** Name the process by which insulin is secreted from  $\beta$  cells.

..... [1]

(iii) Describe the effects of insulin on muscle cells.

.....

.....

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..... [3]

(c) During periods of stress or extreme exercise more glucose needs to be released into the blood. The hormone adrenaline is released and binds to receptors on the cell surface membranes of liver cells.

Describe how the effect of adrenaline on liver cells results in an increase in blood glucose concentration.

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..... [5]

Topical questions | 92 questions

**7 (a)** In mammals, excess amino acids cannot be stored in the body.

..... [3]

..... [4]

(c) Fig. 7.1 is a diagram of a nephron.

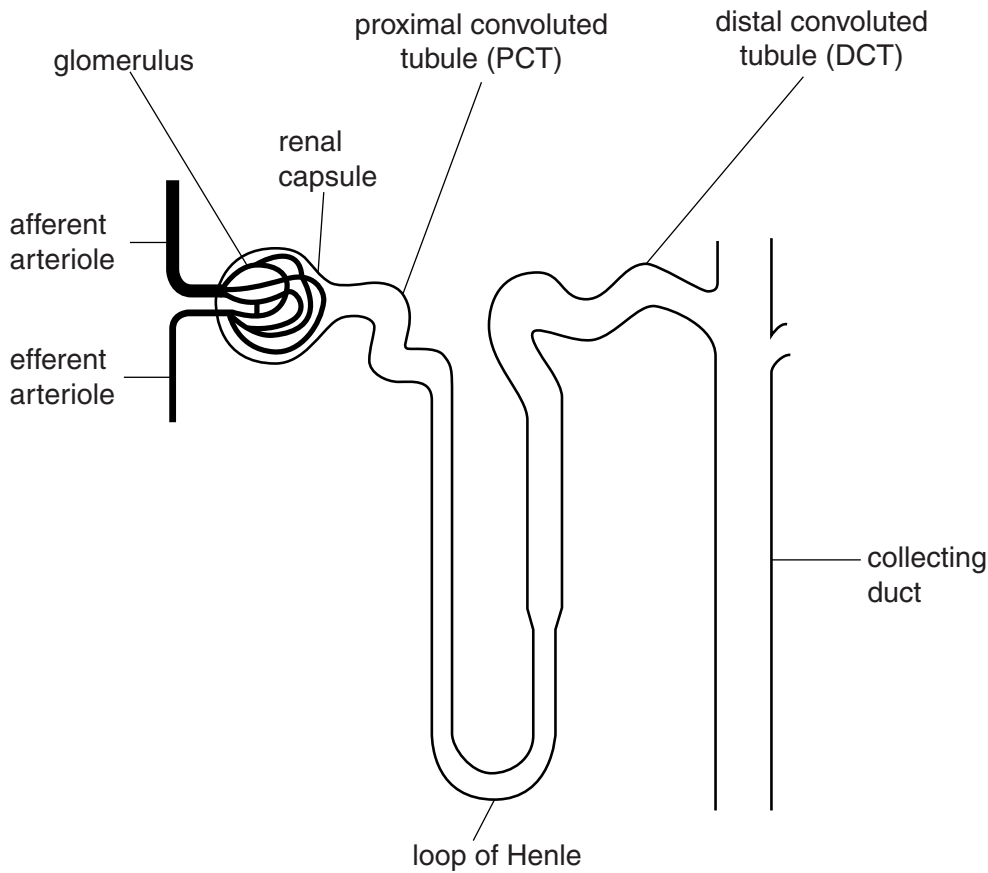


Fig. 7.1

Complete Table 7.1 by naming a part of the nephron that corresponds to each of the statements.

Table 7.1

| statement                                      | part of nephron |
|------------------------------------------------|-----------------|
| passes through the medulla                     | .....           |
| glucose is reabsorbed into the blood           | .....           |
| ADH acts on its walls                          | .....           |
| most of the water is reabsorbed into the blood | .....           |

[4]

[Total: 11]

- 7 (a)** An important function of control systems in mammals is homeostasis.

Explain what is meant by the term *homeostasis*.

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

- (b)** Insulin plays a part in homeostasis. It affects muscle and liver cells to bring about a decrease in blood glucose concentration, particularly after a meal.

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..... [5]

- 6 (a)** Fig. 6.1 shows the concentration of four hormones in a woman's blood during one menstrual cycle.

concentration of hormone in  
blood / arbitrary units

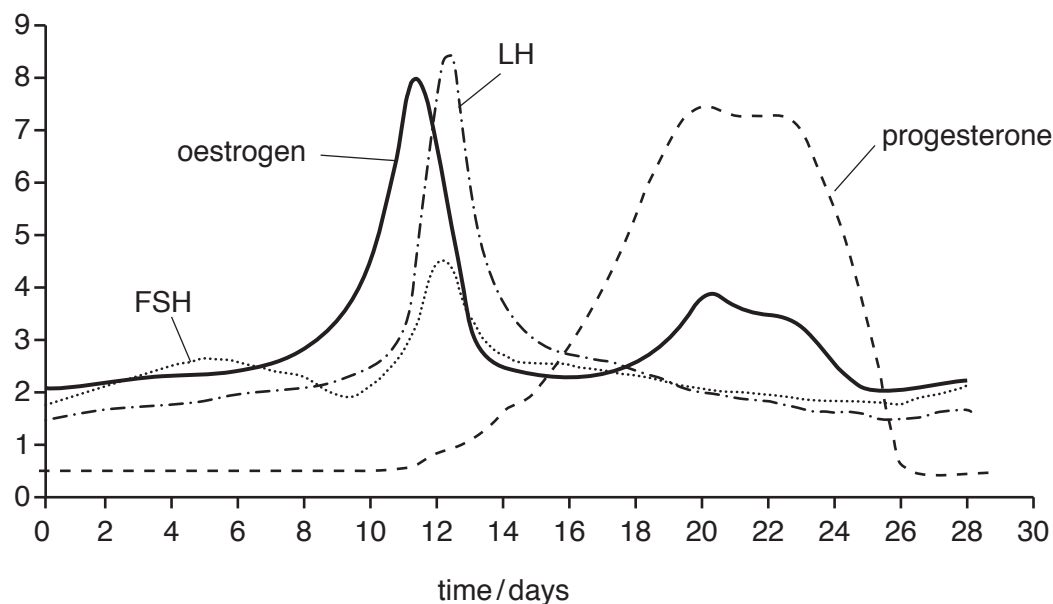


**Fig. 6.1**

- (i)** With reference to Fig. 6.1, explain why there is a large increase in LH at around day 12.

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

- (ii)** State how Fig. 6.1 shows that the woman did not become pregnant during this cycle.

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

**(b)** The combined oral contraceptive pill contains oestrogen and progesterone.

**(i)** Explain how this combined contraceptive pill works to prevent pregnancy.

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.....[4]

**(ii)** Suggest why some women take the combined contraceptive pill for just the first 21 days of their cycles.

.....

.....[1]

**(iii)** Some women have a contraceptive device inserted under the skin. This releases hormones into the blood and can last for up to three years.

Suggest **one** advantage of using such a device rather than taking contraceptive pills.

.....

.....[1]

[Total: 8]

## 9700 Biology Paper 4 - Homeostasis

Topical questions | 92 questions

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7. Question | 9700 Oct-Nov 2016 P4 V1 Q9

- 9**    **(a)** Using examples, outline the importance of homeostasis in a mammal. [7]
- (b)** Describe the main stages of cell signalling in the control of blood glucose concentration by adrenaline. [8]

[Total: 15]

- 1 (a) Diabetes insipidus (DI) is a condition that results in excessive thirst and the excretion of large amounts of dilute urine. A main cause of DI is a deficiency of ADH.

ADH normally binds to receptor proteins on cell surface membranes of cells in the collecting ducts of nephrons.

Outline the effect of ADH on the collecting ducts.

.....

.....

.....

.....

.....

.....

.....

..... [3]

- (b) An inherited form of DI may be caused by faulty membrane receptors. These receptors are coded for by a sex-linked allele.

(i) Explain the term *sex linkage*.

.....

.....

..... [1]

8. Question part 2/2 | 9700 Oct-Nov 2016 P4 V2 Q1

- (ii) Use a genetic diagram to show how parents who do not have this condition can have a child with the inherited form of DI.

*symbols*

.....

.....

*parental genotypes*

*gametes*

*offspring genotypes*

*offspring phenotypes*

[4]

[Total: 8]

- 6 (a)** Fig. 6.1 shows the concentration of four hormones in a woman's blood during one menstrual cycle.

concentration of hormone in  
blood / arbitrary units

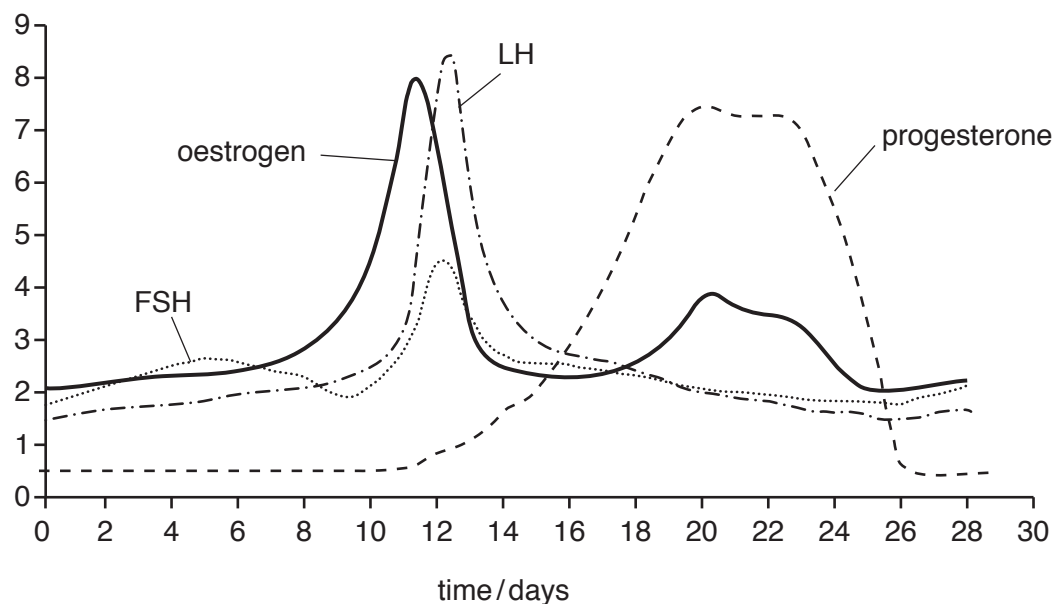


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.....[1]

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.....[1]

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Suggest **one** advantage of using such a device rather than taking contraceptive pills.

.....

.....[1]

[Total: 8]

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10. Question | 9700 Oct-Nov 2016 P4 V2 Q9

- 9**    **(a)** Using examples, outline the importance of homeostasis in a mammal. [7]
- (b)** Describe the main stages of cell signalling in the control of blood glucose concentration by adrenaline. [8]

[Total: 15]

- 6 (a)** Fig. 6.1 shows the concentration of two hormones, oestrogen and progesterone, in a woman's blood during one menstrual cycle.

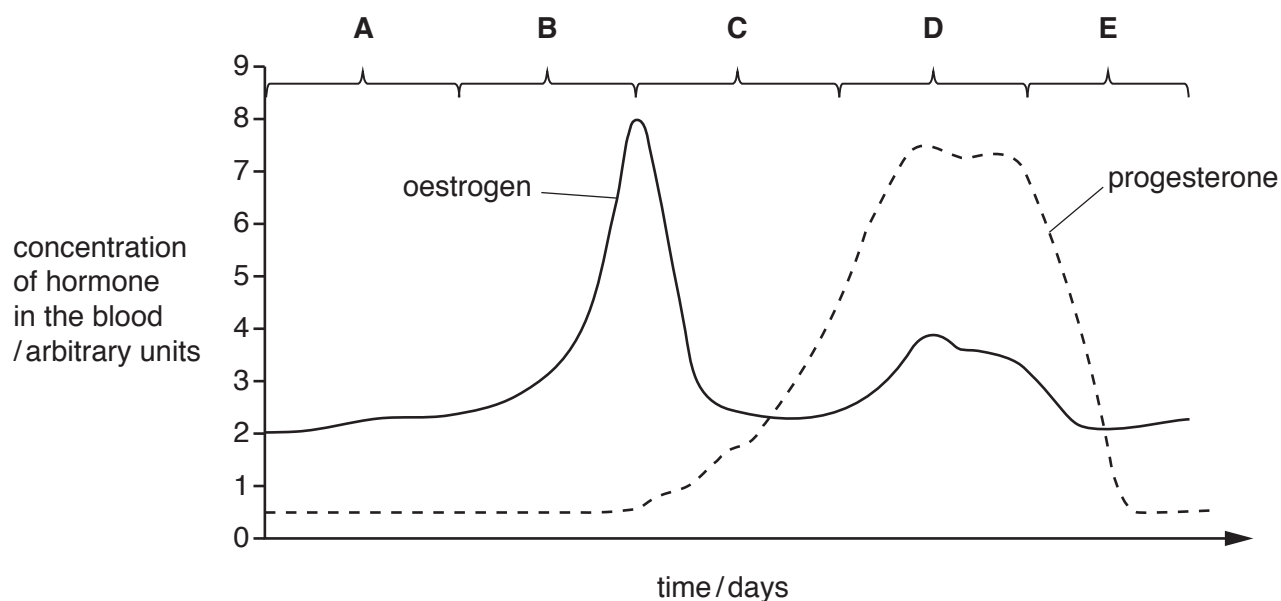


**Fig. 6.1**

- (i) With reference to Fig. 6.1, state the letter of the stage of the cycle during which ovulation occurs.

.....[1]

- (ii) State how Fig. 6.1 shows that the woman did not become pregnant during this cycle.

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

- (iii) Name the ovarian structure that secretes progesterone after ovulation.

.....[1]

- (iv) State the role of progesterone during stage D.

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

**(b)** The combined contraceptive pill contains oestrogen and progesterone.

Explain how this combined contraceptive pill works to prevent pregnancy.

.....

.....

.....

.....

.....

.....

.....

.....[4]

[Total: 8]

## 9700 Biology Paper 4 - Homeostasis

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12. Question | 9700 Oct-Nov 2016 P4 V3 Q9

- 9**    **(a)** Explain how glucose is reabsorbed into the blood from a kidney nephron. [8]
- (b)** Describe the role of ADH when the water potential of blood decreases. [7]

[Total: 15]

- 1 (a) Fig. 1.1 shows diagrams of nephrons from the kidneys of three different mammals, **P**, **Q** and **R**. These are all drawn to the same scale.

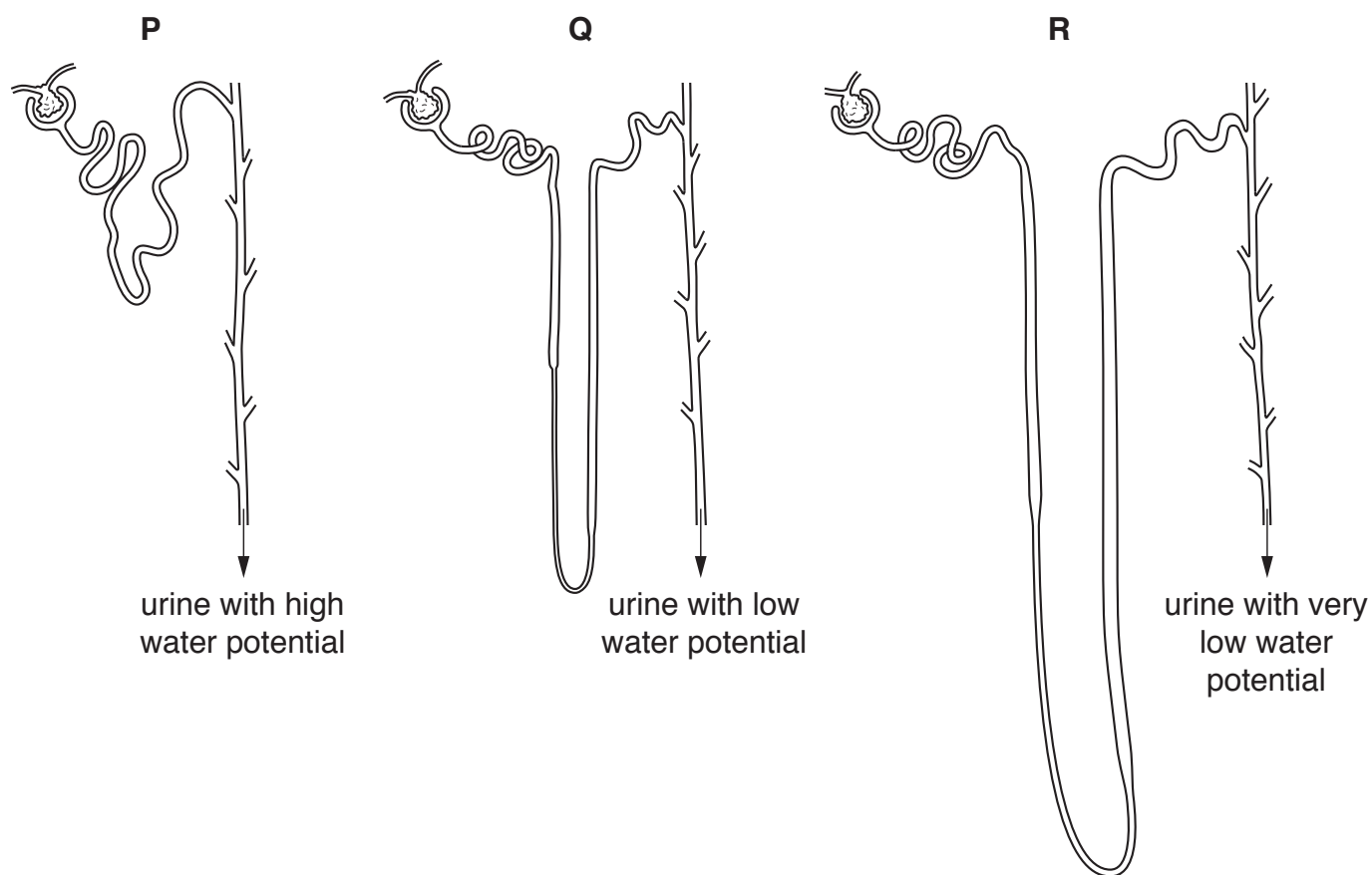


**Fig. 1.1**

- (i) State the relationship between the length of the loop of Henle and the water potential of the urine of the three mammals.

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

- (ii) The nephron of a camel is similar to that of mammal **R**.

Suggest why it is important that the camel produces urine with a very low water potential.

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

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

Table 1.1 lists three features of epithelial cells of the proximal convoluted tubule.

For each feature, explain how it helps the process of selective reabsorption.

Table 1.1

| feature                       | explanation                                                        |
|-------------------------------|--------------------------------------------------------------------|
| microvilli                    | <div><div></div><div></div><div></div><div></div><div></div></div> |
| many mitochondria             | <div><div></div><div></div><div></div><div></div><div></div></div> |
| tight junctions between cells | <div><div></div><div></div><div></div><div></div><div></div></div> |

[6]

[Total: 9]

- 1 (a) The mammalian kidney is an organ involved in homeostasis.

Explain what is meant by the term *homeostasis*.

.....

.....

..... [1]

- (b) Fig. 1.1 shows a section through a kidney.

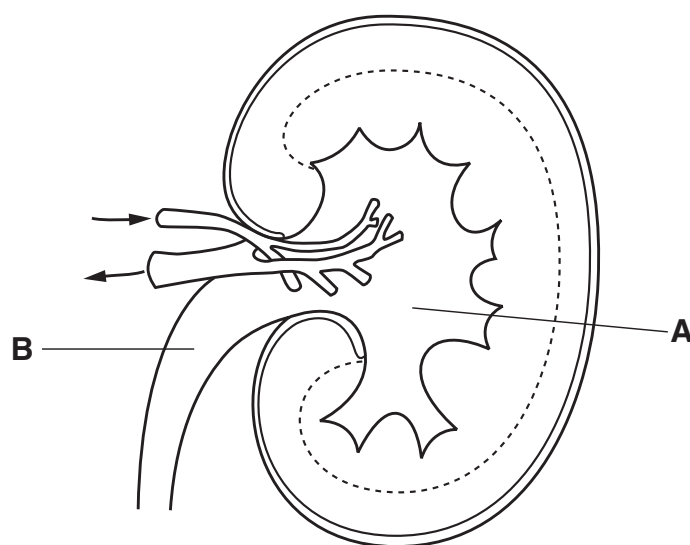


Fig. 1.1

- (i) With reference to Fig. 1.1, name structures **A** and **B**.

**A** .....

**B** .....

[2]

- (ii) On Fig. 1.1, use label lines and letters to label where:

**U** – ultrafiltration occurs

**L** – the loop of Henle is found

**C** – blood urea concentration is low.

[3]

(c) Describe the roles of the hypothalamus and the posterior pituitary in osmoregulation.

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..... [5]

[Total: 11]

## 9700 Biology Paper 4 - Homeostasis

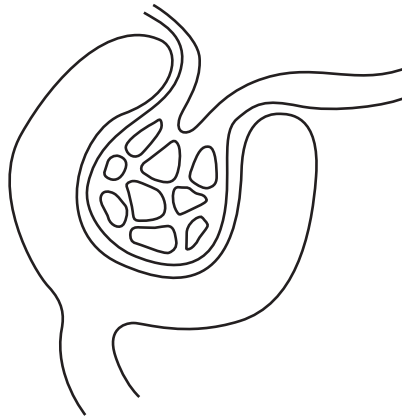
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15. Question | 9700 May-June 2017 P4 V1 Q9

- 9**    **(a)** Explain how dip sticks function to test for glucose in a sample of urine. [8]
- (b)** Outline how a high blood glucose concentration returns to normal in a healthy person. [7]

[Total: 15]



[3]

..... [5]

[5]

**(c)** Complete the following sentences about osmoregulation.

In mammals, the water potential of the blood is constantly monitored by  
..... in the hypothalamus of the brain.

When the water potential of the blood decreases, the production of a hormone  
called ..... in the cells of the  
hypothalamus increases.

This hormone is released into the blood via the .....

This causes the kidneys to retain more water until the water potential of the blood  
returns to the set point.

This is an example of a ..... mechanism.

[4]

[Total: 12]

## 9700 Biology Paper 4 - Homeostasis

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17. Question | 9700 May-June 2017 P4 V2 Q9

- 9**    **(a)** Explain the mechanism by which guard cells open stomata. [9]
- (b)** State the changes in the external environment that lead to stomatal opening and closure.  
          Explain why these stomatal responses are necessary. [6]

[Total: 15]

..... [1]

A diagram of a kidney in cross-section. The outer boundary is the renal capsule. Inside, the renal pelvis is shown as a large, irregularly shaped cavity with a dashed outline, labeled 'A'. The renal pyramids are the triangular structures within the kidney, labeled 'B'. The renal pelvis branches out into the renal pyramids. Arrows indicate the flow of urine from the renal pyramids into the renal pelvis and then out of the kidney through the ureter.

(i) With reference to Fig. 1.1, name structures **A** and **B**.

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

[3]

(c) Describe the roles of the hypothalamus and the posterior pituitary in osmoregulation.

.....

.....

.....

.....

.....

.....

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.....

.....

.....

..... [5]

[Total: 11]

## 9700 Biology Paper 4 - Homeostasis

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19. Question | 9700 May-June 2017 P4 V3 Q9

- 9**    **(a)** Explain how dip sticks function to test for glucose in a sample of urine. [8]
- (b)** Outline how a high blood glucose concentration returns to normal in a healthy person. [7]

[Total: 15]

## 9700 Biology Paper 4 - Homeostasis

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20. Question part 1/4 | 9700 Oct-Nov 2017 P4 V1 Q8

**8 (a)** Homeostasis in mammals involves negative feedback mechanisms.

Outline how a negative feedback mechanism works.

.....[4]

- (b)** Fig. 8.1 is a diagram summarising the role of the nervous and endocrine systems in the control of blood glucose concentration.

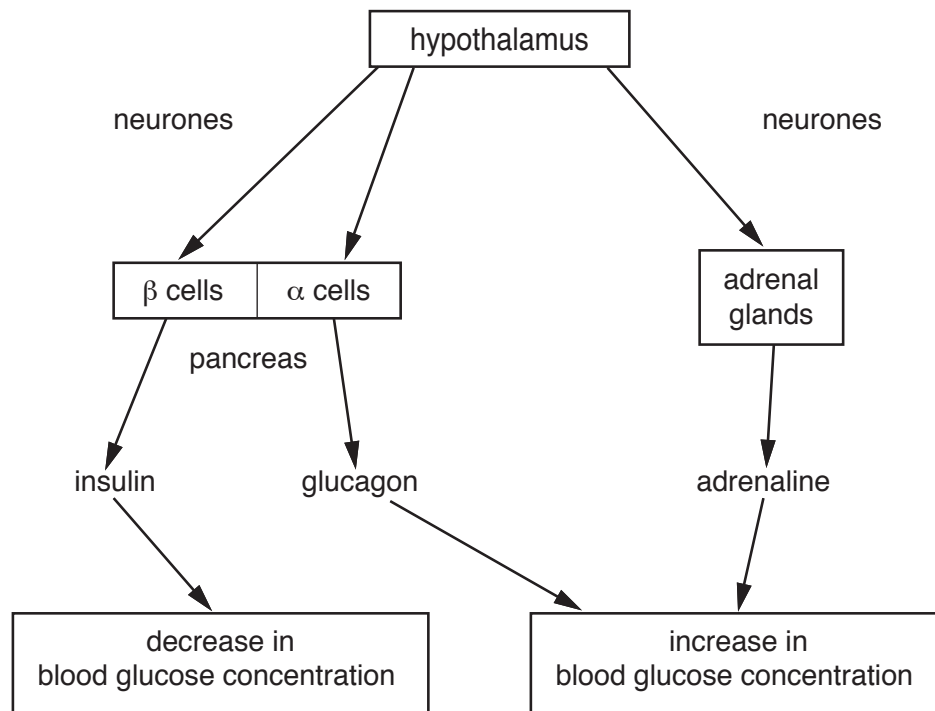


**Fig. 8.1**

With reference to Fig. 8.1, describe the role of the **nervous system** in the control of blood glucose concentration.

.....[4]

(c) If the core temperature of the human body falls, the hypothalamus sends impulses to activate several physiological responses, some of which are listed below.

For each one, state how it would help to bring the core temperature back to normal.

vasoconstriction .....  
.....  
.....  
shivering .....  
.....  
.....  
increasing secretion of adrenaline .....  
.....  
.....[4]

[Total: 12]

## Section B

Answer **one** question.

21. Question part 1/2 | 9700 Oct-Nov 2017 P4 V2 Q4

- 4 (a) The body temperature of a human is maintained at its set point of approximately 37°C. If it rises above this temperature, physiological responses begin to return the temperature to its set point. Two of these responses are vasodilation and sweating.

Explain how vasodilation and sweating help to return the body temperature to its set point.

*vasodilation* .....

.....

.....

.....

.....

*sweating* .....

.....

.....

.....

.....[4]

- (b) Diabetes mellitus is a disease where the pancreas is not able to secrete sufficient insulin.

The symptoms of diabetes mellitus include a tendency to drink a lot of water and a loss of body mass.

Suggest why these symptoms occur.

.....

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.....[4]

(c) A person with diabetes mellitus can use a biosensor to measure the concentration of glucose in their blood.

(i) Outline how a glucose biosensor works.

.....

.....

.....

.....

.....

.....

.....[3]

(ii) Suggest **one** advantage of using a biosensor rather than a dip stick.

.....

.....[1]

[Total: 12]

## 9700 Biology Paper 4 - Homeostasis

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22. Question part 1/4 | 9700 Oct-Nov 2017 P4 V3 Q8

**8 (a)** Homeostasis in mammals involves negative feedback mechanisms.

Outline how a negative feedback mechanism works.

.....[4]

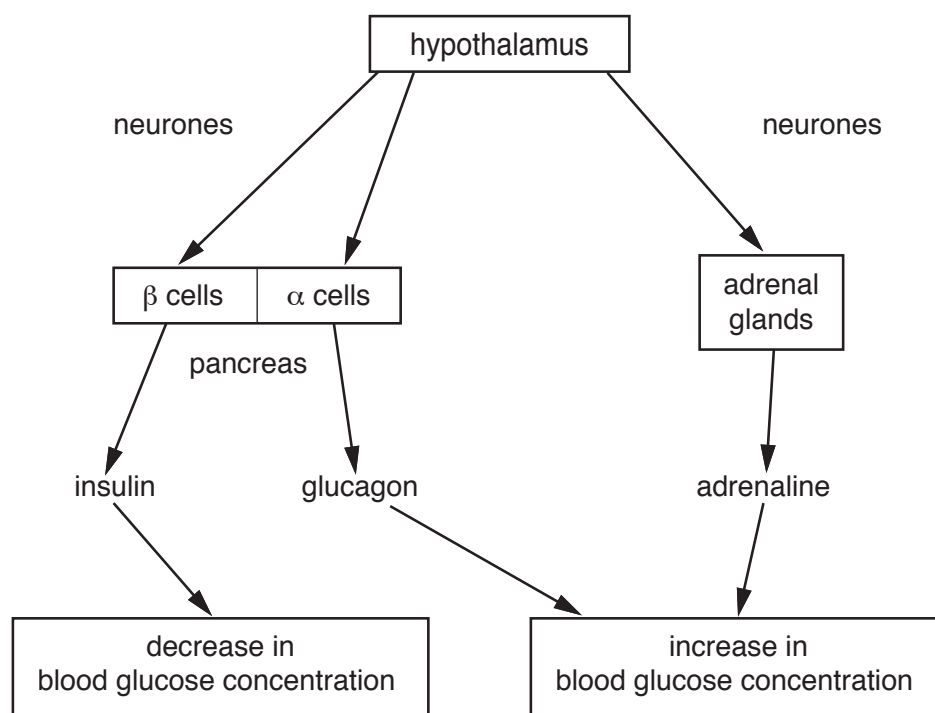


**Fig. 8.1**

With reference to Fig. 8.1, describe the role of the **nervous system** in the control of blood glucose concentration.

.....[4]

- (c) If the core temperature of the human body falls, the hypothalamus sends impulses to activate several physiological responses, some of which are listed below.

For each one, state how it would help to bring the core temperature back to normal.

vasoconstriction .....  
.....  
.....

shivering .....  
.....  
.....

increasing secretion of adrenaline .....  
.....  
.....[4]

[Total: 12]

## Section B

Answer **one** question.

5 (a) The contraction of striated muscle is explained by the sliding filament model.

(i) Describe what happens in the sarcomere when the myosin head releases ADP and inorganic phosphate (Pi).

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

(ii) Explain the **precise** function of ATP in the sliding filament model.

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

(b) During contraction, muscles use up ATP very quickly. For a short period of time, ATP can be resynthesised using creatine phosphate, as shown in Fig. 5.1.

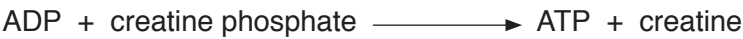


Fig. 5.1

The creatine formed as a result of the resynthesis of ATP is converted to creatinine. Creatinine production in the body stays fairly constant. Creatinine becomes part of the glomerular filtrate during ultrafiltration in the kidney nephrons.

(i) Ultrafiltration requires a high blood pressure in the glomerulus.

Explain how this high blood pressure is achieved.

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

(ii) Name the main filtration barrier in the nephron that allows creatinine to pass into the renal capsule but stops red blood cells from passing through.

.....[1]

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23. Question part 2/4 | 9700 Feb-March 2018 P4 V2 Q5

**Question 5 continues on page 16**

- (c) The concentration of creatinine in the blood largely depends on the glomerular filtration rate (GFR). By measuring the concentration of creatinine in the blood, the GFR can therefore be estimated. The value of the GFR can be used to assess the efficiency of the kidneys.

In humans, a normal value of the GFR is  $100 \text{ cm}^3 \text{ min}^{-1}$ .

Fig. 5.2 shows the relationship between the GFR and the concentration of creatinine in the blood.

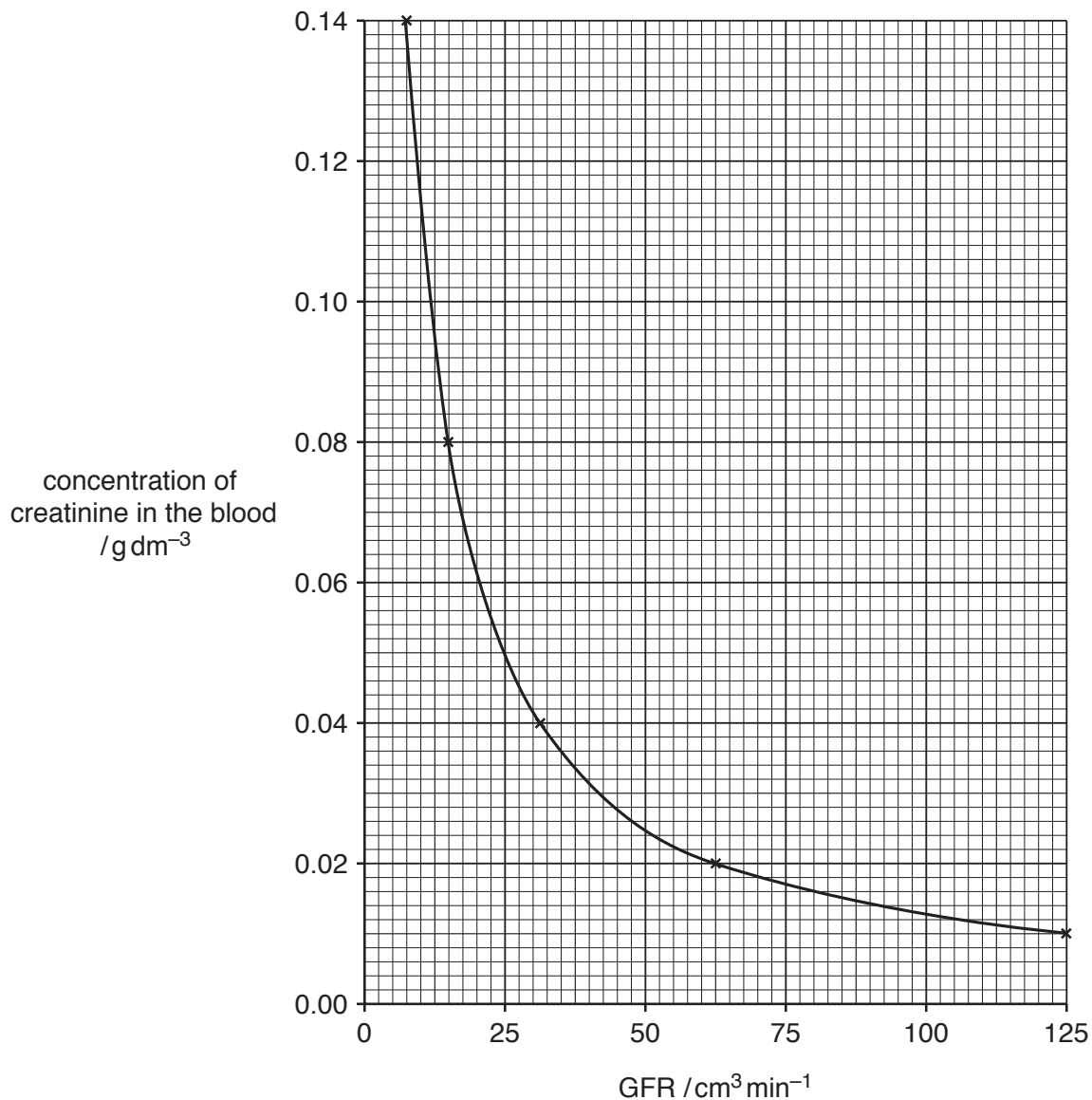


Fig. 5.2

(i) Describe the relationship shown in Fig. 5.2.

.....

.....

.....

.....

.....[2]

(ii) Use Fig. 5.2 to estimate the concentration of creatinine in the blood that indicates a normal GFR.

answer .....[2]

(iii) Suggest **two** reasons why the GFR could decrease.

.....

.....

.....

.....[2]

[Total: 12]

8 (a) In mammals, the nervous system and the endocrine system coordinate responses to the changes in internal and external environments.

Complete Table 8.1 to indicate the differences between the nervous system and the endocrine system.

Table 8.1

| feature                 | nervous system | endocrine system |
|-------------------------|----------------|------------------|
| method of communication | .....          | .....            |
| method of transmission  | .....          | .....            |
| transmission speed      | .....          | .....            |
| duration of effect      | .....          | .....            |

[4]

(b) Fig. 8.1 shows the changes in the concentration of hormones in the blood during the menstrual cycle.

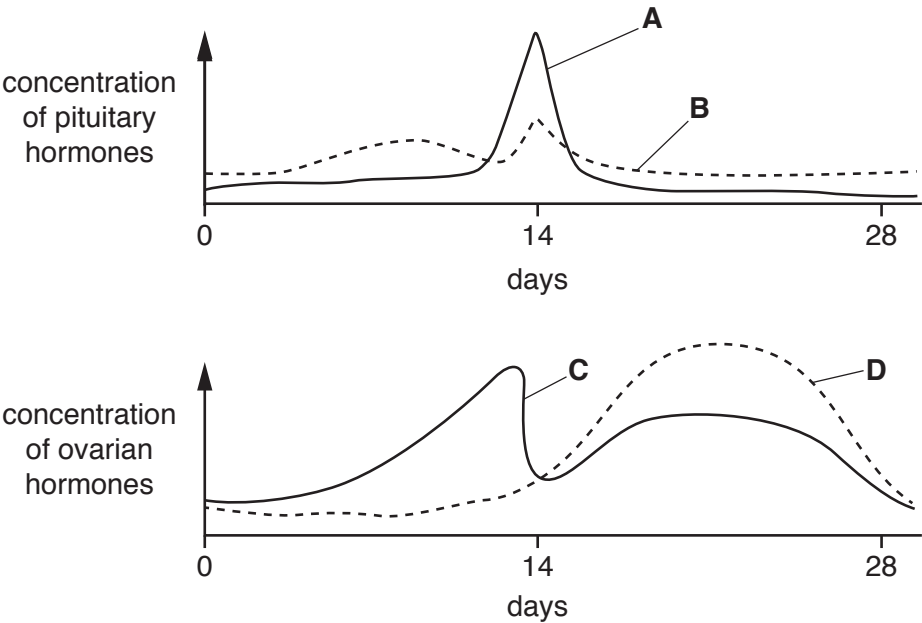


Fig. 8.1

With reference to Fig. 8.1, match hormones **A**, **B**, **C** or **D** to the correct statements 1 to 4.

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

- 1 made by the corpus luteum .....
- 2 stimulates the repair of the endometrium .....
- 3 maintains the endometrium .....
- 4 stimulates ovulation .....

[4]

(c) Outline the biological basis for contraceptive pills containing oestrogen and progesterone.

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.....[5]

[Total: 13]

[illegible]

## 9700 Biology Paper 4 - Homeostasis

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25. Question part 2/3 | 9700 May-June 2018 P4 V2 Q10

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## 9700 Biology Paper 4 - Homeostasis

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25. Question part 3/3 | 9700 May-June 2018 P4 V2 Q10

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26. Question part 1/3 | 9700 May-June 2018 P4 V3 Q10

- 10 (a)** Describe the effect of a high blood concentration of ADH on the kidney. [8]
- (b)** Explain how glucagon brings about a rise in blood glucose concentration. [7]

[Total: 15]

This image shows a blank sheet of white paper with horizontal dashed lines, resembling notebook paper. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

# 9700 Biology Paper 4 - Homeostasis

Topical questions | 92 questions

26. Question part 2/3 | 9700 May-June 2018 P4 V3 Q10

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26. Question part 3/3 | 9700 May-June 2018 P4 V3 Q10

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**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]

[illegible]

# 9700 Biology Paper 4 - Homeostasis

Topical questions | 92 questions

27. Question part 2/3 | 9700 Oct-Nov 2018 P4 V1 Q10

[illegible]

# 9700 Biology Paper 4 - Homeostasis

Topical questions | 92 questions

27. Question part 3/3 | 9700 Oct-Nov 2018 P4 V1 Q10

[illegible]

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Topical questions | 92 questions

**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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# 9700 Biology Paper 4 - Homeostasis

Topical questions | 92 questions

28. Question part 2/3 | 9700 Oct-Nov 2018 P4 V3 Q10

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## 9700 Biology Paper 4 - Homeostasis

Topical questions | 92 questions

28. Question part 3/3 | 9700 Oct-Nov 2018 P4 V3 Q10

[illegible]

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- 2 (a) The hormone glucagon is an example of a cell signalling molecule. Table 2.1 lists the main 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 $\alpha$ 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                                                     |

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               |

(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.

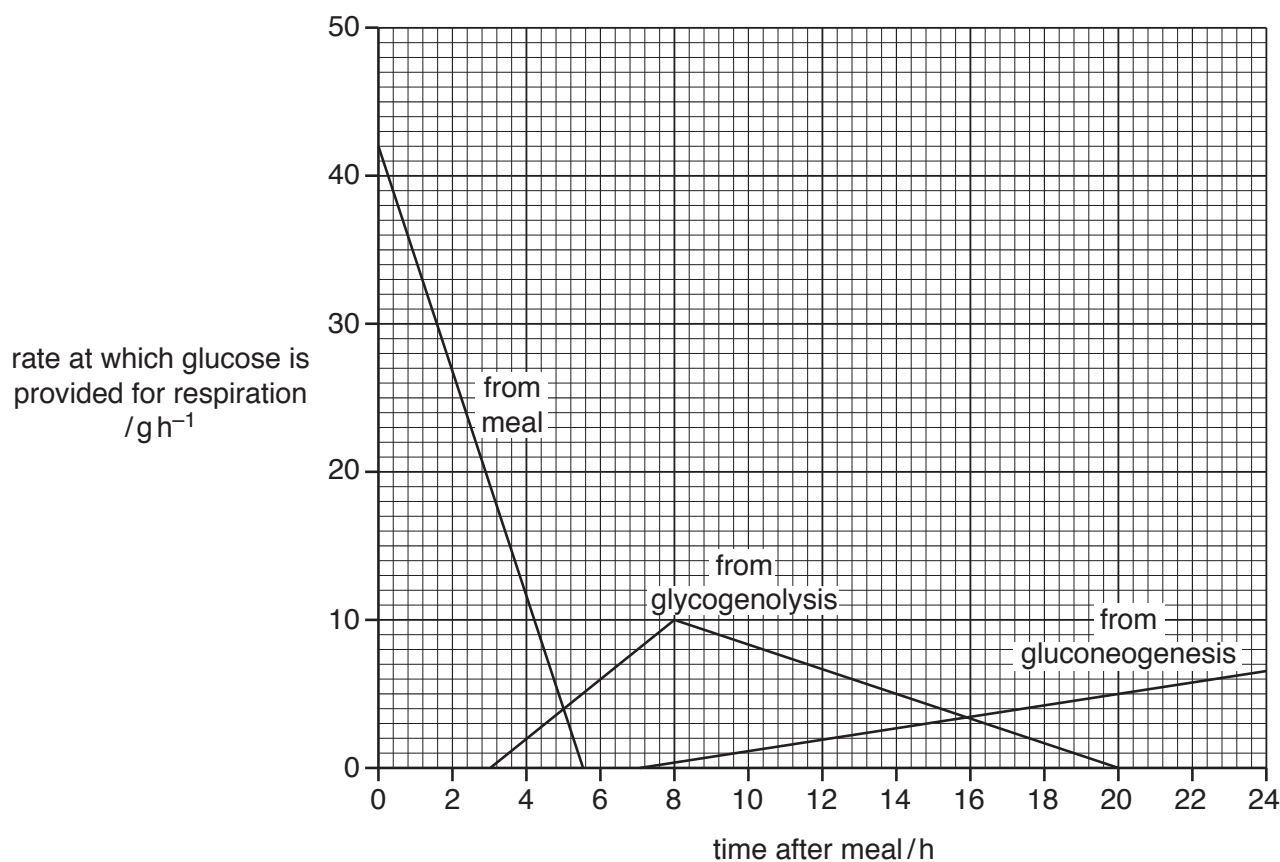


Fig. 2.1

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29. Question part 4/4 | 9700 Feb-March 2019 P4 V2 Q2

- (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]

- 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.

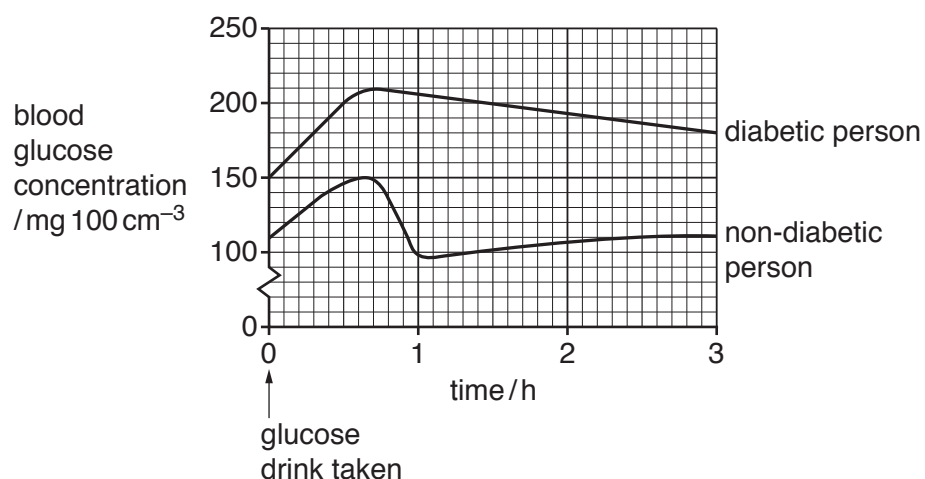


**Fig. 7.1**

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

.....

.....

.....

.....

.....

.....

..... [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]

- (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.

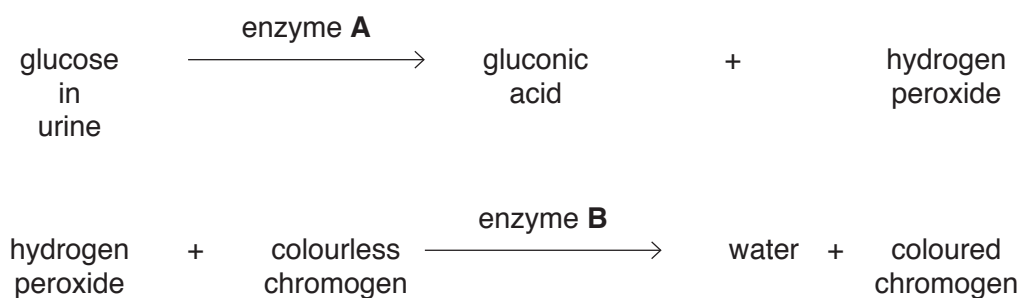


**Fig. 7.2**

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* .....

.....

*dipstick* .....

.....

[2]

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

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [5]

[Total: 14]

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

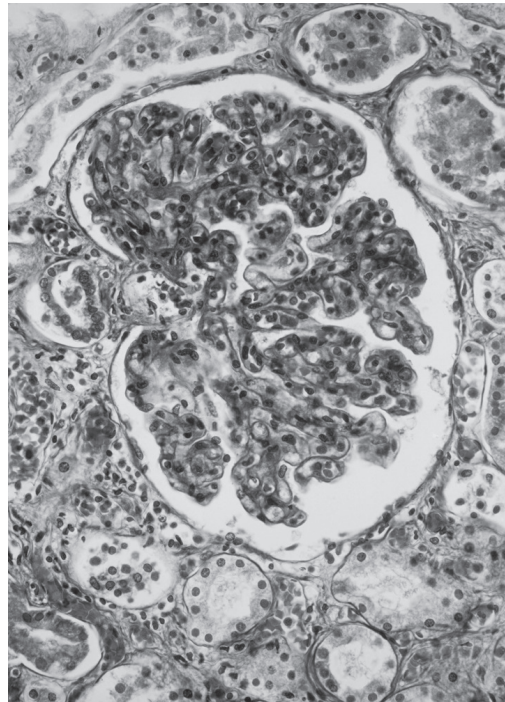


**Fig. 5.1**

- (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]

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

### Table 5.1

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

(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.

..... [5]

[5]

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

.....

.....

.....

.....

.....

..... [3]

[Total: 13]

32. Question part 1/3 | 9700 May-June 2019 P4 V3 Q5

**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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[5]

## 9700 Biology Paper 4 - Homeostasis

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32. Question part 3/3 | 9700 May-June 2019 P4 V3 Q5

- (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]

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

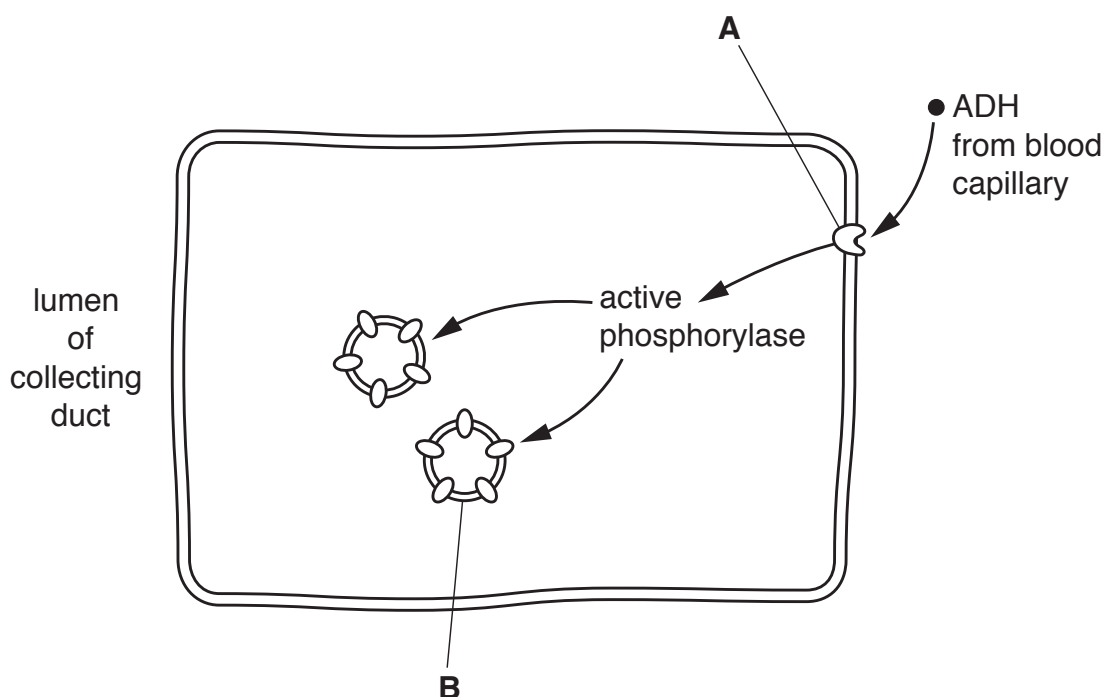
- (i) State **one** change in the internal environment of a mammal that leads to the release of ADH.

..... [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]

## 9700 Biology Paper 4 - Homeostasis

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33. Question part 2/2 | 9700 Oct-Nov 2019 P4 V1 Q1

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

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

[4]

[Total: 8]

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

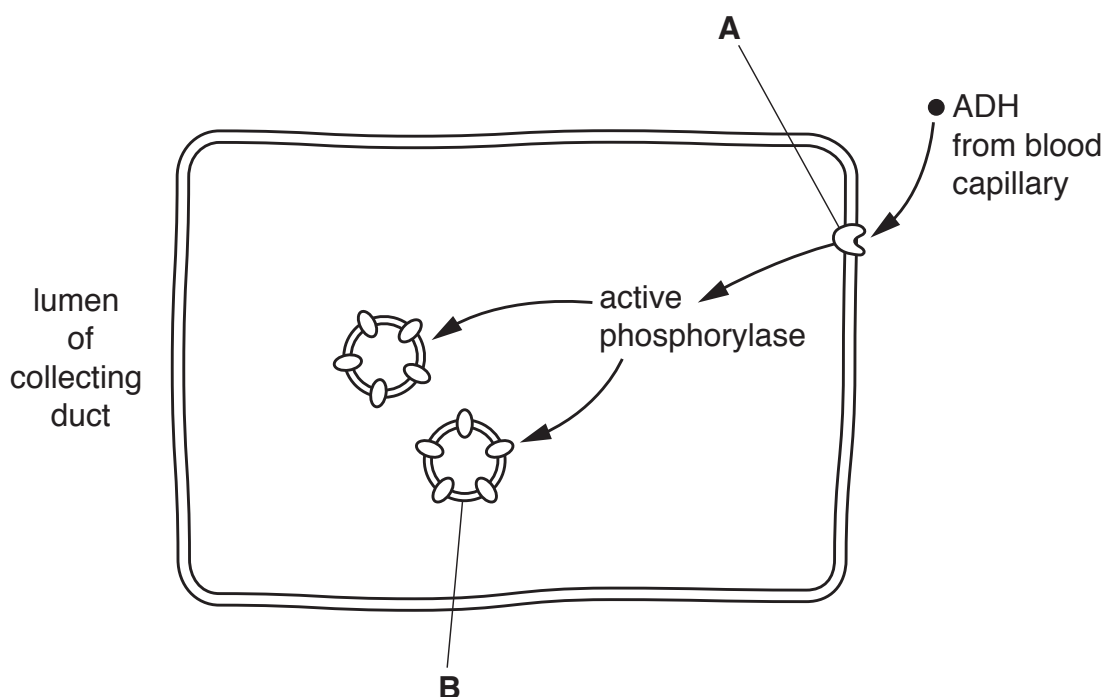
- (i) State **one** change in the internal environment of a mammal that leads to the release of ADH.

..... [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]

## 9700 Biology Paper 4 - Homeostasis

Topical questions | 92 questions

34. Question part 2/2 | 9700 Oct-Nov 2019 P4 V2 Q1

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

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

[4]

[Total: 8]

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

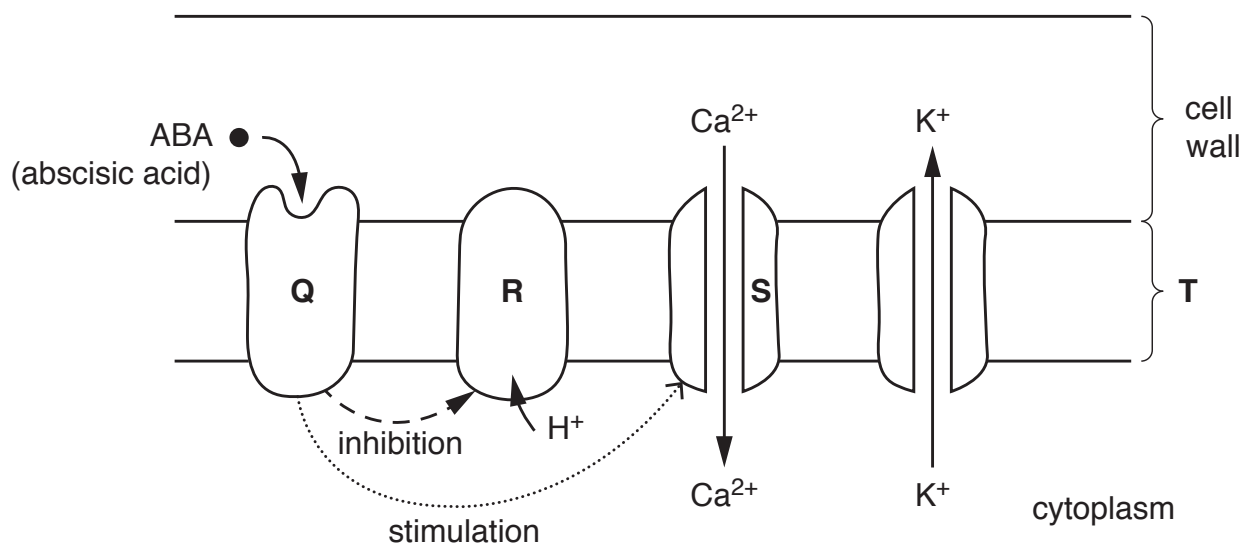


Fig. 1.1

- (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]

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

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [5]

[Total: 9]

- 1 (a) Fig. 1.1 represents part of the wall of a proximal convoluted tubule (pct) in a kidney nephron.

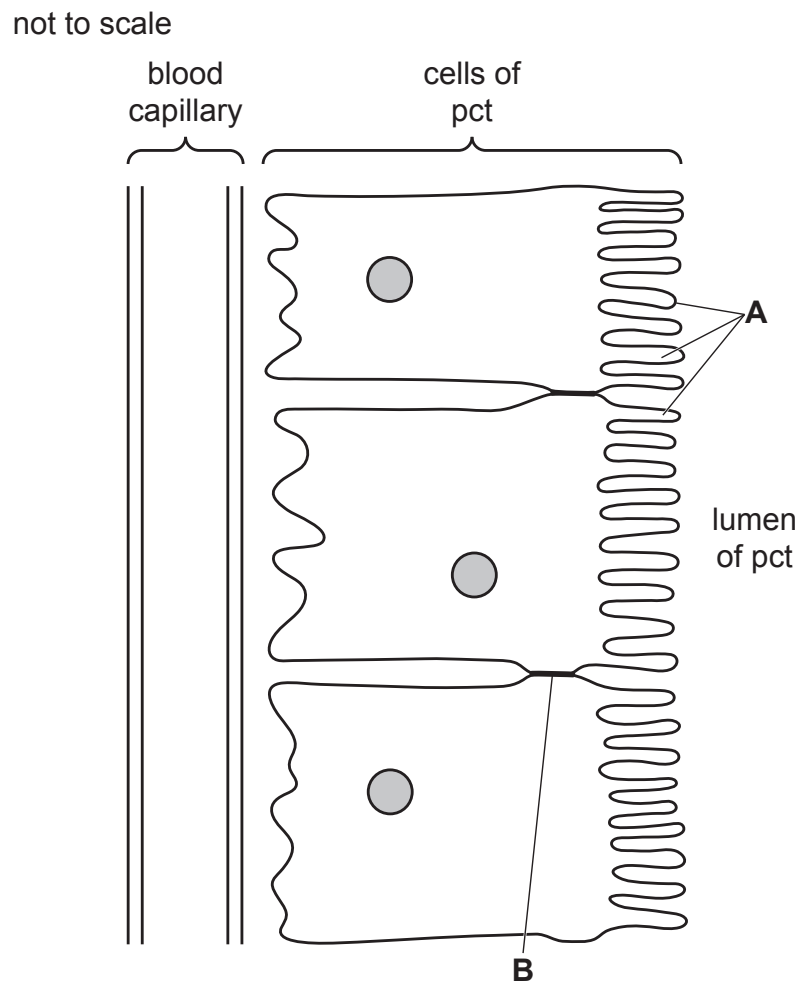


Fig. 1.1

- (i) Name the features of the wall of a pct that are labelled **A** and **B** in Fig. 1.1.

**A** .....

**B** .....

[2]

- (ii) On Fig. 1.1:

- use the letter **C** with a label line to show where co-transport of glucose with sodium ions occurs
- use the letter **D** with a label line to show where active transport of sodium ions occurs.

[2]

(b) Table 1.1 shows the quantities, per day, of some of the substances that are:

- removed from the blood by ultrafiltration
- reabsorbed into the blood by the pct
- excreted in the urine.

**Table 1.1**

| substance   | quantity removed by ultrafiltration and units |                 | percentage reabsorbed into blood from pct | quantity excreted in urine and units |                 |
|-------------|-----------------------------------------------|-----------------|-------------------------------------------|--------------------------------------|-----------------|
| urea        | 56.0                                          | g               | 46.4                                      | 30.0                                 | g               |
| water       | 180.0                                         | dm <sup>3</sup> | 99.2                                      | 1.4                                  | dm <sup>3</sup> |
| sodium ions | 25 200.0                                      | arbitrary units | 99.4                                      | .....                                | arbitrary units |
| glucose     | 800.0                                         | nmol            | 100.0                                     | 0.0                                  | nmol            |

Complete Table 1.1 by calculating the quantity of sodium ions excreted in the urine.

Write your answer in the table to one decimal place.

Show your working in the space below.

[2]

(c) A person who has type 1 diabetes mellitus cannot produce enough insulin. This results in some glucose being excreted in the urine.

The urine can be tested for glucose using a dip stick.

Name the **two** enzymes present on the dip stick **and** outline the reaction catalysed by each enzyme.

enzyme .....

reaction .....

.....

enzyme .....

reaction .....

.....

[2]

[Total: 8]

Describe the main stages of cell signalling involving ACTH.

..... [5]

- Name this type of homeostatic mechanism.

..... [1]

- (c) The domestic dog, *Canis lupus familiaris*, is a mammal. A dog may develop a condition called Cushing’s disease, which is a result of too much cortisol being secreted by the adrenal glands. The most common cause of this is an increased secretion of ACTH because of a tumour in the anterior pituitary gland.

Explain how a tumour develops.

.....

.....

.....

.....

..... [2]

- (d) One symptom of Cushing’s disease in a dog is that the dog will want to drink much more than normal.

Suggest **one other** reason why a dog would want to drink much more than normal.

.....

..... [1]

[Total: 9]

- 1 (a) The enzyme alanine transaminase (ALT) is found in the liver. The function of ALT is to convert the amino acid  $\alpha$ -ketoglutarate into another amino acid, glutamate.

Suggest why the liver may need to convert one amino acid into another.

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

- (b) Tumours can form in the liver.

Explain how a liver tumour develops.

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

- (c) ALT can leak into the blood from liver tumour cells.

An increase in the concentration of ALT in the blood causes a decrease in the water potential of the blood.

State precisely the name **and** location of the cells where a change in the water potential of the blood would be detected.

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

- (d) Describe the homeostatic role of ADH when the water potential of the blood **decreases**.

.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
..... [5]

- 6 (a)** Thyrotoxic myopathy (TM) is a neuromuscular disorder caused by overproduction of the thyroid hormone thyroxine. One of the main symptoms of TM is muscle fatigue.

Fig. 6.1 outlines the effects of overproduction of thyroxine on striated muscle.

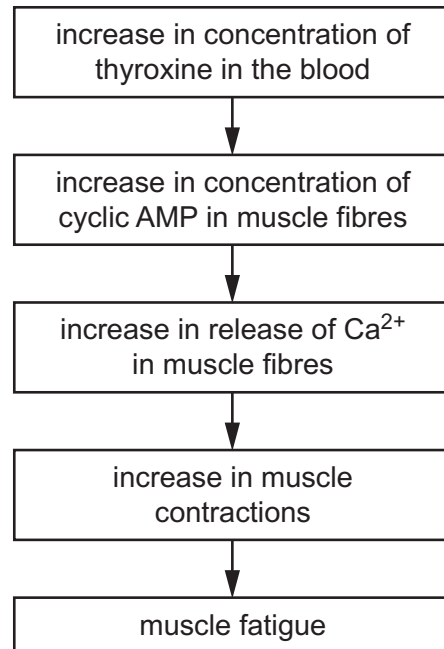


**Fig. 6.1**

- (i)** The concentration of thyroxine in the blood usually fluctuates around a set point.

Name the mechanism that keeps the concentration of thyroxine in the blood close to its set point.

..... [1]

- (ii)** Name the part of the striated muscle fibre that releases Ca<sup>2+</sup>.

..... [1]

(iii) Describe the role of  $\text{Ca}^{2+}$ , troponin and tropomyosin in the contraction of striated muscle.

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]

(iv) Cyclic AMP (cAMP) is also involved in the response of liver cells to glucagon.

Describe the role of cAMP in the response of liver cells to glucagon.

.....

.....

.....

..... [2]

(b) An increase in the concentration of thyroxine in the blood can lead to a condition called insulin resistance (IR). IR decreases the sensitivity to insulin of target cells, such as muscle and liver cells.

Suggest how decreased sensitivity to insulin affects target cells.

.....

.....

.....

.....

.....

..... [3]

2 (a) Diabetes insipidus (DI) is a condition in humans that causes a person to have an excessive thirst, which leads to increased drinking. One form of DI is caused by a tumour in the region of the hypothalamus concerned with osmoregulation.

(i) Explain how a tumour develops in the hypothalamus.

.....

.....

..... [2]

(ii) Suggest how a tumour in the hypothalamus can lead to a person producing a large volume of dilute urine.

.....

.....

.....

.....

.....

.....

.....

..... [3]

(b) The nervous and endocrine systems of a mammal co-ordinate responses to changes in the internal and external environment. Table 2.1 compares some features of the nervous and endocrine systems.

Complete Table 2.1.

Table 2.1

| feature                          | nervous system | endocrine system |
|----------------------------------|----------------|------------------|
| signal                           | impulse        | .....            |
| method of transmission of signal | .....          | in blood         |
| type of communication            | .....          | chemical         |
| duration of effect               | .....          | .....            |

[4]

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**10 (a)** Describe how adrenaline can stimulate liver cells to convert glycogen to glucose. [7]

[Total: 15]

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## 9700 Biology Paper 4 - Homeostasis

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41. Question part 2/6 | 9700 Oct-Nov 2020 P4 V1 Q10

[illegible]

## 9700 Biology Paper 4 - Homeostasis

Topical questions | 92 questions

41. Question part 3/6 | 9700 Oct-Nov 2020 P4 V1 Q10

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# 9700 Biology Paper 4 - Homeostasis

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41. Question part 4/6 | 9700 Oct-Nov 2020 P4 V1 Q10

[illegible]

# 9700 Biology Paper 4 - Homeostasis

Topical questions | 92 questions

41. Question part 5/6 | 9700 Oct-Nov 2020 P4 V1 Q10

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## 9700 Biology Paper 4 - Homeostasis

Topical questions | 92 questions

41. Question part 6/6 | 9700 Oct-Nov 2020 P4 V1 Q10

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42. Question | 9700 Oct-Nov 2020 P4 V2 Q7

7 Insulin is transported around the body in the blood. The cells of the liver, muscle tissue and adipose (fat) tissue have receptors for insulin.

- (a) State:
- the precise cellular location of the insulin receptors
  - the type of biological molecule that forms an insulin receptor.

location .....

type of biological molecule .....

[2]

(b) Insulin stimulates the activity of the enzyme glycogen synthetase in liver cells.

Fig. 7.1 shows the activity of glycogen synthetase in liver cells for 210 seconds after glucose has been injected into the bloodstream.

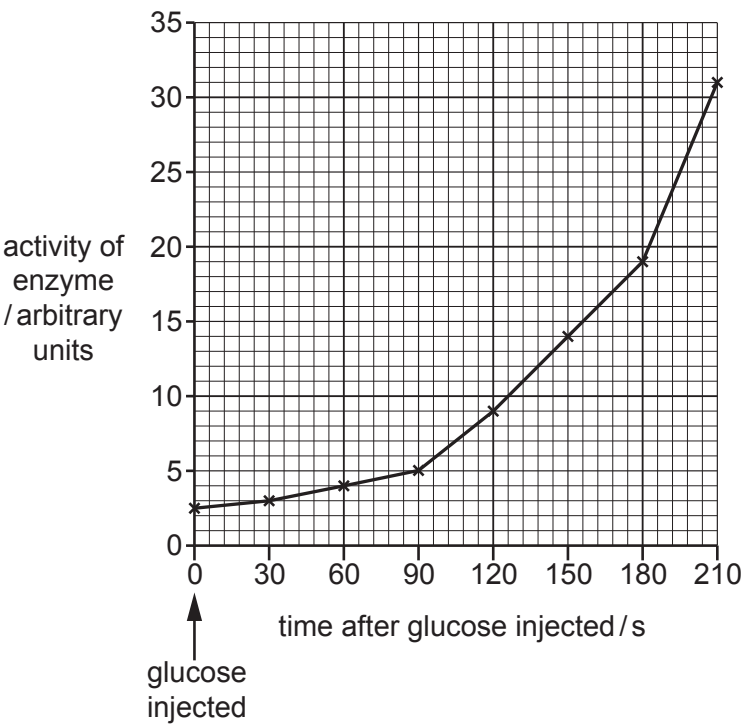


Fig. 7.1

- (i) Calculate the percentage increase in glycogen synthetase activity between 90s and 180s after glucose was injected into the blood.

Show your working and write your answer to the nearest whole number.

answer .....% [2]

- (ii) Suggest the role of glycogen synthetase in the regulation of blood glucose concentration.

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

[Total: 5]

## 9700 Biology Paper 4 - Homeostasis

Topical questions | 92 questions

43. Question part 1/6 | 9700 Oct-Nov 2020 P4 V3 Q10

- 10 (a)** Describe how adrenaline can stimulate liver cells to convert glycogen to glucose. [7]
- (b)** Describe the role of abscisic acid (ABA) in the closure of stomata during times of drought. [8]

[Total: 15]

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# 9700 Biology Paper 4 - Homeostasis

Topical questions | 92 questions

43. Question part 2/6 | 9700 Oct-Nov 2020 P4 V3 Q10

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# 9700 Biology Paper 4 - Homeostasis

Topical questions | 92 questions

43. Question part 3/6 | 9700 Oct-Nov 2020 P4 V3 Q10

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# 9700 Biology Paper 4 - Homeostasis

Topical questions | 92 questions

43. Question part 4/6 | 9700 Oct-Nov 2020 P4 V3 Q10

[illegible]

## 9700 Biology Paper 4 - Homeostasis

Topical questions | 92 questions

43. Question part 5/6 | 9700 Oct-Nov 2020 P4 V3 Q10

[illegible]

# 9700 Biology Paper 4 - Homeostasis

Topical questions | 92 questions

43. Question part 6/6 | 9700 Oct-Nov 2020 P4 V3 Q10

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6 (a) Thermoregulation is the control of the core temperature of the body.

Thermoreceptors send information about a change in core temperature to the hypothalamus. The hypothalamus controls the core temperature by sending impulses to activate several physiological responses.

Table 6.1 lists physiological responses to a **decrease** in core temperature.

Complete Table 6.1 to explain how each response contributes to maintaining a core temperature within narrow limits.

Table 6.1

| response                                                      | explanation             |
|---------------------------------------------------------------|-------------------------|
| blood vessels near the surface of the skin constrict (narrow) | .....<br>.....<br>..... |
| shivering occurs                                              | .....<br>.....<br>..... |
| hairs rise                                                    | .....<br>.....<br>..... |
| reduction in the production of sweat                          | .....<br>.....<br>..... |

[4]

(b) Animals can also use behaviour to adapt to temperature changes.

Suggest why some animals curl up their bodies in cold weather.

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

- (c) The Sitatunga deer, *Tragelaphus spekii*, and the Nile monitor lizard, *Varanus niloticus*, live in Africa.

Fig. 6.1 shows a Sitatunga and Fig. 6.2 shows a Nile monitor.



Fig. 6.1



Fig. 6.2

An investigation was carried out to measure the core temperature of the Sitatunga and the Nile monitor as the environmental temperature was increased.

The results are shown in Fig. 6.3.

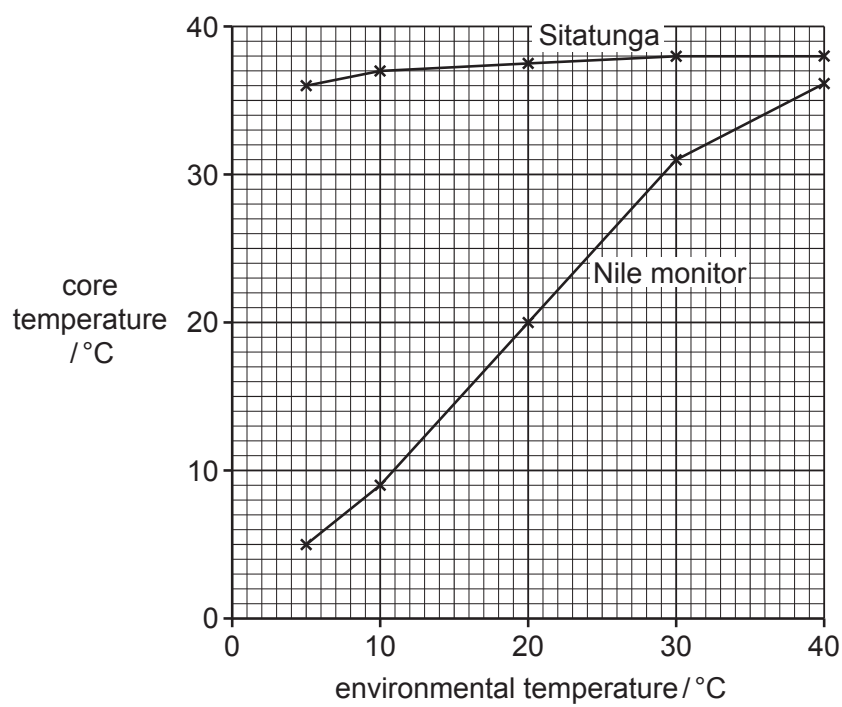


Fig. 6.3

(i) Describe the results shown in Fig. 6.3.

.....

.....

.....

.....

.....

.....

.....

..... [3]

(ii) When the environmental temperature is low, Nile monitors are relatively inactive.

Suggest **one** disadvantage to the Nile monitor of being inactive.

.....

.....

..... [1]

(d) Thermoregulation relies on negative feedback.

Explain what is meant by negative feedback.

.....

.....

.....

.....

.....

.....

..... [3]

[Total: 12]

- 6 Glucagon-like peptide-1 (GLP-1) is a hormone consisting of 31 amino acids. It is secreted by specialised intestinal epithelial cells known as L cells.

Fig. 6.1 outlines the secretion of GLP-1 and its effects on the pancreas, brain and stomach.

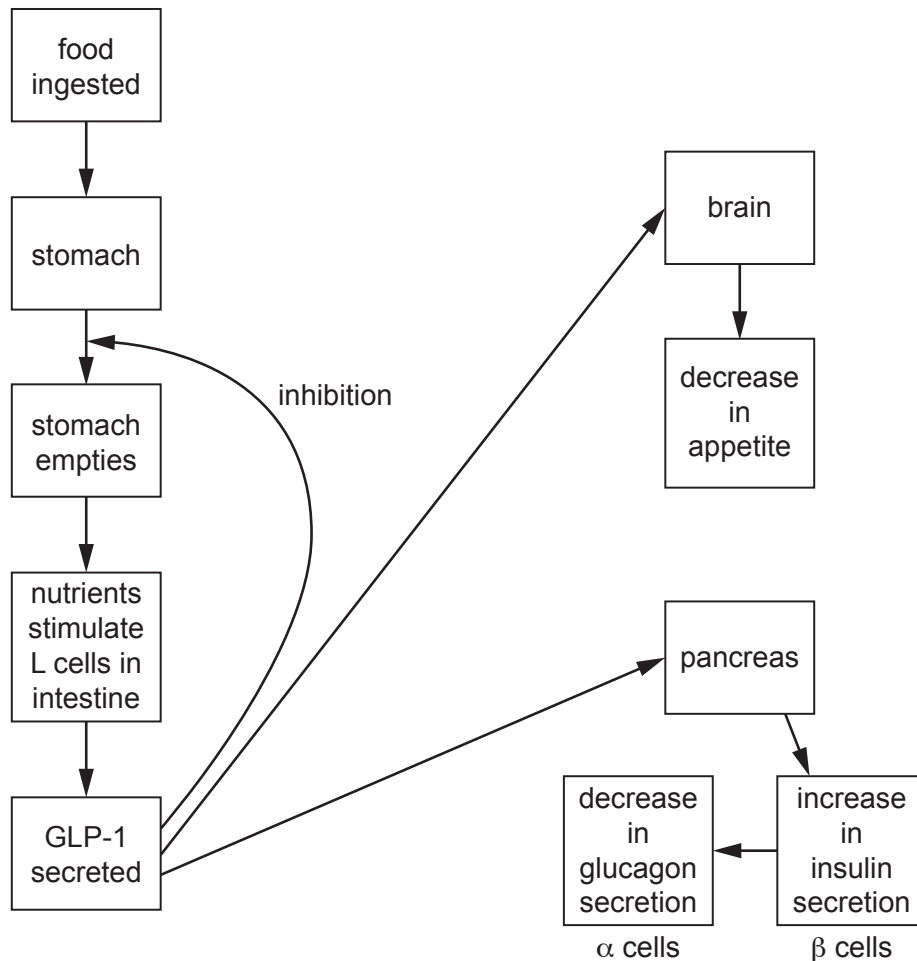


**Fig. 6.1**

- (a) GLP-1 binds to receptors on cell surface membranes of  $\beta$  cells in the pancreas. These cells secrete insulin.

- (i) Name the type of membrane component that forms a receptor in the cell surface membrane.

..... [1]

- (ii) State how GLP-1 is transported to the pancreas.

..... [1]

(b) GLP-1 inhibits the secretion of glucagon by  $\alpha$  cells in the pancreas.

Describe **two** processes in the liver that are stimulated by glucagon.

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..... [2]

(c) Suggest **one** reason why GLP-1 causes a decrease in appetite.

..... [1]

(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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..... [3]

(e) A transcription factor is involved in the production of GLP-1. An insertion mutation in the gene that codes for the transcription factor can affect the production of GLP-1.

Outline the effect of an insertion mutation on the production of GLP-1.

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..... [3]

- 6 (a) The bottlenose dolphin, *Tursiops truncatus*, is an aquatic mammal. It has adaptations to conserve heat when swimming in cold water.

Fig. 6.1 shows a bottlenose dolphin.

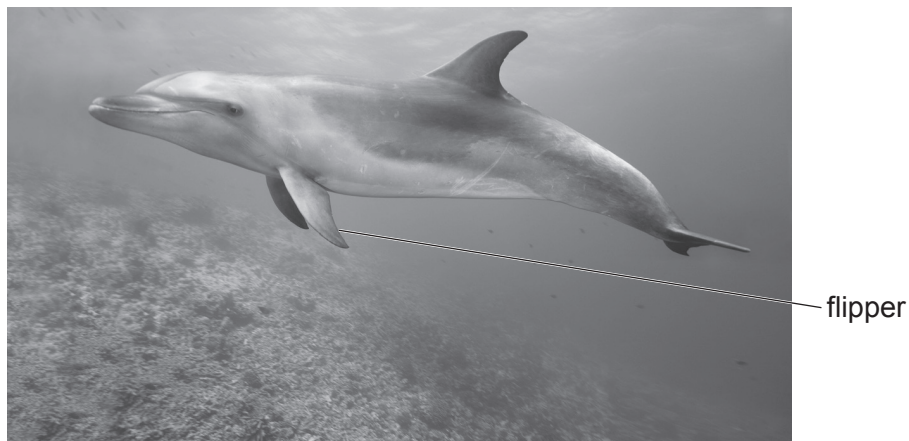


Fig. 6.1

- (i) The arteries in the bottlenose dolphin that carry blood to the flippers are surrounded by veins bringing blood back to the rest of the body.

Outline how this arrangement of blood vessels is an adaptation to conserve body heat.

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

- (ii) When a dolphin has exercised for a long time, it may need to lose excess heat. Unlike humans, dolphins do **not** produce sweat.

Suggest how a dolphin may lose excess heat.

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

(b) The control of blood glucose concentration in dolphins is the same as in most mammals.

A study was carried out to investigate the concentration of insulin in the blood of dolphins that were provided with a diet of fish, supplemented with glucose.

- One group of dolphins ate fish with 3 g of glucose for every kg of fish.
- Another group ate fish with 11 g of glucose for every kg of fish.

The concentration of insulin in the blood was measured 60 minutes before being fed, at the time of being fed and at regular intervals afterwards.

Measurements were also taken for a third group of dolphins, at the same time intervals, that were not fed any fish (fasting).

The results of the study are shown in Fig. 6.2.

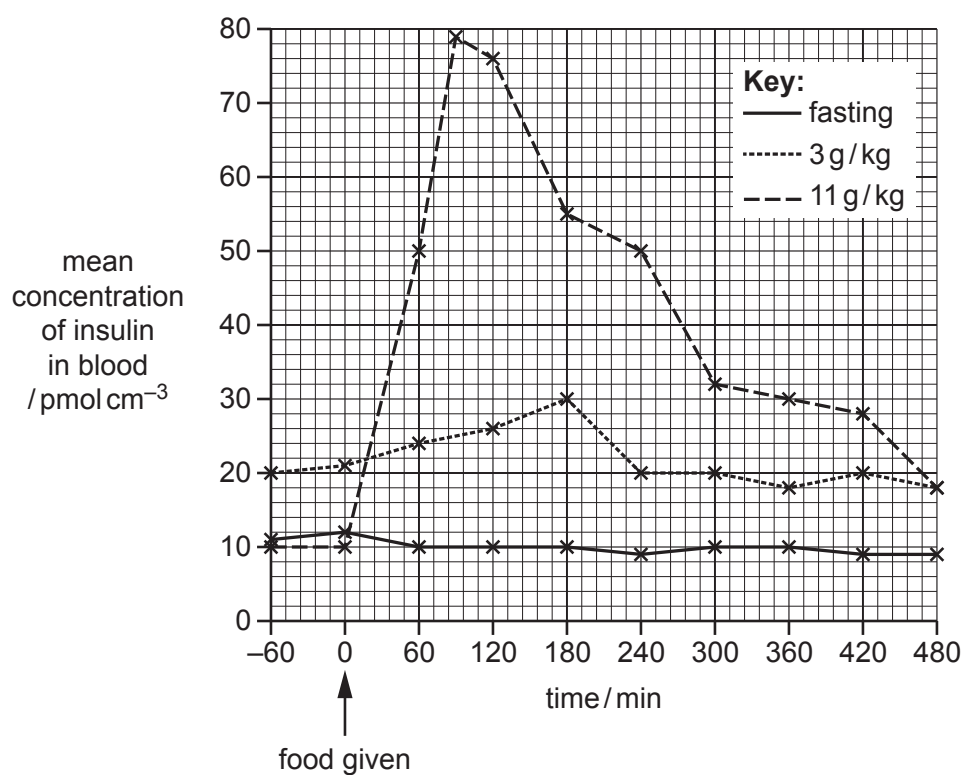


Fig. 6.2

(i) Describe the trends shown in Fig. 6.2.

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..... [4]

(ii) The mean concentration of insulin in the blood changes over time for the dolphins that were fed fish with 11 g of glucose per kg of fish.

Calculate the rate of change in the mean concentration of insulin in this group of dolphins from the time of being fed until the concentration reaches its maximum.

Show your working.

.....  $\text{pmol cm}^{-3} \text{ min}^{-1}$  [2]

(c) Blood glucose concentration is regulated by negative feedback.

Explain what is meant by negative feedback.

.....

.....

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.....

..... [3]

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

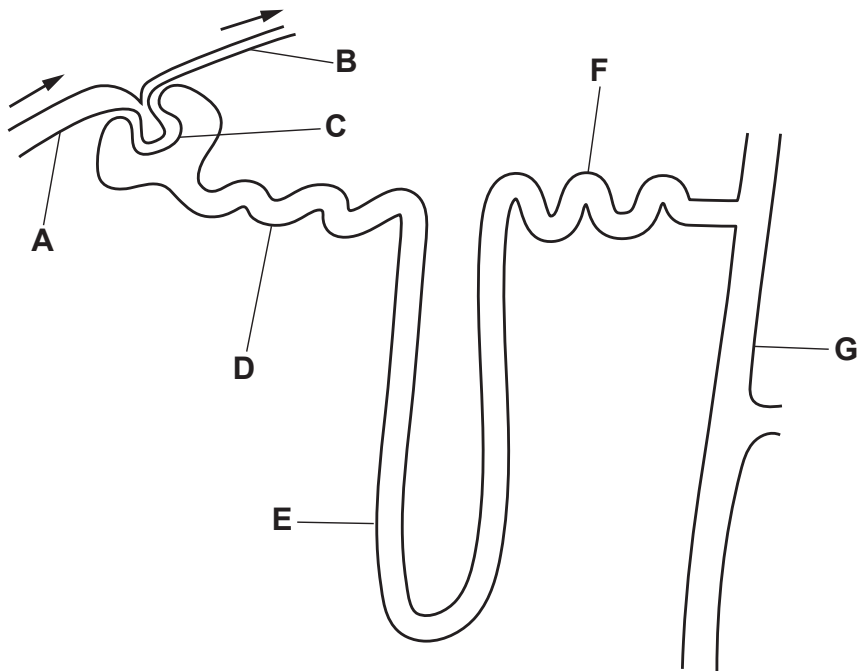


Fig. 1.1

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 | .....  |

## 9700 Biology Paper 4 - Homeostasis

Topical questions | 92 questions

47. Question part 2/4 | 9700 Oct-Nov 2021 P4 V1 Q1

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

[5]

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

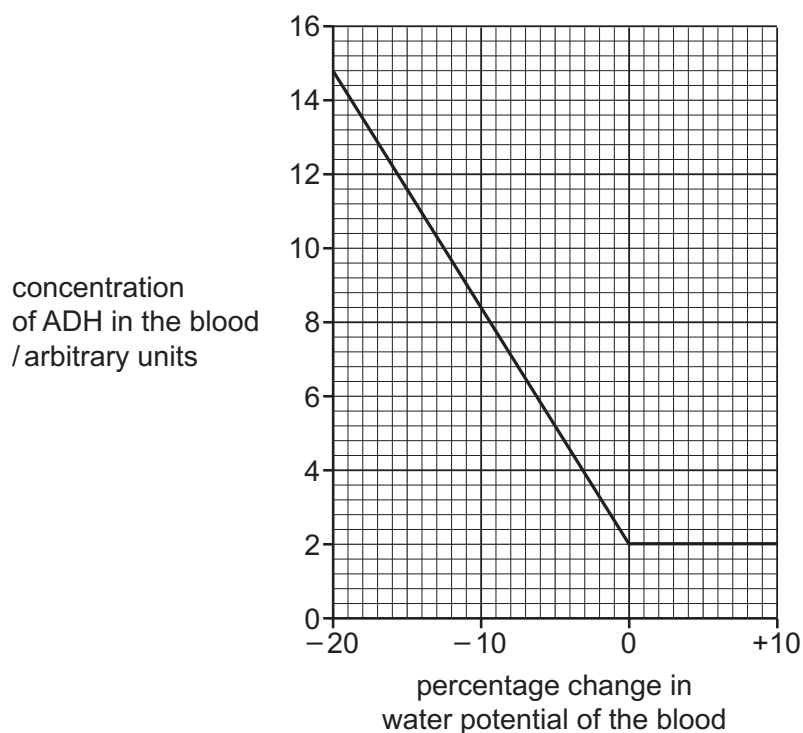


Fig. 1.2

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

.....

.....

.....

.....

.....

..... [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.

.....

.....

..... [1]

[Total: 12]

# 9700 Biology Paper 4 - Homeostasis

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47. Question part 4/4 | 9700 Oct-Nov 2021 P4 V1 Q1

**Turn over for Question 2**

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.

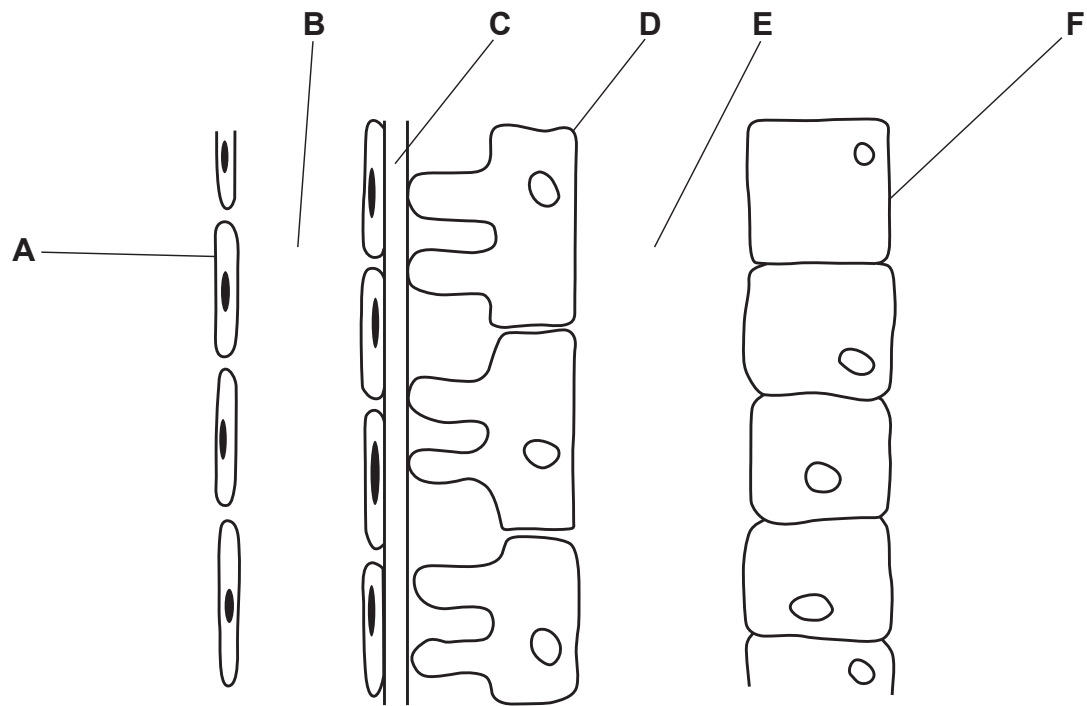


Fig. 1.1

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 | .....  |

# 9700 Biology Paper 4 - Homeostasis

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48. Question part 2/4 | 9700 Oct-Nov 2021 P4 V2 Q1

- (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.

[5]

[5]

- (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.

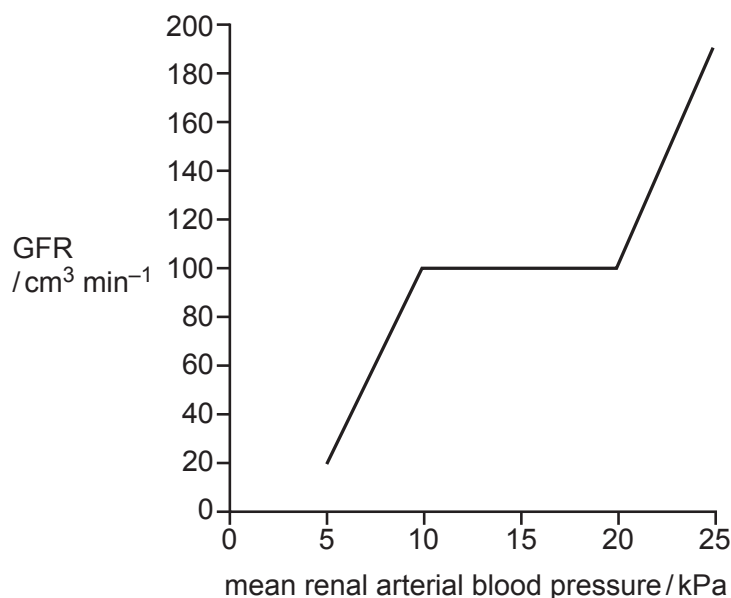


Fig. 1.2

- (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.

.....

.....

..... [1]

[Total: 12]

# 9700 Biology Paper 4 - Homeostasis

Topical questions | 92 questions

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48. Question part 4/4 | 9700 Oct-Nov 2021 P4 V2 Q1

**Question 2 starts on page 6.**

## 9700 Biology Paper 4 - Homeostasis

Topical questions | 92 questions

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49. Question | 9700 Oct-Nov 2021 P4 V2 Q9

- 9**    **(a)** Describe the roles of ADH **and** the collecting ducts in osmoregulation. [9]
- (b)** Describe the structure of a motor neurone. [6]

[Total: 15]

Topical questions | 92 questions

[Total: 15]

# 9700 Biology Paper 4 - Homeostasis

Topical questions | 92 questions

50. Question part 2/3 | 9700 Oct-Nov 2021 P4 V2 Q10

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

# 9700 Biology Paper 4 - Homeostasis

Topical questions | 92 questions

50. Question part 3/3 | 9700 Oct-Nov 2021 P4 V2 Q10

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

51. Question part 1/4 | 9700 Oct-Nov 2021 P4 V3 Q1

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

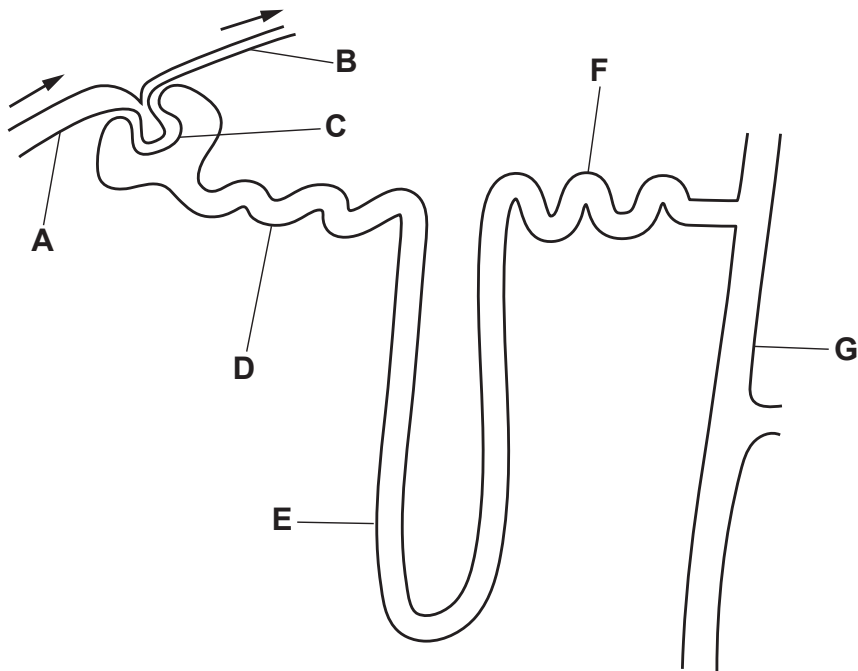


Fig. 1.1

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 | .....  |

## 9700 Biology Paper 4 - Homeostasis

Topical questions | 92 questions

51. Question part 2/4 | 9700 Oct-Nov 2021 P4 V3 Q1

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

[5]

[5]

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

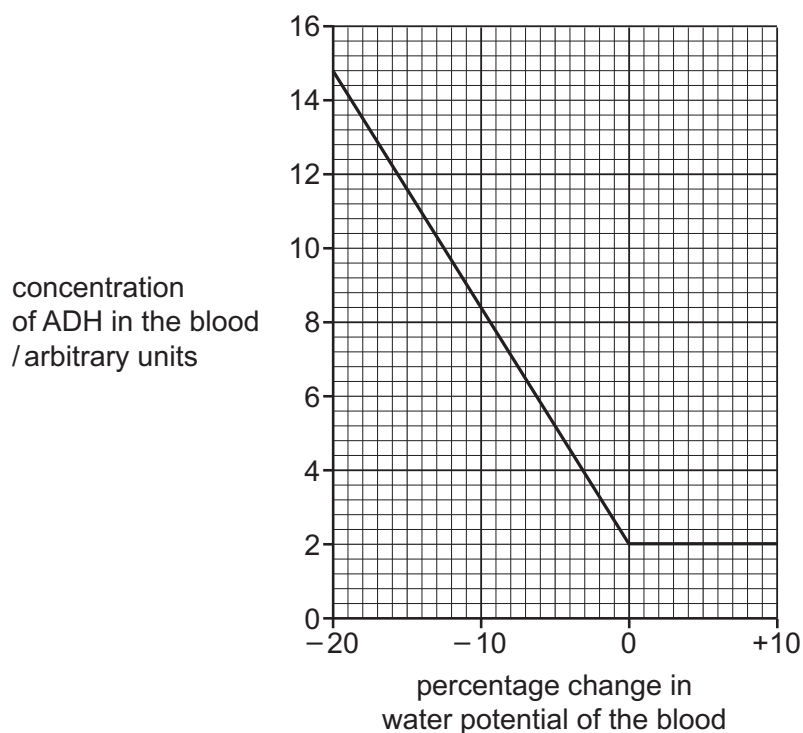


**Fig. 1.2**

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

.....

.....

.....

.....

.....

..... [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.

.....

.....

..... [1]

[Total: 12]

# 9700 Biology Paper 4 - Homeostasis

Topical questions | 92 questions

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51. Question part 4/4 | 9700 Oct-Nov 2021 P4 V3 Q1

**Turn over for Question 2**

- [5]

- ..... [1]

- ..... [1]

(c) People with kidney disease may be at a higher risk of TACO following a blood transfusion.

A study carried out in 2019 investigated whether there is a link between kidney disease and TACO. This study included data from:

- 200 people who developed TACO after a blood transfusion
- 405 people who did **not** develop TACO after a blood transfusion.

The people in the study were put into one of four categories:

- people with acute (short-term) kidney injury (AKI)
- people with chronic (long-term) kidney disease (CKD) who do **not** require dialysis
- people with severe chronic kidney disease who do require dialysis (CKD + D)
- people who do **not** have kidney disease.

In dialysis, a machine is used to carry out the function of the kidneys.

The results of this study are shown in Fig. 3.1.

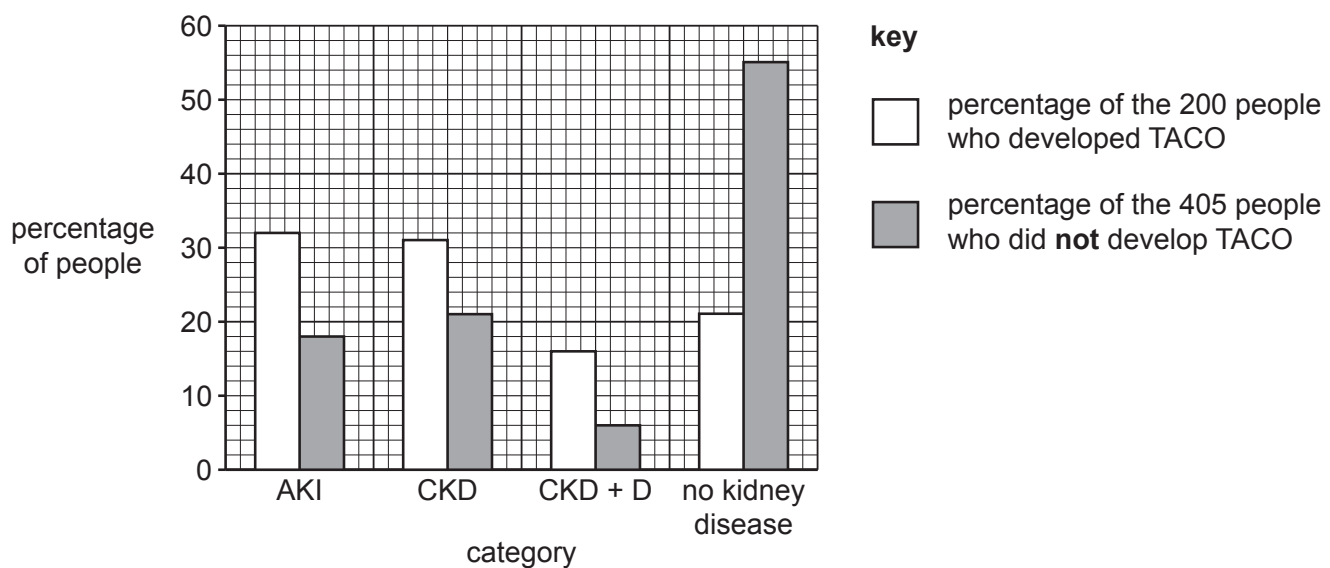


Fig. 3.1

With reference to Fig. 3.1, describe the effect of having kidney disease on the risk of developing TACO.

Suggest reasons for this effect.

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..... [4]

(d) Patients who are at high risk of developing TACO following a blood transfusion can be given a type of drug called a loop diuretic.

In normal urine production, 99% of sodium ions in the glomerular filtrate are reabsorbed and 1% are excreted. In urine production of people who take loop diuretics, 80% of sodium ions in the glomerular filtrate are reabsorbed and 20% are excreted.

Explain how loop diuretics affect water reabsorption in the kidneys **and** suggest why this reduces the risk of developing TACO following a blood transfusion.

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..... [3]

10 (a) Fig. 10.1 shows the structure of two guard cells.

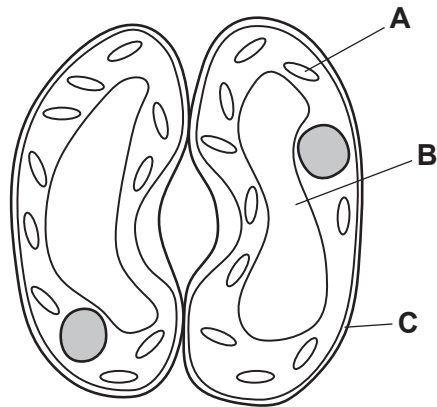


Fig. 10.1

Name the structures labelled **A**, **B** and **C** in Fig. 10.1.

**A** .....

**B** .....

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

(b) In times of water stress, abscisic acid is released. This results in the closure of stomata to reduce water loss by transpiration.

Describe the role of abscisic acid in stomatal closure.

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..... [4]

- 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 ( $\alpha$ ) 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.

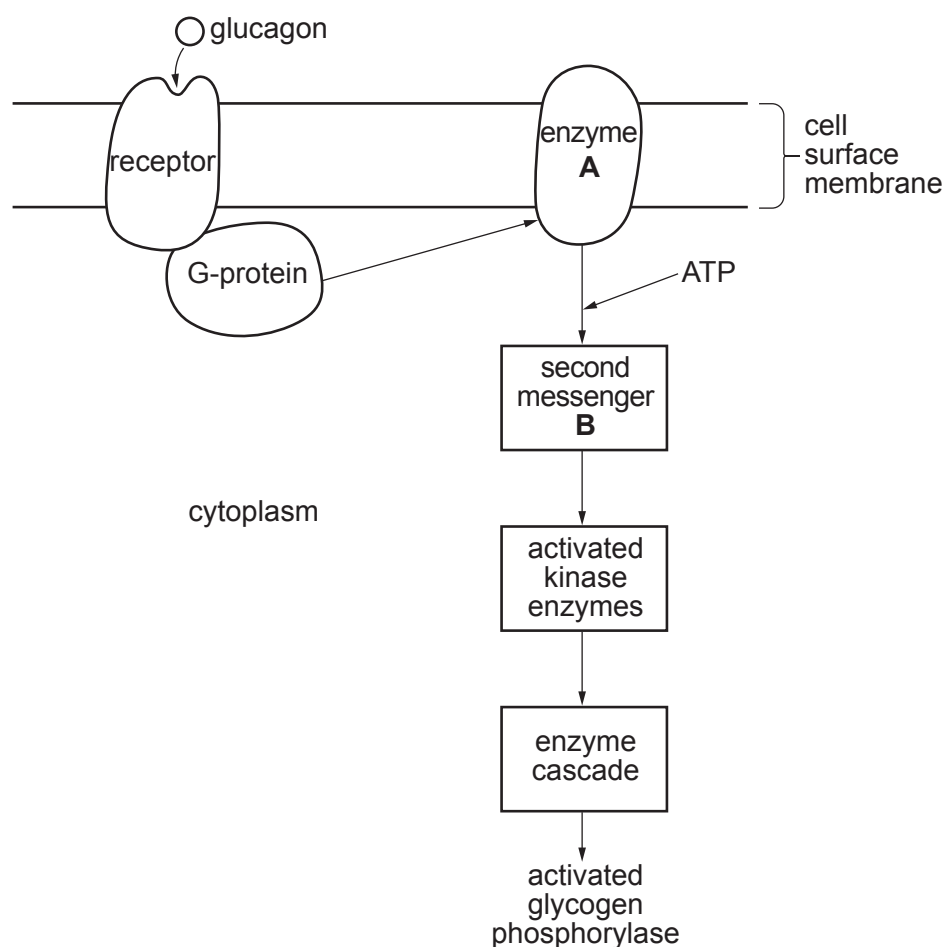


Fig. 6.1

- (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]

- 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.

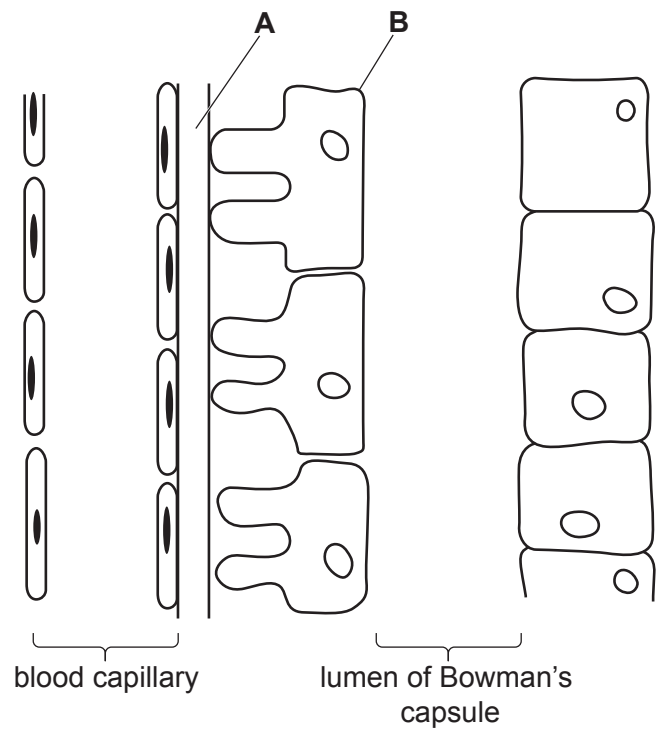


Fig. 9.1

- (i) Name A and B.

A .....

B ..... [2]

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

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..... [3]

[Total: 7]

- 1 (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

| mammal       | habitat          | RMT | urine<br>concentration / arbitrary<br>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.

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

- (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]

# 9700 Biology Paper 4 - Homeostasis

Topical questions | 92 questions

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56. Question part 3/3 | 9700 May-June 2022 P4 V3 Q1

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**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.

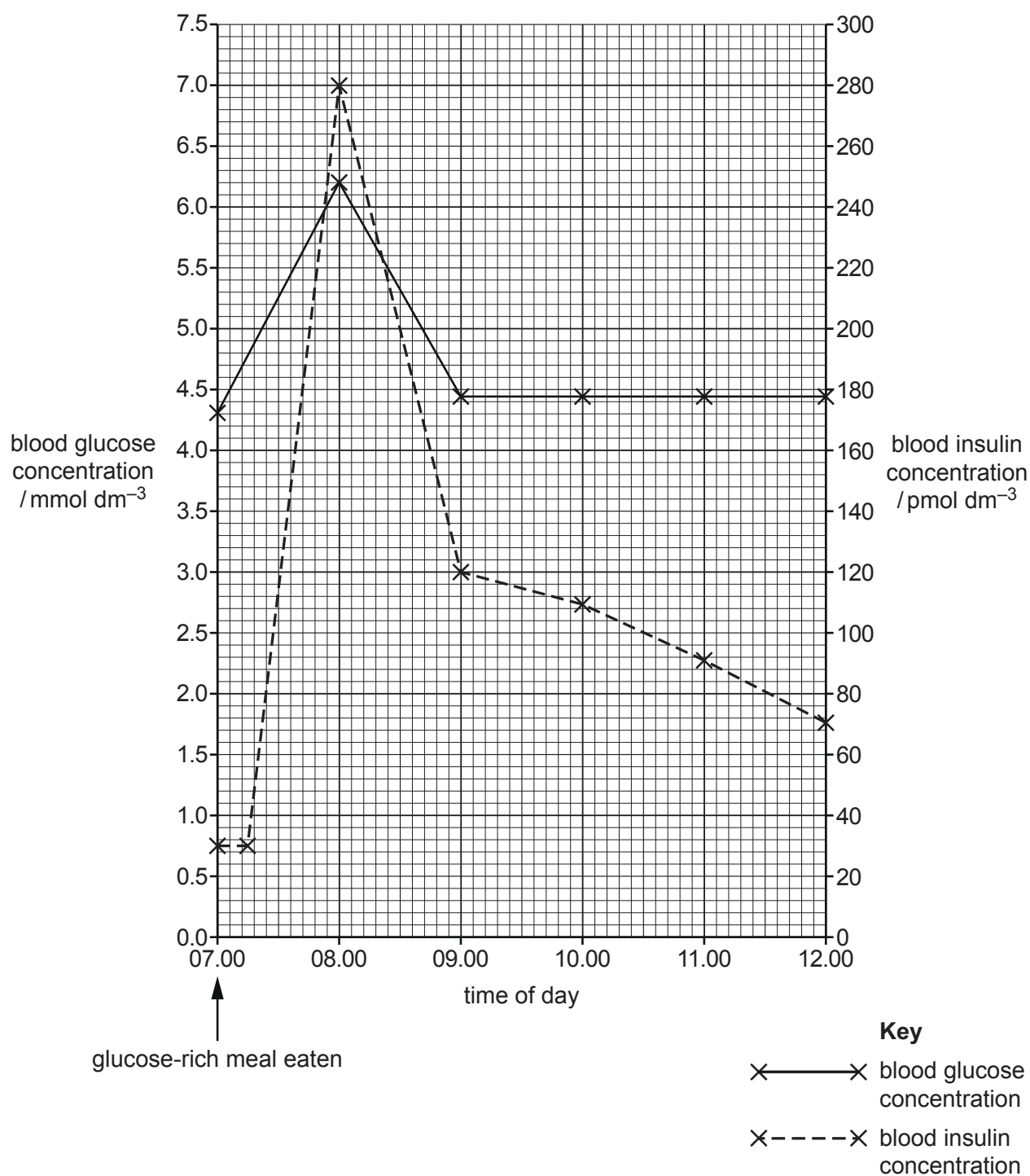


**Fig. 10.1**

(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]

Topical questions | 92 questions

**(b)** Glucagon is synthesised by cells in the pancreas known as alpha ( $\alpha$ ) 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.

[4]

[Total: 10]

Cambridge Assessment International Education is part of Cambridge Assessment. Cambridge Assessment is the brand name of the University of Cambridge Local Examinations Syndicate (UCLES), which is a department of the University of Cambridge.

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

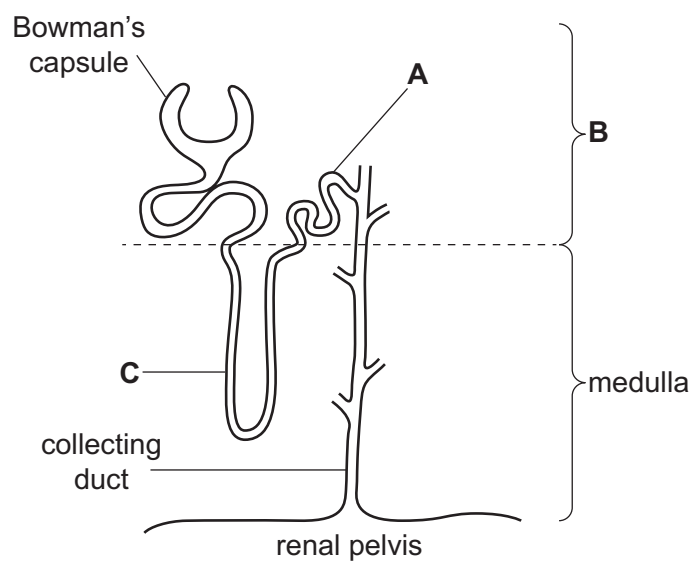


**Fig. 8.1**

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

**A** .....

**B** .....

**C** .....

[3]

(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.

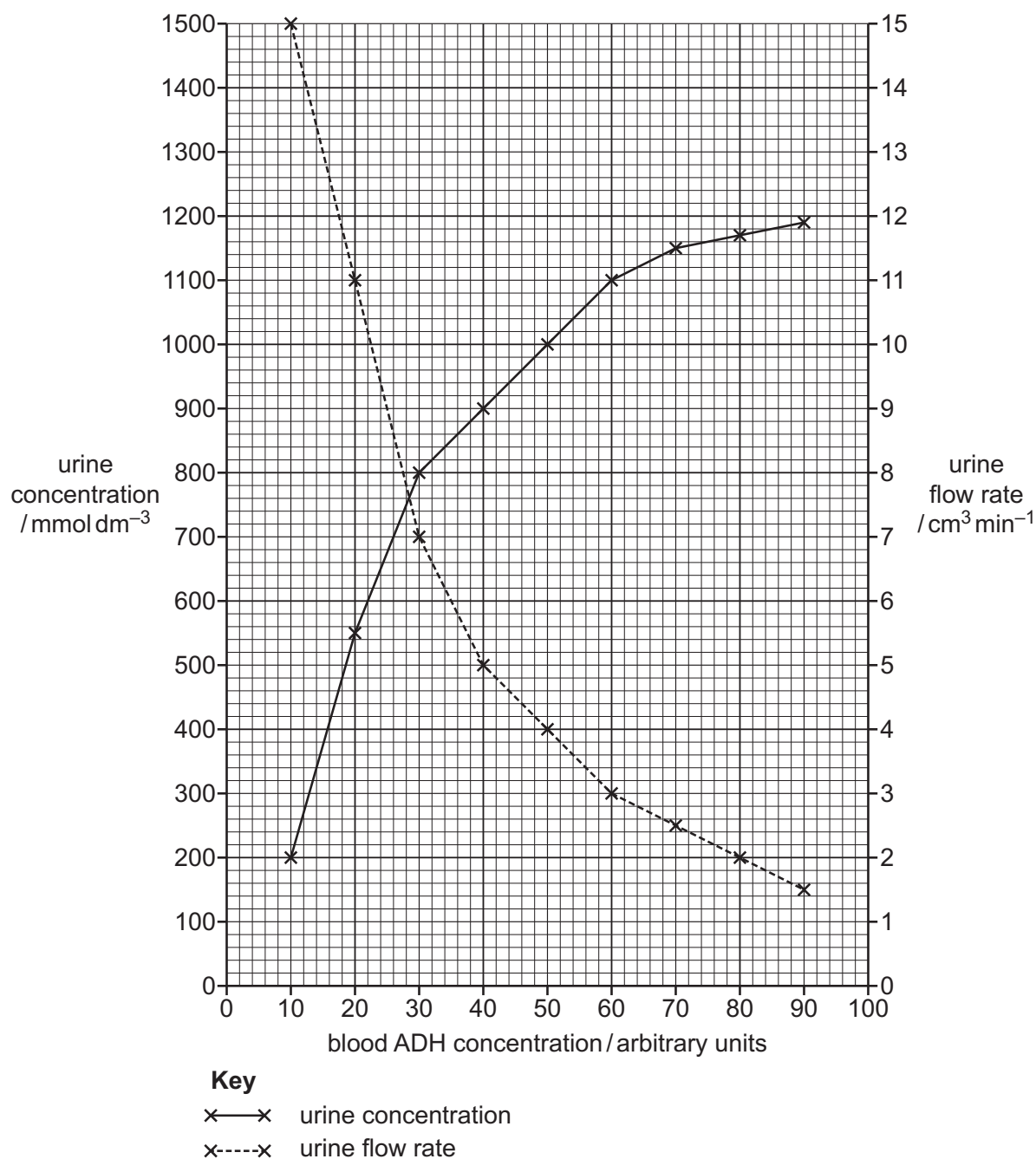


Fig. 8.2

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]

**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]

The diagram illustrates a single proximal convoluted tubule cell. The cell is elongated and has a wavy, brush border (microvilli) on its left side, which is labeled "lumen of proximal convoluted tubule". The right side of the cell is flatter and is labeled "blood plasma". Inside the cell, there is a large, dark, oval nucleus. A small black rectangular structure, representing a mitochondrion, is located near the center of the cell. The entire cell is labeled "proximal convoluted tubule cell" at the bottom.

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

[5]

(c) The plasma, the glomerular filtrate and urine are composed of various substances.

Table 8.1 shows the percentage composition of plasma, the glomerular filtrate and urine.

**Table 8.1**

| substance        | percentage composition |                     |       |
|------------------|------------------------|---------------------|-------|
|                  | plasma                 | glomerular filtrate | urine |
| water            | 90.00                  | 90.00               | 94.00 |
| glucose          | 0.10                   | 0.10                | 0.00  |
| amino acids      | 0.05                   | 0.05                | 0.00  |
| plasma proteins  | 8.00                   | 0.00                | 0.00  |
| urea             | 0.03                   | 0.03                | 2.00  |
| other substances | 1.82                   | 9.82                | 4.00  |

As a result of the action of the cells of the proximal convoluted tubule, glucose and amino acids have been reabsorbed by the blood, whereas only some of the urea has been reabsorbed.

Calculate how many times the percentage composition of urea has increased in the urine compared with the glomerular filtrate.

Show your working and give your answer to the nearest whole number.

answer ..... [2]

[Total: 9]

**Key**

- \*—\* blood glucose concentration
- \*---\* blood glucagon concentration

| time / min | blood glucose concentration / $\text{mmol dm}^{-3}$ | blood glucagon concentration / $\text{pmol dm}^{-3}$ |
|------------|-----------------------------------------------------|------------------------------------------------------|
| 0          | 5.0                                                 | 10                                                   |
| 15         | 4.5                                                 | 10                                                   |
| 30         | 3.0                                                 | 12                                                   |
| 45         | 2.5                                                 | 20                                                   |
| 60         | 4.0                                                 | 38                                                   |
| 75         | 5.0                                                 | 30                                                   |
| 90         | 5.0                                                 | 18                                                   |

Explain the relationship shown in Fig. 10.1.

[4]

**(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]

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

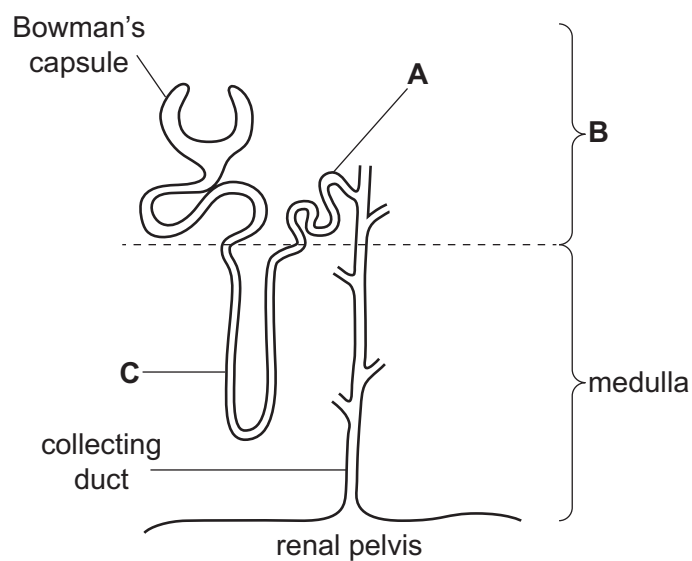


**Fig. 8.1**

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

**A** .....

**B** .....

**C** .....

[3]

(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.

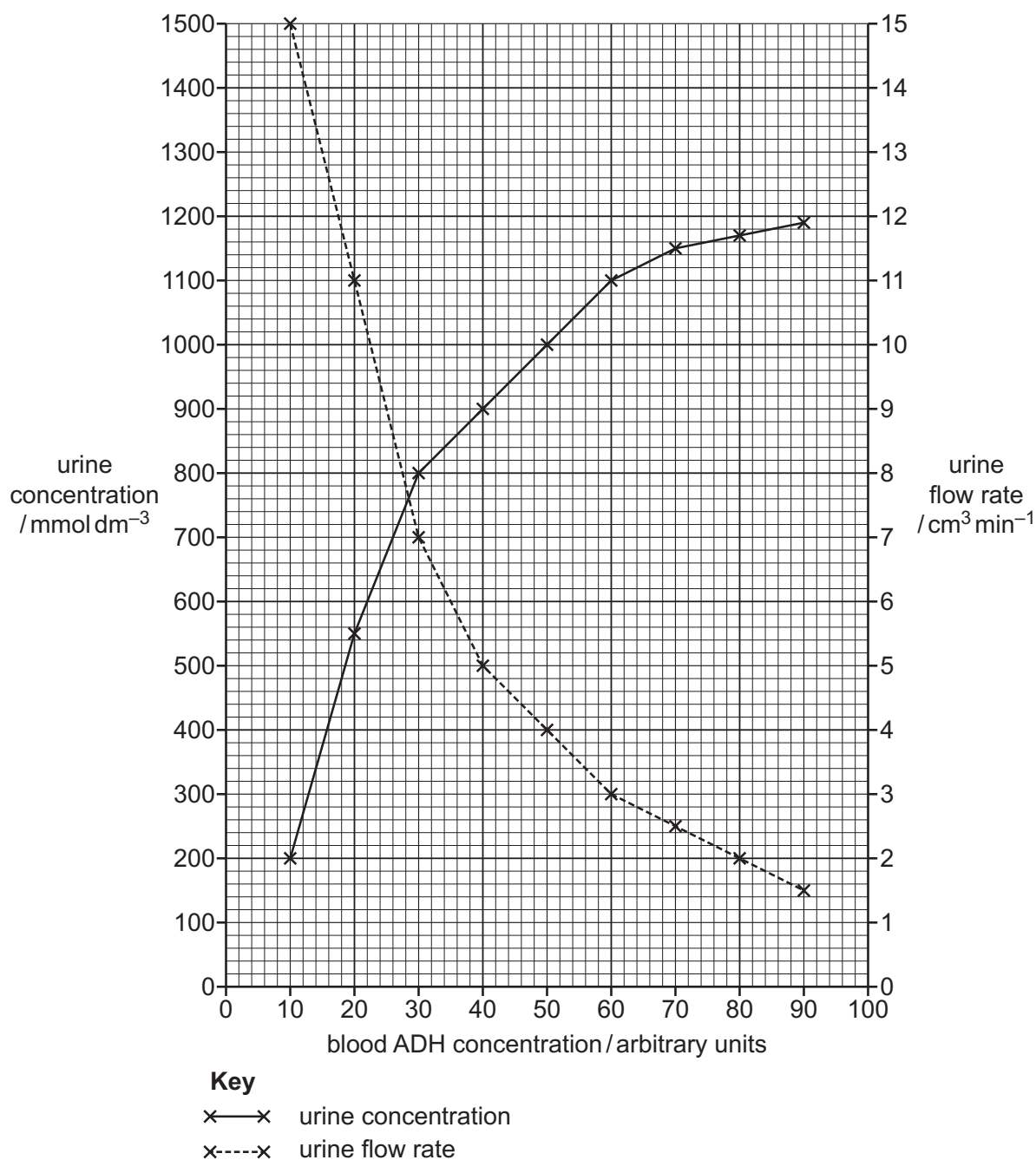


Fig. 8.2

Describe the relationships shown in Fig. 8.2.

.....

.....

.....

.....

.....

..... [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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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]

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

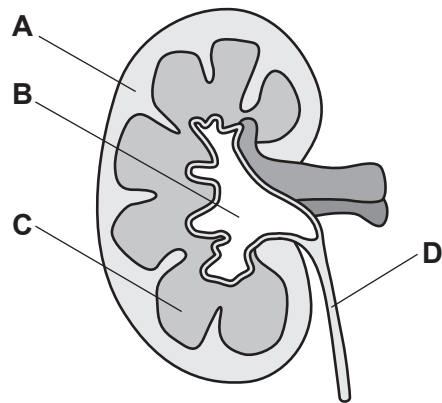


Fig. 1.1

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]

(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]

# 9700 Biology Paper 4 - Homeostasis

Topical questions | 92 questions

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64. Question part 3/3 | 9700 Feb-March 2023 P4 V2 Q1

**Question 2 starts on page 5.**

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.

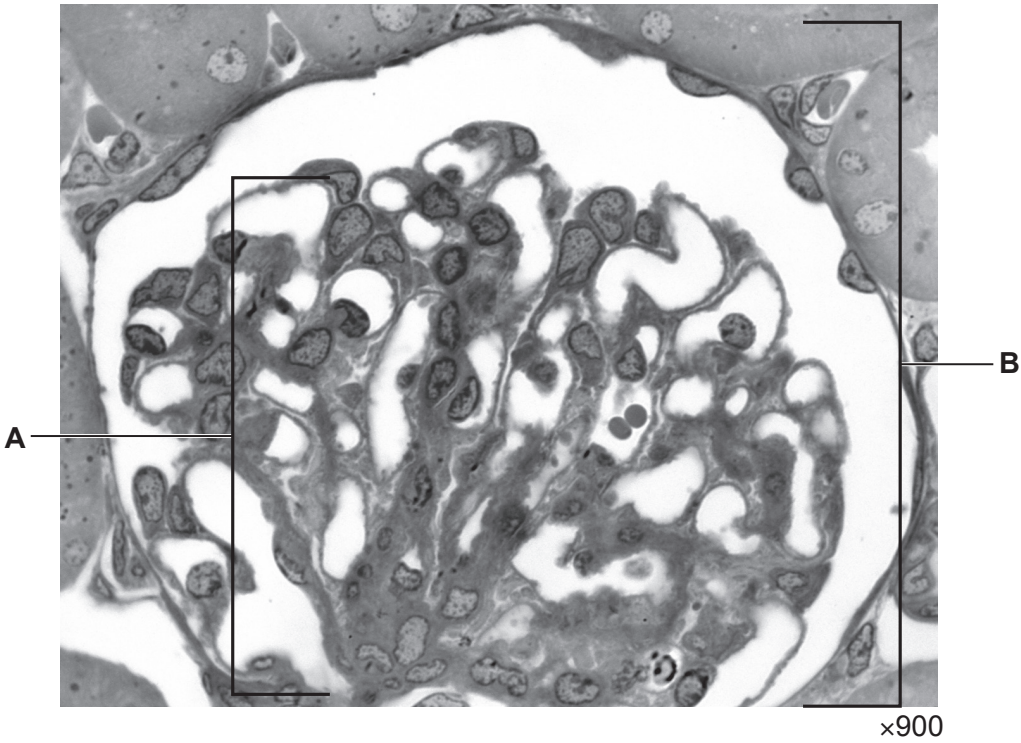


Fig. 5.1

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

**A** .....

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

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

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..... [4]

- (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.

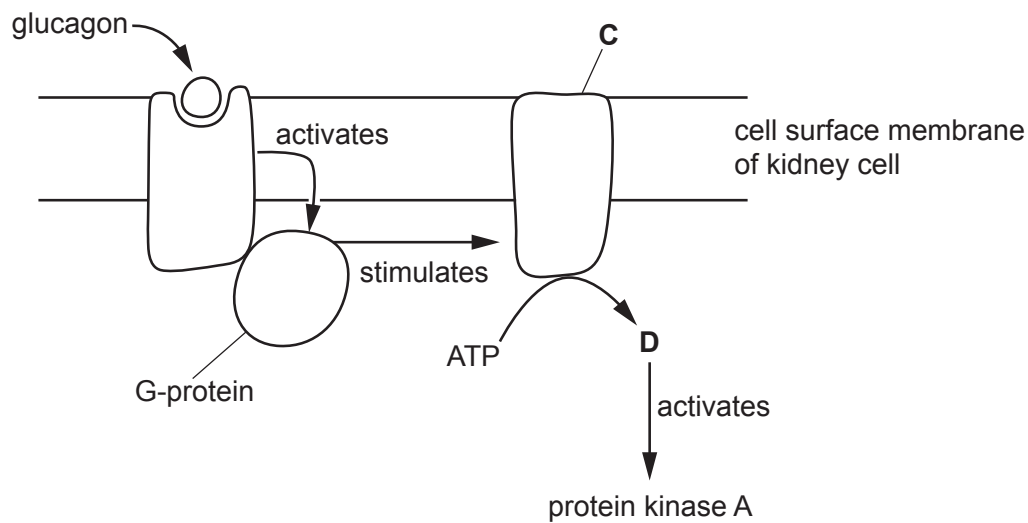


Fig. 5.2

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

**C** .....

**D** .....

[2]

(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.

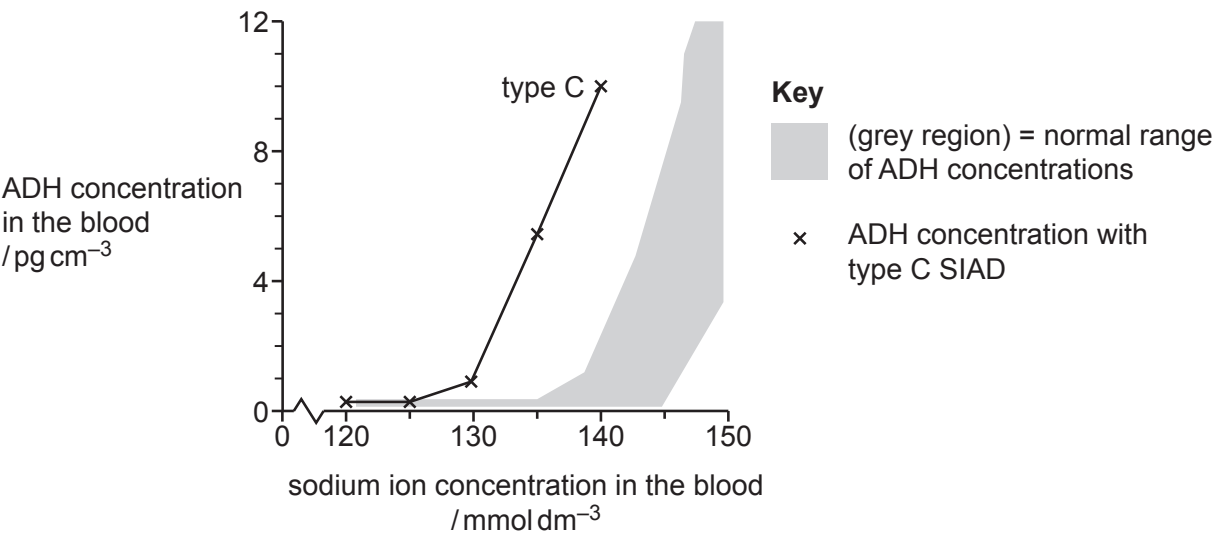


Fig. 5.3

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]

66. Question part 1/3 | 9700 May-June 2023 P4 V2 Q6

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

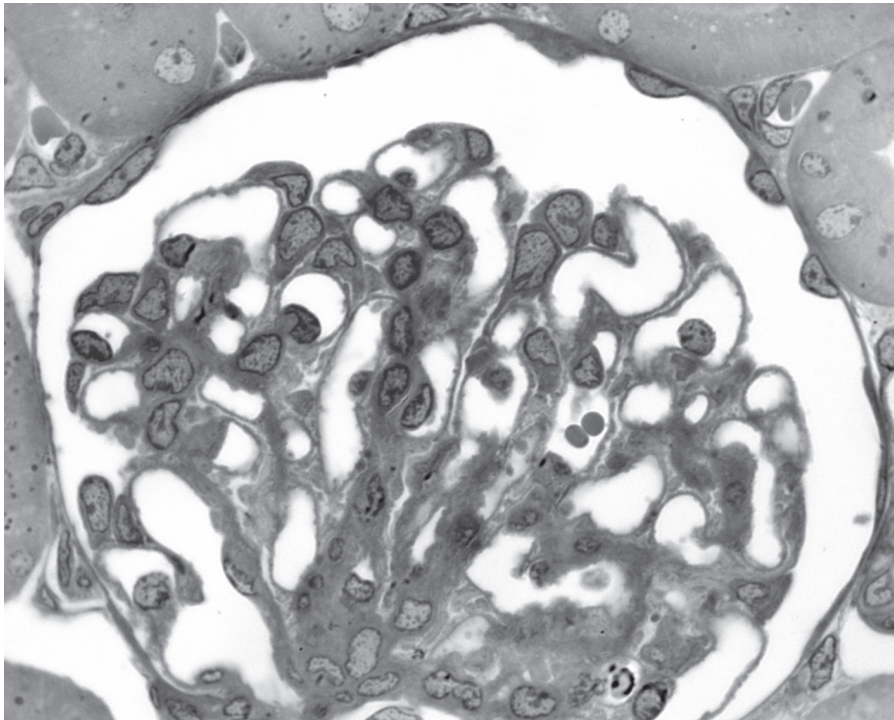


**Fig. 6.1**

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]

(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.

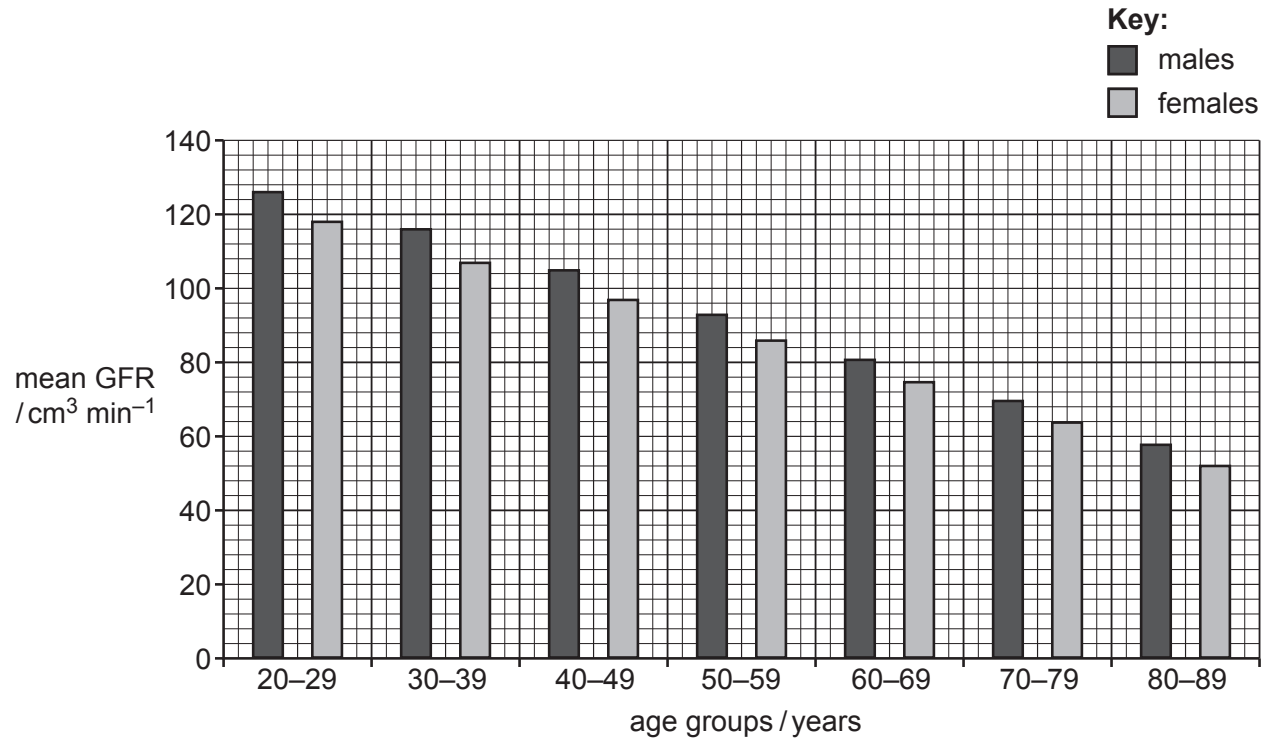


Fig. 6.2

(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]

(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]

**9 (a)** The passage outlines the endocrine system.

Complete the passage by using the most appropriate scientific terms.

The endocrine system consists of tissues and ..... , which secrete hormones such as insulin, glucagon and antidiuretic hormone (ADH). Glucagon only affects target cells that have complementary receptors, which are located on the ..... . Glucagon binds to these receptors and this leads to the production of a ..... , which transfers the signal throughout the cytoplasm. The target cells for insulin are in the liver, ..... and adipose tissue. The target cells for ADH are those of the distal convoluted tubule and the ..... of the kidney nephron. These hormones are involved in ..... , which is the maintenance of a constant internal environment. [6]

**(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.

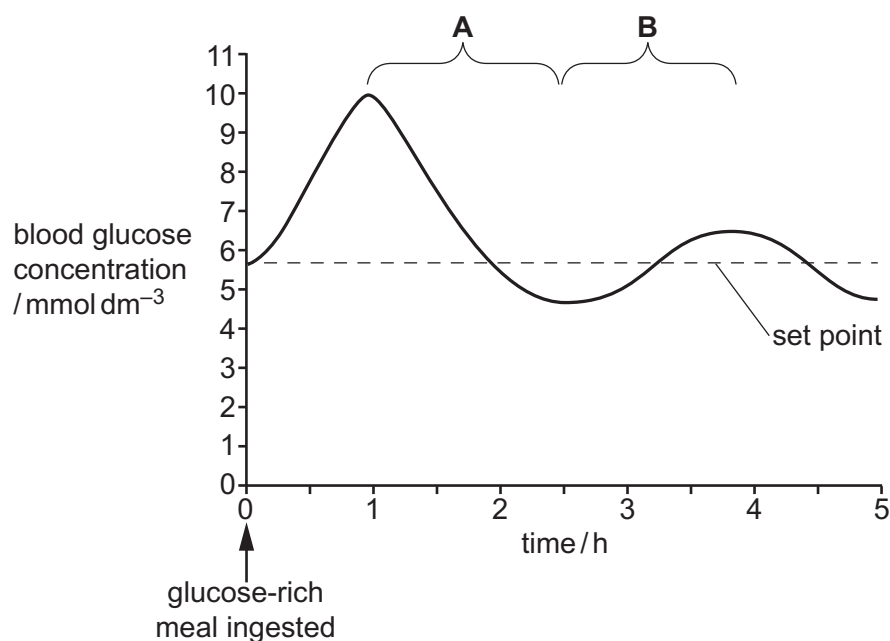


**Fig. 9.1**

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

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..... [3]

(ii) Suggest why the blood glucose concentration increases again during phase **B**.

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..... [1]

[Total: 10]

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

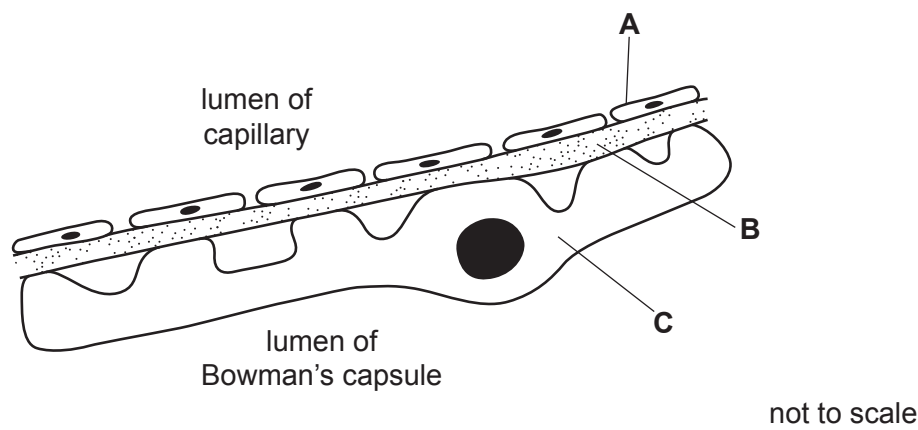


Fig. 6.1

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.

- .....
- .....
- .....
- .....
- ..... [2]

(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.

- 180dm<sup>3</sup> of water forms part of the glomerular filtrate each day.
- 1.4dm<sup>3</sup> 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]

## 9700 Biology Paper 4 - Homeostasis

Topical questions | 92 questions

68. Question part 2/2 | 9700 May-June 2023 P4 V3 Q6

- (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.

[7]

[Total: 14]

- 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.

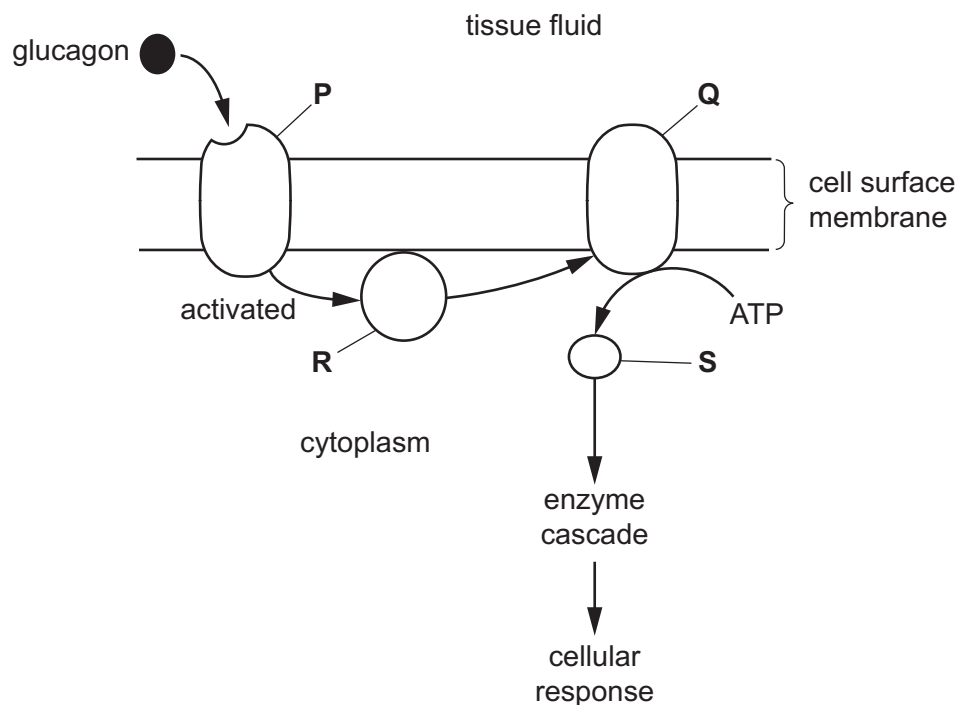


Fig. 6.1

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

**P** .....

**Q** .....

**R** .....

**S** .....

[4]

- (ii) Table 6.1 shows four processes carried out by liver cells that are affected by a decrease in blood glucose concentration. Some of these are cellular responses from cell signalling by glucagon.

Complete Table 6.1 by stating whether the rate of each process **increases** or **decreases** when blood glucose concentration decreases.

Table 6.1

| process                                | effect on rate of process when blood glucose concentration decreases |
|----------------------------------------|----------------------------------------------------------------------|
| glycogenolysis<br>(glycogen breakdown) | .....                                                                |
| glycogenesis<br>(glycogen formation)   | .....                                                                |
| glycolysis                             | .....                                                                |
| fatty acid synthesis                   | .....                                                                |

[3]

Topical questions | 92 questions

[Total: 14]

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

A student drank  $0.5 \text{ dm}^3$  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.

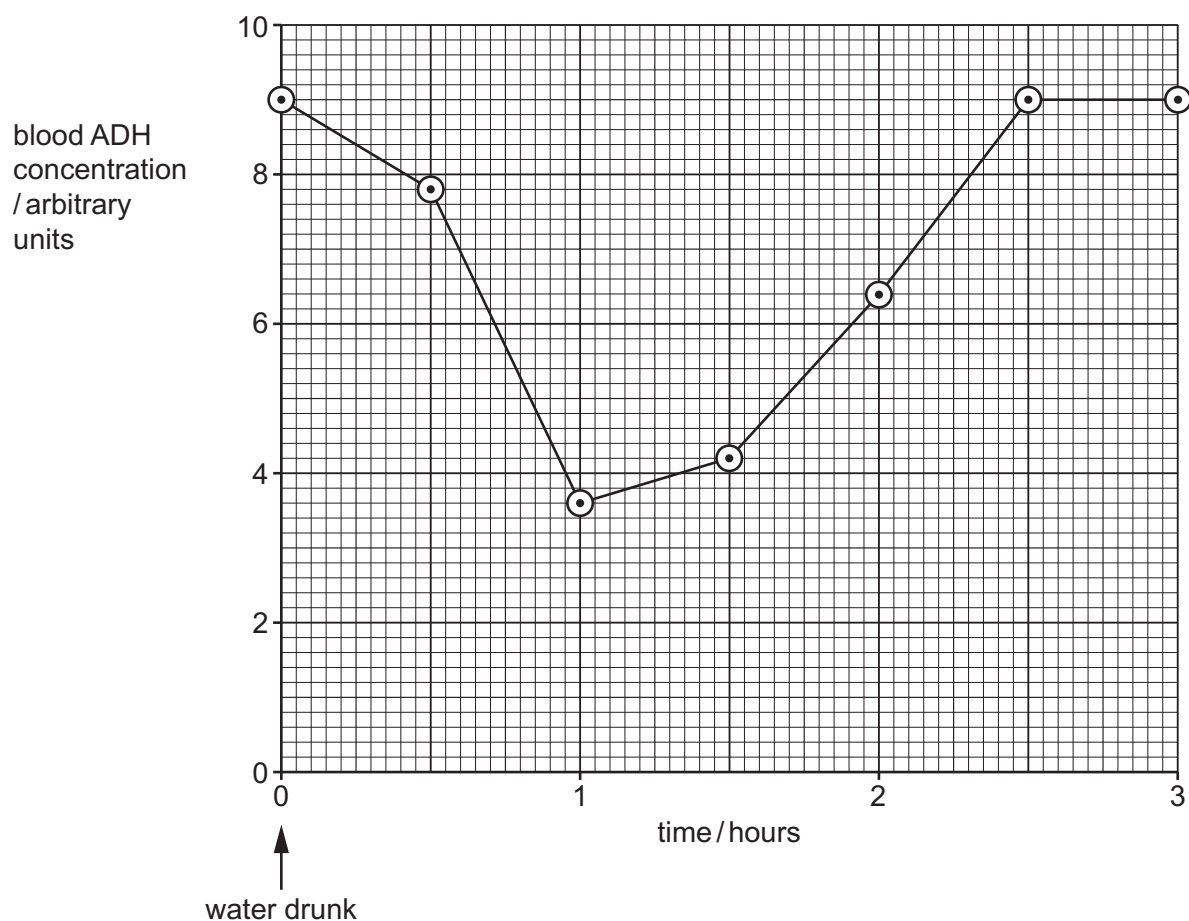


Fig. 9.1

Explain the results shown in Fig. 9.1.

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**(b)** Outline the differences between the endocrine system and the nervous system.

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..... [4]

[Total: 8]

- 1 (a) Fig. 1.1 is a diagram of a nephron.

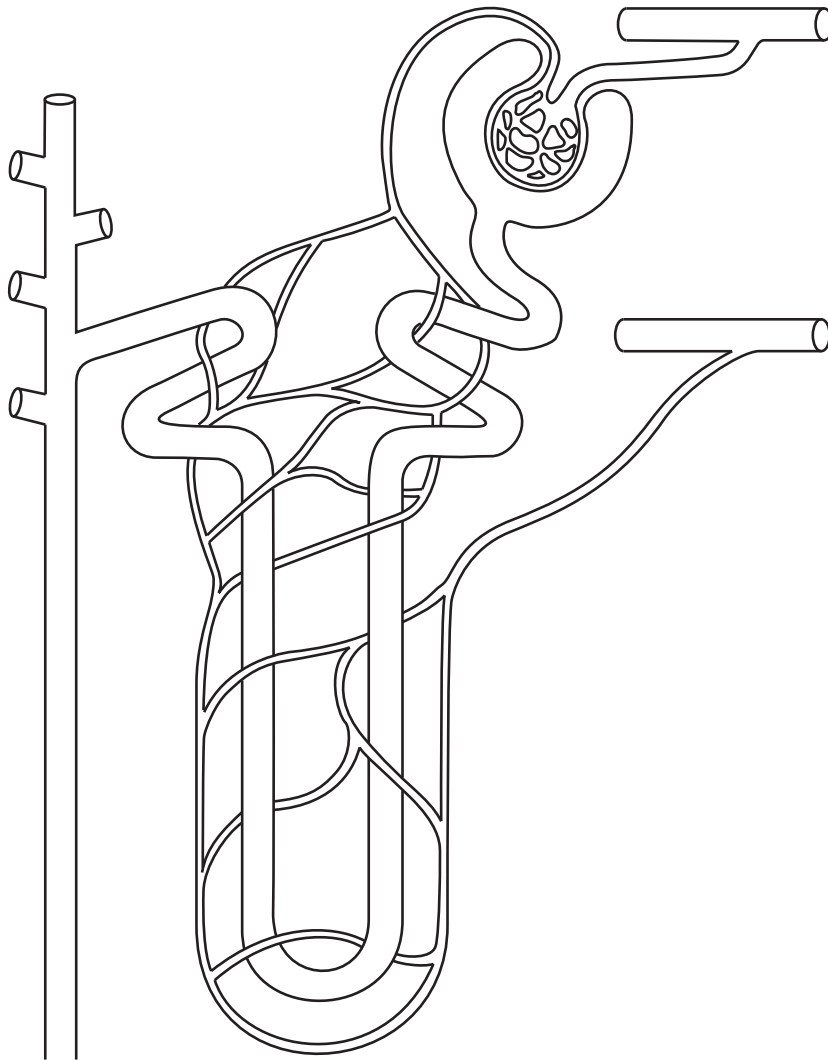


Fig. 1.1

Label Fig. 1.1 using:

- one labelling line and the letter **A** to identify a region that contains urine
- one labelling line and the letter **B** to identify a region that contains podocytes
- one labelling line and the letter **C** to identify a region of the nephron that is within the medulla of the kidney
- one labelling line and the letter **D** to identify the afferent arteriole.

[4]

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

Describe **and** explain how these cells are adapted to carry out selective reabsorption.

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..... [4]

[Total: 8]

72. Question part 1/6 | 9700 Feb-March 2024 P4 V2 Q4

- 4 Holstein Friesian cattle are a breed of cattle used by dairy farmers in many countries of the world for the high milk yield of their cows.

Fig. 4.1 shows Holstein Friesian cattle.



**Fig. 4.1**

Milk yield in Holstein Friesian cattle is affected by heat stress. Heat stress occurs when homeostatic mechanisms are **not** enough to keep the body temperature down to normal levels.

One of the factors that contributes to heat stress is air temperature.

Fig. 4.2 shows:

- the mean daily air temperature in Central Europe
- the mean monthly milk yield per cow of Holstein Friesian cattle in Central Europe.

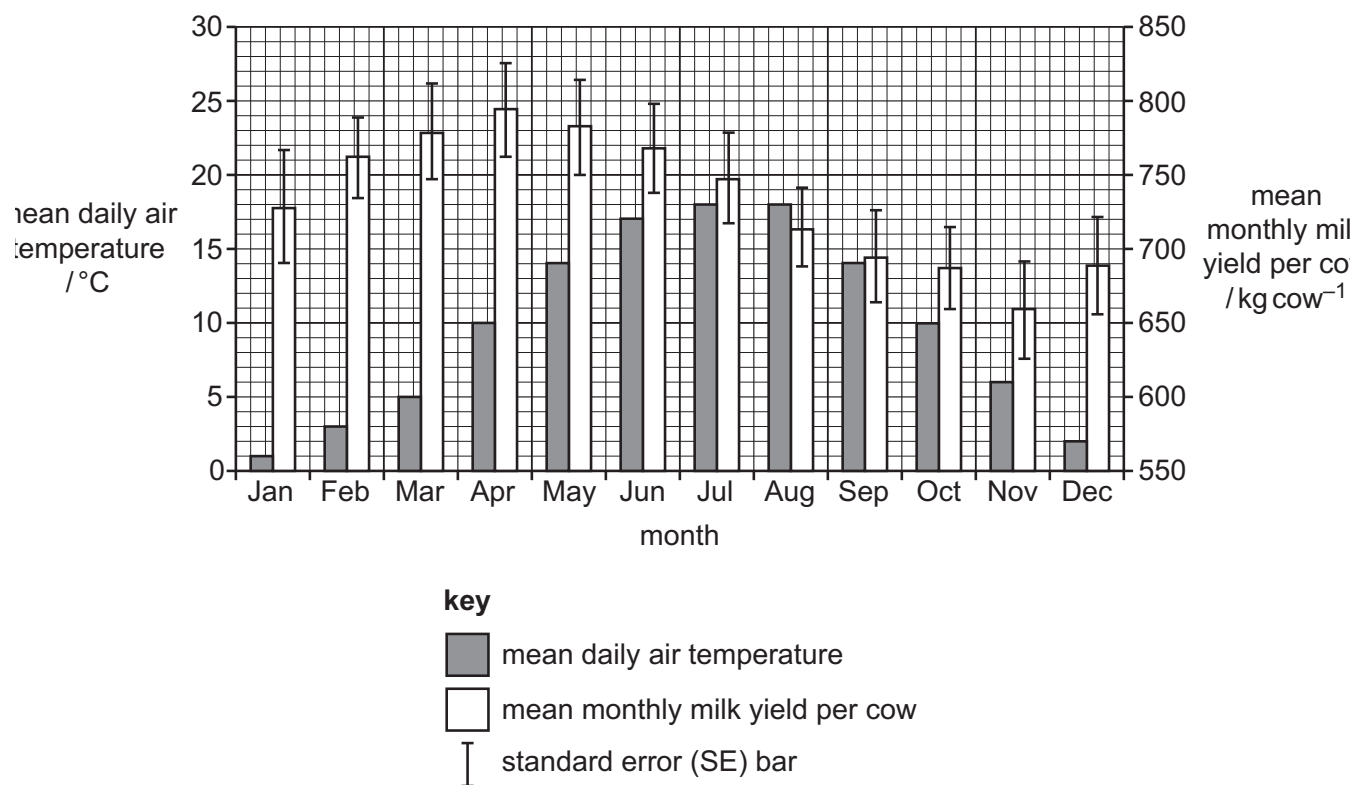


**Fig. 4.2**

- (a) With reference to Fig. 4.2, describe the trends in air temperature and milk yield from April to August.

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..... [2]

- (b) Many dairy farmers in tropical regions use cattle breeds that are tolerant to heat stress (heat-tolerant cattle). These heat-tolerant cattle:
- can tolerate higher air temperatures than Holstein Friesian cattle before heat stress occurs
  - have milder symptoms of heat stress than Holstein Friesian cattle for the same high air temperatures.

Where heat stress does **not** occur, heat-tolerant cattle produce a lower milk yield than Holstein Friesian cattle under the same conditions.

Scientists compared DNA sequences of Holstein Friesian cattle and heat-tolerant cattle for a number of genes known to have an effect on body temperature.

Twenty genes were found that had alleles associated **only** with heat-tolerant cattle.

With reference to the information provided, including the data in Fig. 4.2:

- state the type (pattern) of phenotypic variation shown by milk yield in cattle
- identify factors that cause phenotypic variation in milk yield in cattle.

In each case, give a reason for your choice.

type (pattern) of phenotypic variation and reason for choice .....

.....  
.....

factors that cause phenotypic variation and reason for each choice .....

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- Cattle with the *SLICK* allele have short hair due to reduced hair growth.

- March, when the mean daily air temperature is 5 °C.
- September, when the mean daily air temperature is 14 °C.



With reference to Fig. 4.3, describe the effect of the *SLICK* allele on milk yield in Holstein Friesian cattle.

[3]

Topical questions | 92 questions

[Total: 14]

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- 9 (a) An investigation was carried out to study the effect of different intensities of blue light on the percentage germination of barley seeds. Barley seeds were exposed to blue light for a period of seven days. All other variables were kept constant.

The results are shown in Table 9.1.

Table 9.1

| light intensity<br>/arbitrary units (au) | percentage<br>germination |
|------------------------------------------|---------------------------|
| 0 (dark)                                 | 98.0                      |
| 36                                       | 76.9                      |
| 48                                       | 45.0                      |
| 57                                       | 14.7                      |

The effect of blue light on the concentration of abscisic acid (ABA) was also investigated. ABA concentration was measured at intervals over seven days in barley seeds exposed to blue light at an intensity of 57 arbitrary units.

The results are shown in Table 9.2.

Table 9.2

| day | concentration of ABA<br>/arbitrary units (au) |
|-----|-----------------------------------------------|
| 0   | 100                                           |
| 1   | 90                                            |
| 3   | 350                                           |
| 5   | 351                                           |
| 7   | 381                                           |

For comparison, in the dark the concentration of ABA in barley seeds fell from 100au at the start (day 0) to 45au on day 1 and did **not** increase from day 1 to day 7.

Topical questions | 92 questions

ABA is thought to affect gibberellin synthesis or activity.

[4]

[7]

[Total: 11]

**1** Osmoregulation is the control of the water potential of body fluids such as blood.

**(a)** Osmoreceptors and antidiuretic hormone (ADH) have an important role in osmoregulation.

**(i)** Name the location of osmoreceptors.

..... [1]

**(ii)** State the stimulus that is detected by osmoreceptors.

..... [1]

**(iii)** Name the structure that secretes ADH into the blood.

..... [1]

**(b)** ADH acts on the cells of the collecting duct, resulting in changes in the volume and concentration of urine.

Fig. 1.1 shows the relationship between the concentration of ADH in the blood and the rate of production of urine by the kidneys.

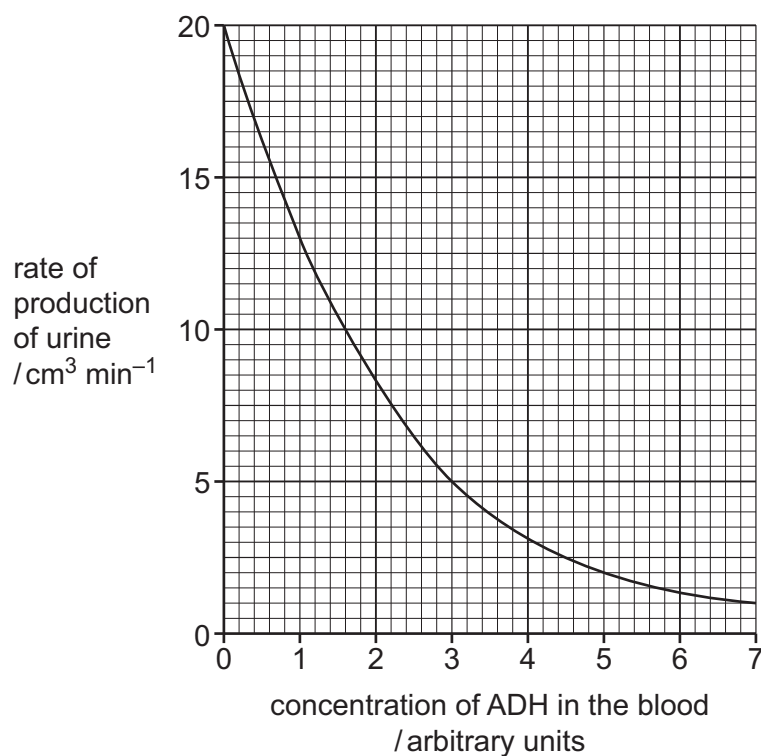


**Fig. 1.1**



- (i) As the concentration of ADH in the blood increases, the rate of production of urine decreases.

Using Fig. 1.1, calculate the percentage decrease in the rate of production of urine between ADH concentrations of 1 and 3 arbitrary units.

Show your working.

Give your answer to **one** decimal place.

answer = ..... [2]

- (ii) Explain the relationship shown in Fig. 1.1.

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[Total: 8]

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

..... [1]

- 
- A line graph showing blood glucose concentration in  $\text{mmol dm}^{-3}$  on the y-axis (ranging from 4 to 7) against time in minutes on the x-axis (ranging from 0 to 100). The curve starts at 5.1 at 0 min, peaks at 5.2 at 12 min, drops to a minimum of 4.4 at 38 min, rises to a maximum of 5.6 at 72 min, and then gradually declines to 5.3 at 100 min. A horizontal double-headed arrow labeled 'period of exercise' spans from 12 min to 80 min.
- | time / min | blood glucose concentration / $\text{mmol dm}^{-3}$ |
|------------|-----------------------------------------------------|
| 0          | 5.1                                                 |
| 10         | 5.2                                                 |
| 12         | 5.2                                                 |
| 20         | 5.0                                                 |
| 30         | 4.6                                                 |
| 38         | 4.4                                                 |
| 40         | 4.4                                                 |
| 50         | 4.8                                                 |
| 60         | 5.3                                                 |
| 72         | 5.6                                                 |
| 80         | 5.5                                                 |
| 90         | 5.4                                                 |
| 100        | 5.3                                                 |

Explain the results shown in Fig. 10.1 between 15 minutes and 70 minutes.

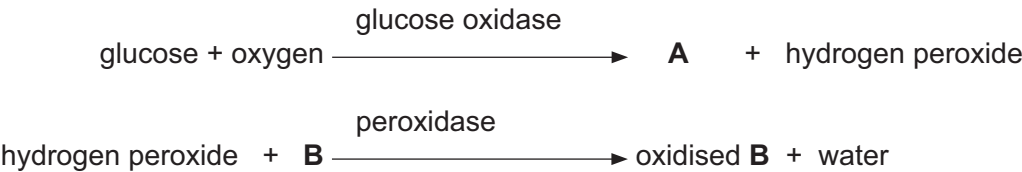
..... [3]



(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:



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

**A** .....

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

(ii) Most people with diabetes mellitus use a biosensor to obtain their blood glucose concentration.

Suggest the advantages of using a biosensor rather than test strips.

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..... [2]

[Total: 8]

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- 1 Fig. 1.1 outlines the effect of antidiuretic hormone (ADH) on the cells of the collecting duct. The cell-signalling mechanism of ADH is similar to that of glucagon on liver cells.

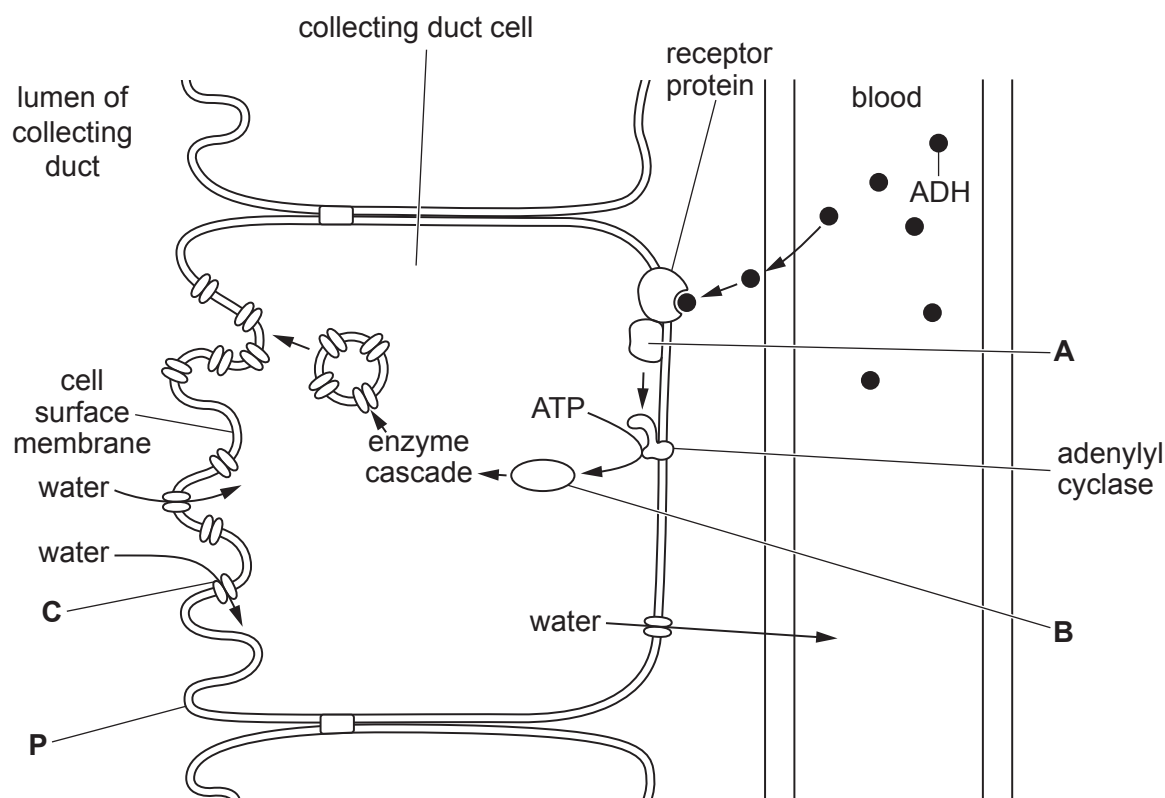


Fig. 1.1

- (a) Name structures A, B and C.

A .....

B .....

C .....

[3]

- (b) ADH is secreted by the posterior pituitary gland when the water potential of the blood decreases.

Suggest reasons why the water potential of the blood may decrease.

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[3]

- (c) Diabetes insipidus is a condition affecting osmoregulation by the kidney. One form of diabetes insipidus is caused by a tumour in the pituitary gland, which results in a decreased secretion of ADH.

Suggest the symptoms that would occur in a person with diabetes insipidus.

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..... [2]

- (d) Neurogenic diabetes insipidus (NDI) is another form of diabetes insipidus. In NDI, ADH molecules cannot bind to the receptor proteins located in the cell surface membranes of the cells of the collecting duct.

With reference to Fig. 1.1, explain the effect on the cell surface membrane labelled **P** if ADH cannot bind to the receptor proteins.

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..... [2]

- (e) NDI is caused by a recessive allele of the gene coding for the receptor protein. The gene is located on the X chromosome.

Explain why a man with NDI could **not** have inherited the condition from his father.

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..... [2]

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# 9700 Biology Paper 4 - Homeostasis

Topical questions | 92 questions

77. Question | 9700 May-June 2024 P4 V3 Q6

- 6 (a)** In plants, stomata open and close in response to changes in environmental conditions.

Explain why stomata need to open and close according to environmental conditions.

..... [3]

- (b)** Describe the mechanism occurring in guard cells that leads to the opening of a stoma.

..... [6]

[Total: 9]

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.

.....

.....

..... [2]

(ii) Homeostatic control of the water potential of blood includes receptors, effectors and target cells.

Identify the names **and** locations of these components of homeostatic control in osmoregulation.

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..... [3]

(b) The glomerulus and Bowman’s capsule of the nephron are important in the formation of urine.

Outline the role of the glomerulus and Bowman’s capsule in the formation of urine.

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..... [3]



- (c) Concentrated urine contains a high concentration of solutes and a small volume of water. Different species of mammals vary in their ability to produce urine with a high solute concentration.

Table 6.1 compares the ratio of the solute concentration of urine (U) to the solute concentration of blood plasma (P) in some mammal species. The habitats of the mammal species are also shown.

Table 6.1

| mammal species | maximum ratio of<br>solute concentration of urine<br>to solute concentration of blood plasma<br>(U : P) | habitat          |
|----------------|---------------------------------------------------------------------------------------------------------|------------------|
| beaver         | 1.7 : 1                                                                                                 | rivers and lakes |
| human          | 4.5 : 1                                                                                                 | variable         |
| camel          | 8.0 : 1                                                                                                 | desert           |
| rat            | 9.0 : 1                                                                                                 | variable         |
| kangaroo rat   | 16.0 : 1                                                                                                | desert           |

With reference to Table 6.1, suggest what the different values of U : P show about the ability of these mammal species to tolerate a shortage of water in their environment.

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..... [3]

[Total: 11]

1 (a) Fig. 1.1 is a diagram of part of a Bowman’s capsule and a glomerular capillary.

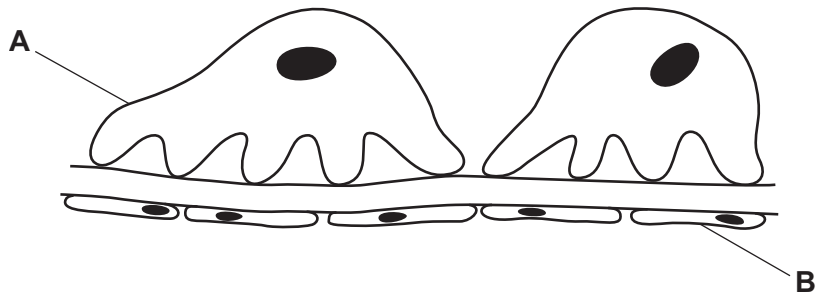


Fig. 1.1

(i) Identify structures A and B.

A .....

B .....

[2]

(ii) The glomerular filtrate is produced in the Bowman’s capsule by the process of ultrafiltration.

State the conditions required for ultrafiltration.

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

79. Question part 2/2 | 9700 Oct-Nov 2024 P4 V2 Q1



(b) As the newly formed glomerular filtrate passes along the proximal convoluted tubule, selective reabsorption takes place. The fluid remaining in the proximal convoluted tubule eventually forms urine.

Table 1.1 lists three of the components of blood plasma that enter the glomerulus in a healthy person.

Complete Table 1.1 by writing:

- **increased**, if the component is present and is higher in concentration than in blood plasma
- **decreased**, if the component is present and is lower in concentration than in blood plasma
- **same**, if the component is present and is of the same concentration as blood plasma
- **not present**, if the component is absent.

You may use each response once, more than once or not at all.

Table 1.1

| component of blood plasma entering glomerulus | component in newly formed glomerular filtrate | component in urine |
|-----------------------------------------------|-----------------------------------------------|--------------------|
| glucose                                       |                                               |                    |
| large plasma proteins                         |                                               |                    |
| urea                                          |                                               |                    |

[3]

(c) Sweating during exercise can lead to a response in the posterior pituitary gland and in the kidney.

State the response to sweating that occurs in the posterior pituitary gland **and** the response that occurs in the kidney.

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..... [2]

[Total: 9]

Topical questions | 92 questions

80. Question part 1/2 | 9700 Oct-Nov 2024 P4 V2 Q10

Explain the principles of homeostasis.

[4]

A mutation in *PYGL* leads to a condition called glycogen storage disease type VI (GSDVI), in which glycogen is not broken down efficiently.

[3]



(c) Glycogen synthase catalyses the conversion of glucose to glycogen in liver cells. The production of glycogen synthase is coded for by the gene *GYS2*.

A mutation in *GYS2* leads to a condition called glycogen storage disease type 0 (GSD0) in which glycogen is not formed efficiently.

Suggest what the consequences would be if a person with GSD0 has a meal rich in glucose.

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..... [3]

[Total: 10]

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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.

.....

.....

..... [2]

(ii) Homeostatic control of the water potential of blood includes receptors, effectors and target cells.

Identify the names **and** locations of these components of homeostatic control in osmoregulation.

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.....

..... [3]

(b) The glomerulus and Bowman’s capsule of the nephron are important in the formation of urine.

Outline the role of the glomerulus and Bowman’s capsule in the formation of urine.

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..... [3]

81. Question part 2/2 | 9700 Oct-Nov 2024 P4 V3 Q6



- (c) Concentrated urine contains a high concentration of solutes and a small volume of water. Different species of mammals vary in their ability to produce urine with a high solute concentration.

Table 6.1 compares the ratio of the solute concentration of urine (U) to the solute concentration of blood plasma (P) in some mammal species. The habitats of the mammal species are also shown.

Table 6.1

| mammal species | maximum ratio of<br>solute concentration of urine<br>to solute concentration of blood plasma<br>(U : P) | habitat          |
|----------------|---------------------------------------------------------------------------------------------------------|------------------|
| beaver         | 1.7 : 1                                                                                                 | rivers and lakes |
| human          | 4.5 : 1                                                                                                 | variable         |
| camel          | 8.0 : 1                                                                                                 | desert           |
| rat            | 9.0 : 1                                                                                                 | variable         |
| kangaroo rat   | 16.0 : 1                                                                                                | desert           |

With reference to Table 6.1, suggest what the different values of U : P show about the ability of these mammal species to tolerate a shortage of water in their environment.

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..... [3]

[Total: 11]

- 6 (a) Fig. 6.1 outlines part of the control mechanism that regulates blood glucose concentration.

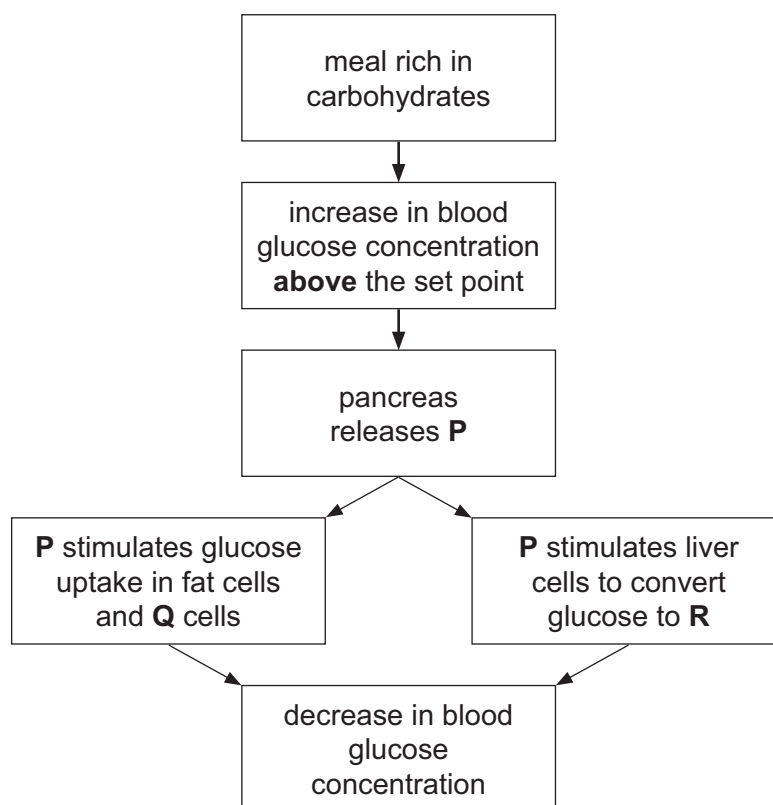


Fig. 6.1

- (i) Identify **P**, **Q** and **R**.

**P** .....

**Q** .....

**R** .....

[3]

- (ii) State the type of homeostatic control mechanism operating in Fig. 6.1.

..... [1]

## 9700 Biology Paper 4 - Homeostasis

Topical questions | 92 questions

82. Question part 2/2 | 9700 Feb-March 2025 P4 V2 Q6



- (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.

[7]

[Total: 11]

83. Question part 1/2 | 9700 May-June 2025 P4 V1 Q6

6 (a) In the kidney, various molecules move between the blood and the kidney nephron.

Table 6.1 describes the movements of molecules at three regions of the nephron, **P**, **Q** and **R**.

Table 6.1

| region of nephron | molecule(s)                                                   | direction of movement                                               |
|-------------------|---------------------------------------------------------------|---------------------------------------------------------------------|
| <b>P</b>          | amino acids, glucose and water                                | from nephron to blood                                               |
| <b>Q</b>          | water                                                         | from nephron to blood in the presence of antidiuretic hormone (ADH) |
| <b>R</b>          | water and molecules with a molecular mass of less than 68,000 | from blood to nephron                                               |

(i) Name the processes, **other than** diffusion, osmosis and active transport, that are occurring at **P**, **Q** and **R**.

**P** .....  
**Q** .....  
**R** .....

[3]

(ii) Identify the regions of the nephron represented by **P**, **Q** and **R**.

**P** .....  
**Q** .....  
**R** .....

[3]

83. Question part 2/2 | 9700 May-June 2025 P4 V1 Q6



**(b)** A student cut a fresh kidney lengthways and placed one half in the freezer. After 24 hours, the student examined the kidney section and tested its firmness with a mounted needle.

Sodium chloride concentration affects the freezing point of a solution.

The student drew the diagram in Fig. 6.1 to show an area that had frozen hard and an area that was softer and less frozen.

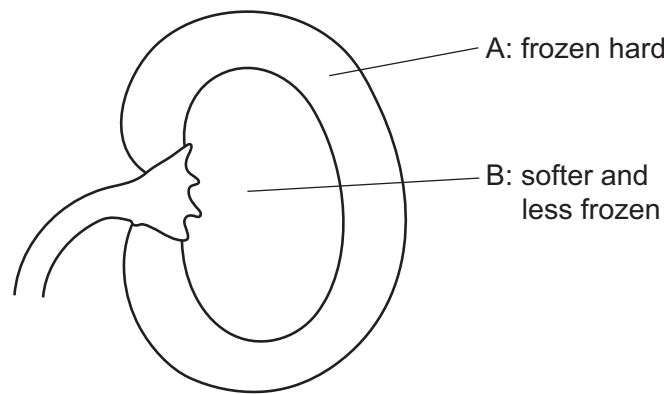


**Fig. 6.1**

Suggest an explanation for the observations in Fig. 6.1 made by the student.

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..... [2]

[Total: 8]

84. Question part 1/2 | 9700 May-June 2025 P4 V1 Q7

7 Insulin is an example of a cell-signalling molecule of the endocrine system.

(a) Outline why insulin can be described as an example of a cell-signalling molecule of the endocrine system.

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..... [4]

(b) Researchers compared the effect of two types of meal on the mean blood glucose concentration and the mean blood insulin concentration of twelve volunteers. The measurements were made for three hours after the meal.

Meal A contained 55% carbohydrate, 27% fat and 18% protein.  
Meal B contained 3% carbohydrate, 90% fat and 7% protein.

Fig. 7.1 shows the results.

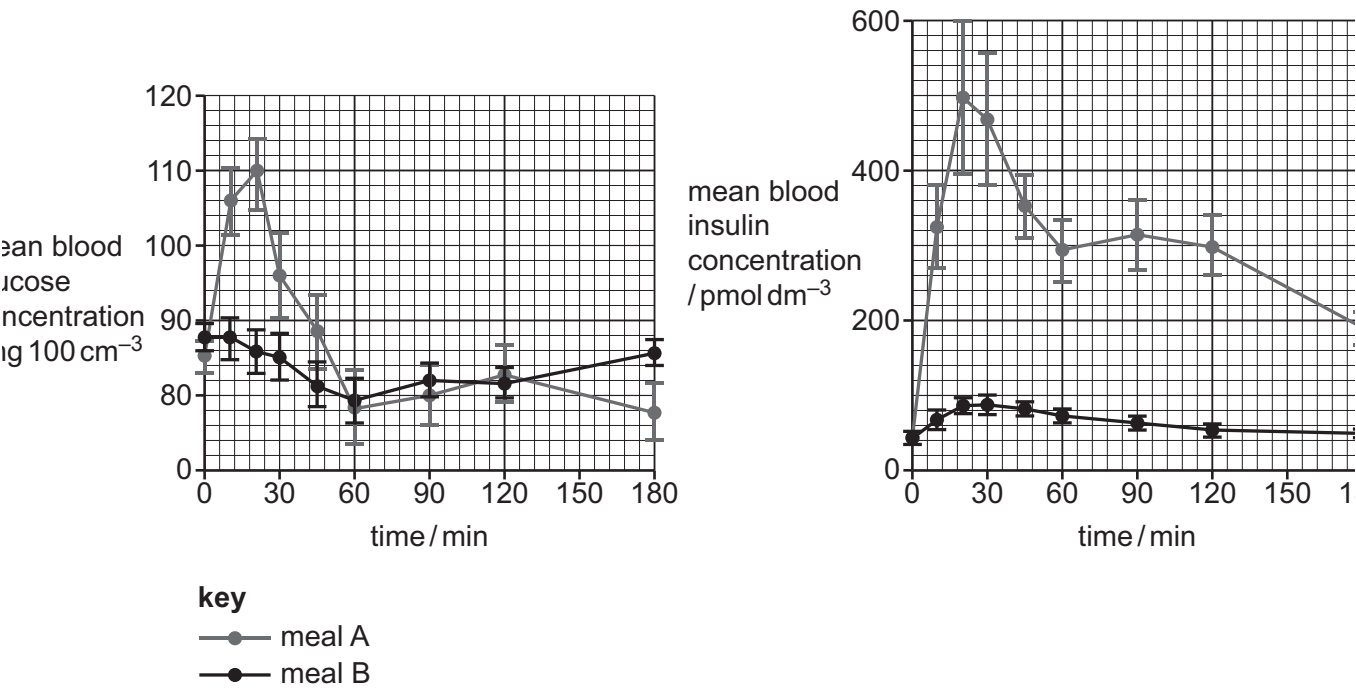


Fig. 7.1

84. Question part 2/2 | 9700 May-June 2025 P4 V1 Q7



(i) With reference to Fig. 7.1, explain how negative feedback operates to control mean blood glucose concentration in the volunteers who ate meal A.

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..... [4]

(ii) Suggest explanations for the changes in mean blood glucose concentration of the volunteers who ate meal B.

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..... [3]

[Total: 11]

85. Question part 1/3 | 9700 May-June 2025 P4 V2 Q6

6 Guard cells are located in the epidermis of the leaves of most plants. When environmental conditions change, this causes changes in guard cells that control the opening and closing of stomata.

(a) Describe the structure of guard cells.

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..... [4]

(b) Stomata have daily rhythms of opening and closing.

Fig. 6.1 shows the percentage of stomata open at different times of the day, over a period of three days, in the thale cress plant, *Arabidopsis thaliana*.

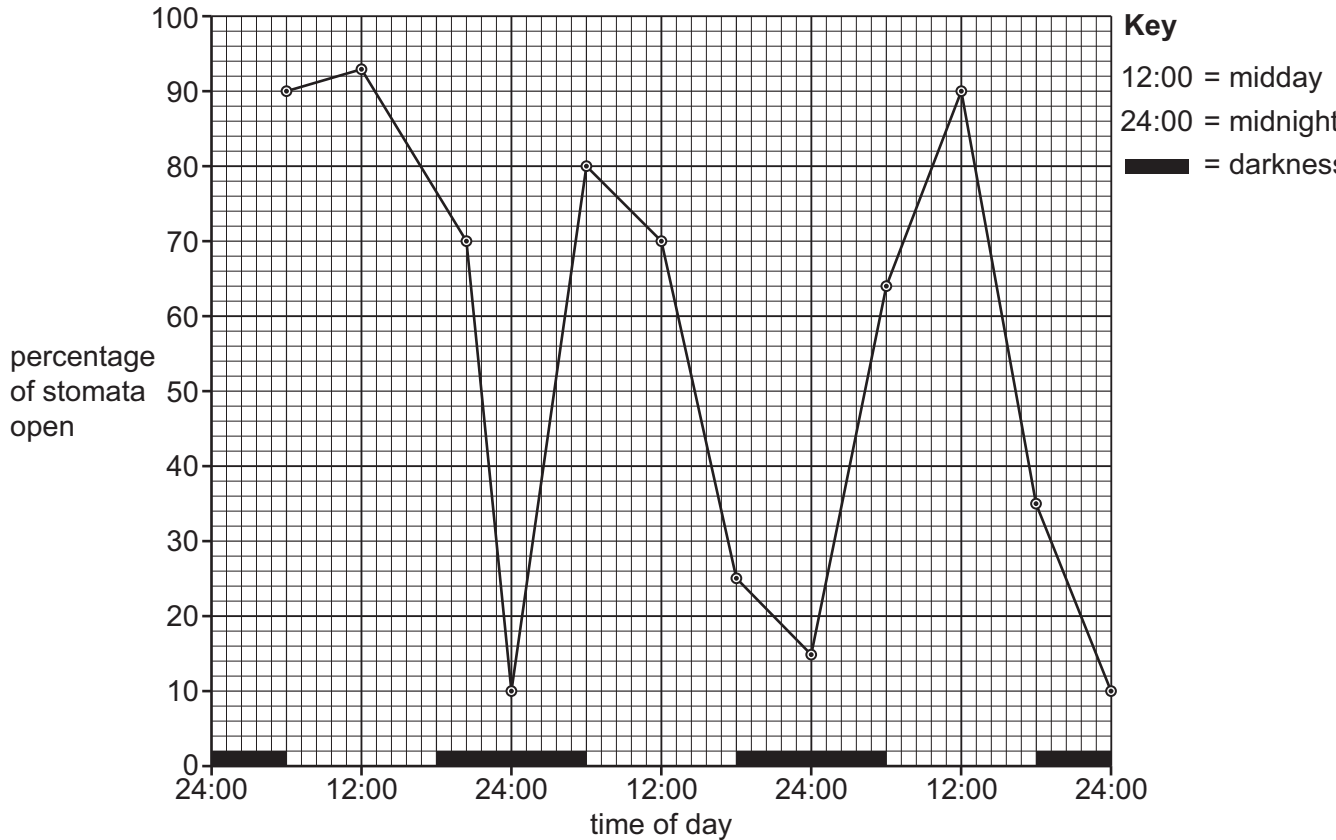


Fig. 6.1

85. Question part 2/3 | 9700 May-June 2025 P4 V2 Q6



(i) With reference to Fig. 6.1, describe the rhythm of stomatal opening and closing.

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..... [2]

(ii) Suggest other environmental factors, apart from the time of day, that can contribute to stomatal closure.

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..... [2]

85. Question part 3/3 | 9700 May-June 2025 P4 V2 Q6



(c) Table 6.1 shows some of the events occurring during the closure of a stoma.

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

Table 6.1

| event | description of event                                                         |
|-------|------------------------------------------------------------------------------|
| A     | water leaves the guard cells by osmosis                                      |
| B     | active transport of hydrogen ions out of the guard cells stops               |
| C     | stoma closes                                                                 |
| D     | plant is subjected to a change in environmental conditions                   |
| E     | plant releases abscisic acid                                                 |
| F     | calcium ions move into the cytoplasm of the guard cells                      |
| G     | abscisic acid binds to receptors on the cell surface membrane of guard cells |
| H     | guard cells become flaccid                                                   |
| I     | water potential of the guard cells increases                                 |
| J     | potassium ions leave the guard cells                                         |

Complete Table 6.2 to show the correct order of the events shown in Table 6.1.

Three of the events have been completed for you.

Table 6.2

| correct order | letter of event |
|---------------|-----------------|
| 1             | D               |
| 2             | .....           |
| 3             | .....           |
| 4             | .....           |
| 5             | F               |
| 6             | .....           |
| 7             | .....           |
| 8             | .....           |
| 9             | .....           |
| 10            | C               |

[4]

[Total: 12]

**(a) (i)** Name the **main** metabolic waste product excreted by the kidneys.

(ii) State **how** this metabolic product is made.

(iii) State **where** this metabolic product is made.

**(b)** Glomerular filtrate is formed by the process of ultrafiltration.

Describe the process of ultrafiltration.

..... [7]

86. Question part 2/2 | 9700 May-June 2025 P4 V3 Q6



(c) Different mammals have different thicknesses of medulla relative to the size of the kidney.

Fig. 6.1 shows the relationship between the mean thickness of the medulla in kidneys of different mammals and concentration of urine produced by the kidneys.

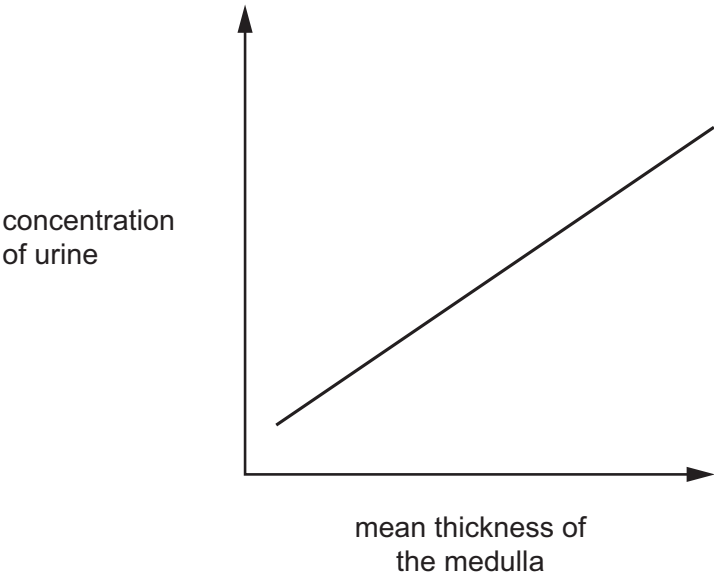


Fig. 6.1

Suggest an explanation for the relationship shown in Fig. 6.1.

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..... [2]

[Total: 12]

- 1 (a) Describe how a decrease in the water potential of the blood leads to an increase in the concentration of antidiuretic hormone (ADH) in the blood.

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..... [3]

- (b) ADH is transported in the blood to the cells of the collecting duct of the kidney.

Fig. 1.1 is a diagram outlining the action of ADH on the cells of the collecting duct.

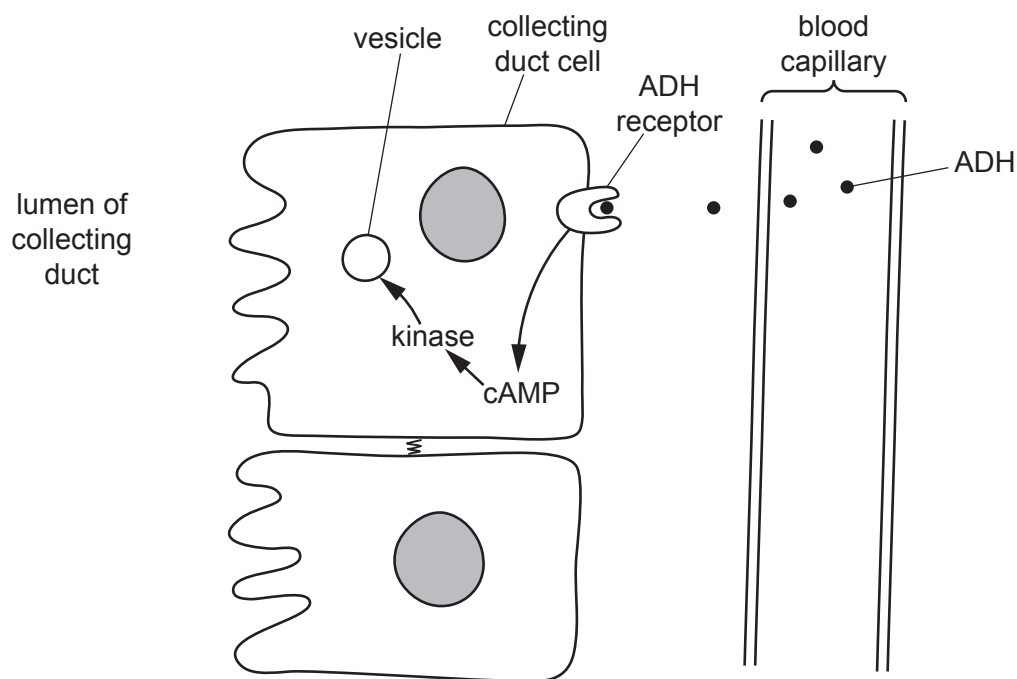


Fig. 1.1

- (i) Binding of ADH to the ADH receptor triggers reactions within the cell. One of the first reactions is the production of cyclic AMP (cAMP).

State the term used to describe molecules such as cAMP in cell signalling.

..... [1]

(ii) Describe the role of the vesicle when stimulated by kinase enzyme.

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..... [2]

(iii) On Fig. 1.1, draw arrows to show the direction of movement of water molecules after the cells of the collecting duct have responded to ADH. [1]

(c) Some people have a rare kidney disorder in which ADH is not able to bind to ADH receptors. Suggest the effects of this disorder on osmoregulation.

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..... [2]

[Total: 9]

9 (a) Fig. 9.1 shows a longitudinal section of a human kidney.

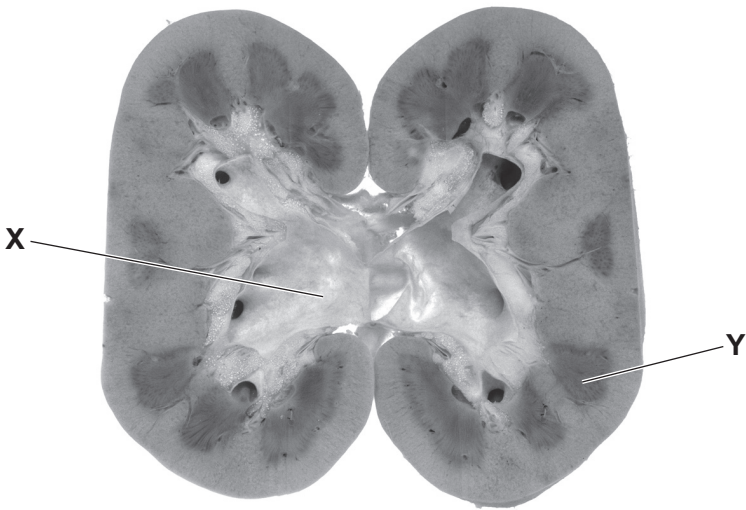


Fig. 9.1

Name the regions of the kidney labelled X and Y in Fig. 9.1.

X .....  
Y ..... [2]

(b) A biosensor can be used to measure the concentration of glucose in urine.

Outline how a biosensor measures the concentration of glucose in urine.

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..... [4]

[Total: 6]

- 6 (a) Phosphoinositide 3-kinase (PI3K) and protein kinase B (PKB) are enzymes involved in the regulation of blood glucose concentration.

Fig. 6.1 shows a cell-signalling pathway involving insulin, PI3K and PKB in a muscle cell.

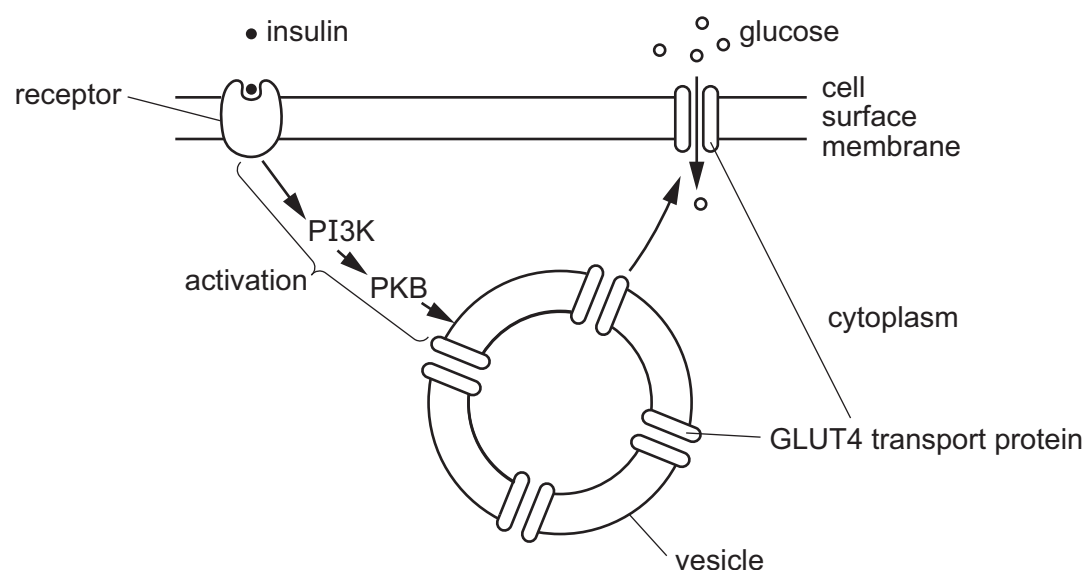


Fig. 6.1

Type 2 diabetes mellitus is a common disease. Some people with type 2 diabetes have a low concentration of PI3K in their muscle cells and cannot maintain their blood glucose concentration within normal limits.

With reference to Fig. 6.1, suggest why a low concentration of PI3K can lead to type 2 diabetes.

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## 9700 Biology Paper 4 - Homeostasis

Topical questions | 92 questions

89. Question part 2/2 | 9700 Oct-Nov 2025 P4 V2 Q6



**(b)** Describe how a biosensor can be used to measure blood glucose concentration.

[7]

[Total: 11]

90. Question | 9700 Oct-Nov 2025 P4 V3 Q9

9 (a) Fig. 9.1 shows a longitudinal section of a human kidney.

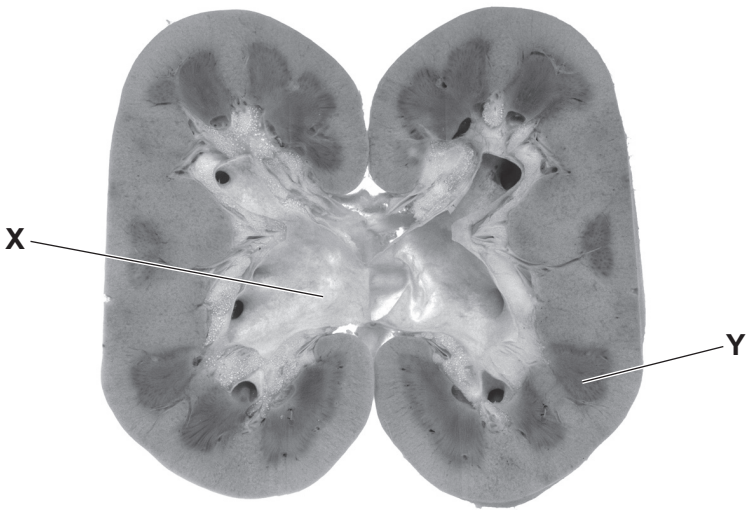


Fig. 9.1

Name the regions of the kidney labelled X and Y in Fig. 9.1.

X .....  
Y ..... [2]

(b) A biosensor can be used to measure the concentration of glucose in urine.

Outline how a biosensor measures the concentration of glucose in urine.

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

[Total: 6]

91. Question part 1/2 | 9700 Oct-Nov 2025 P4 V4 Q6

- 6 Some people can develop a condition called type 2 diabetes. In people with type 2 diabetes, glucose uptake from the blood is decreased. In some cases, the pancreas cannot make enough insulin to keep blood glucose concentration within a healthy range.

- (a) A person with type 2 diabetes and a person without type 2 diabetes were given a glucose drink. The blood glucose concentration of each person was measured at regular intervals for 120 minutes.

The results are shown in Fig. 6.1.

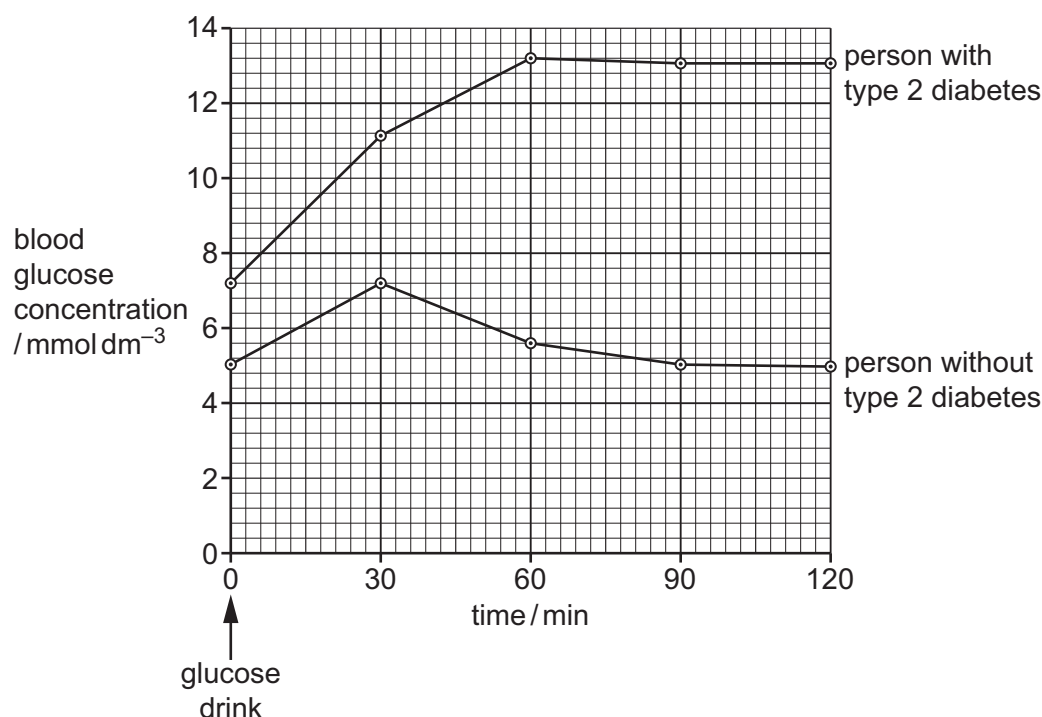


Fig. 6.1

- (i) Describe the curve for the person **without** type 2 diabetes.

.....

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..... [2]

- (ii) Calculate the percentage increase in blood glucose concentration, between 0 and 60 minutes, for the person **with** type 2 diabetes.

answer ..... [2]

Topical questions | 92 questions



..... [2]

Blank lined paper for writing.

[Total: 13]

- ABA binds to receptors in the cell surface membranes of guard cells. This triggers a series of events in the cells, which results in stomatal closure.

Fig. 8.1 is a diagram of part of a guard cell showing some of the events that occur when ABA binds to its receptor.

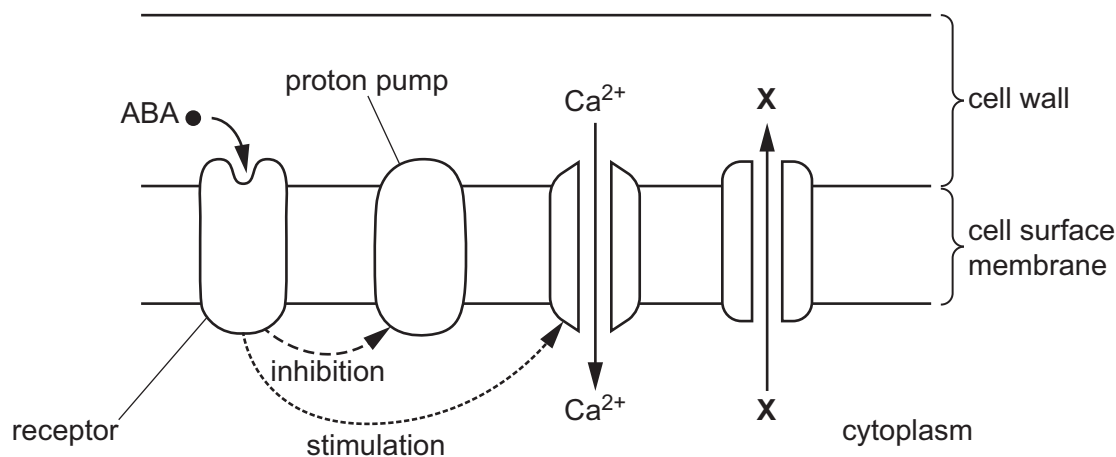


**Fig. 8.1**

Fig. 8.1 shows that calcium ions are involved in the events within a guard cell that result in stomatal closure.

Outline the role of calcium ions in the response of the guard cell to a reduced water supply **and** explain how this response results in stomatal closure.

Identify **X** in your answer.

..... [4

92. Question part 2/2 | 9700 Oct-Nov 2025 P4 V4 Q8



**(b)** Explain, using examples, why the homeostatic control involving the opening and closing of stomata is important for the efficient functioning of plants.

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..... [4]

[Total: 8]