HELICATE · A-LEVEL BIOLOGY · TOPIC BANK

3.6.4 Homeostasis is the maintenance of a stable internal environment

Topic question bank

Version 1 · 14 October 2026

Name

Date

QUESTIONS	TOTAL MARKS	TIME	YOUR SCORE
12	78	No time limit	/ 78

Contents

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Total		**78**

Instructions

- Answer the questions in the spaces provided. Show all your working.
- The marks for each question are shown in brackets. Use them to judge how much detail to give.
- Work through a subtopic at a time, then mark your answers with the matching mark scheme.

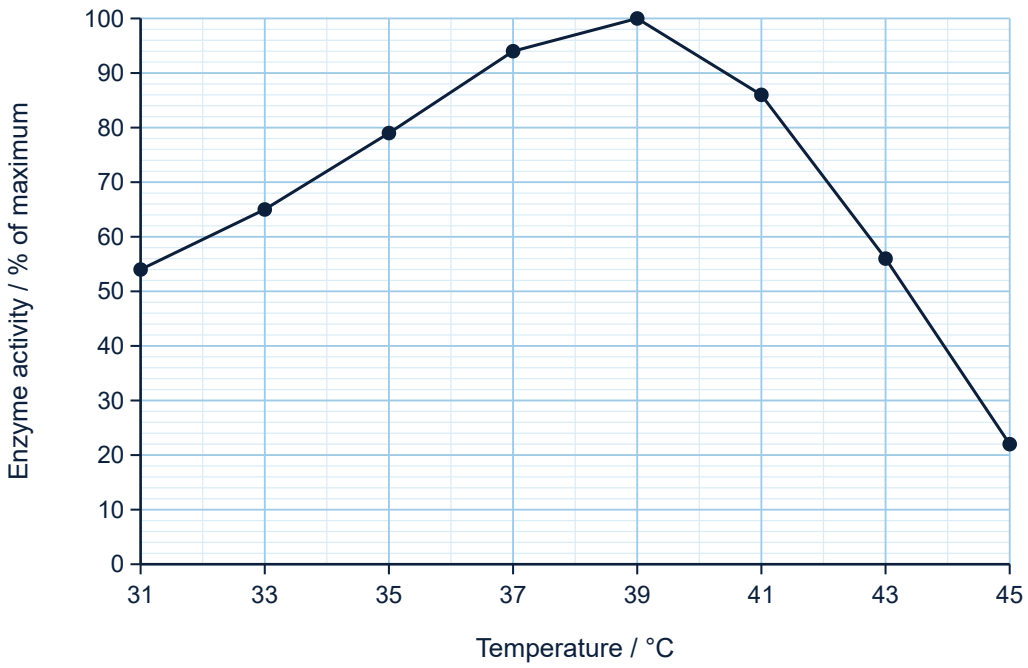
Original questions by Helicate for AQA A-level Biology (7402), specification section 3.6.4. Not affiliated with or endorsed by AQA.

Do not write outside the box

Principles of homeostasis and negative feedback 3.6.4.1

Scientists extracted an enzyme from human liver cells. They measured its activity at different temperatures, at pH 7.4. Figure 1 shows their results.

Figure 1



0 1 . 1 Which statement describes negative feedback?
Tick (✓) one box.

[1 mark]

A change from the norm is detected and the response causes a further change in the same direction. ☐

A change from the norm is detected and the response returns the system to its original level. ☐

The response to a change always involves nerve impulses rather than hormones. ☐

The internal environment is kept at exactly the same value at all times. ☐

Question 1 continues on the next page

Do not write outside the box

0 1 . 2 During a severe fever, a person's core body temperature rose from 37 °C to 43 °C.
Use Figure 1 to calculate the percentage decrease in the activity of this enzyme.

[2 marks]

Answer _____ **%**

0 1 . 3 Use Figure 1 and your knowledge of enzymes to explain why it is important to maintain a stable core body temperature.

[3 marks]

6

Turn over for the next question

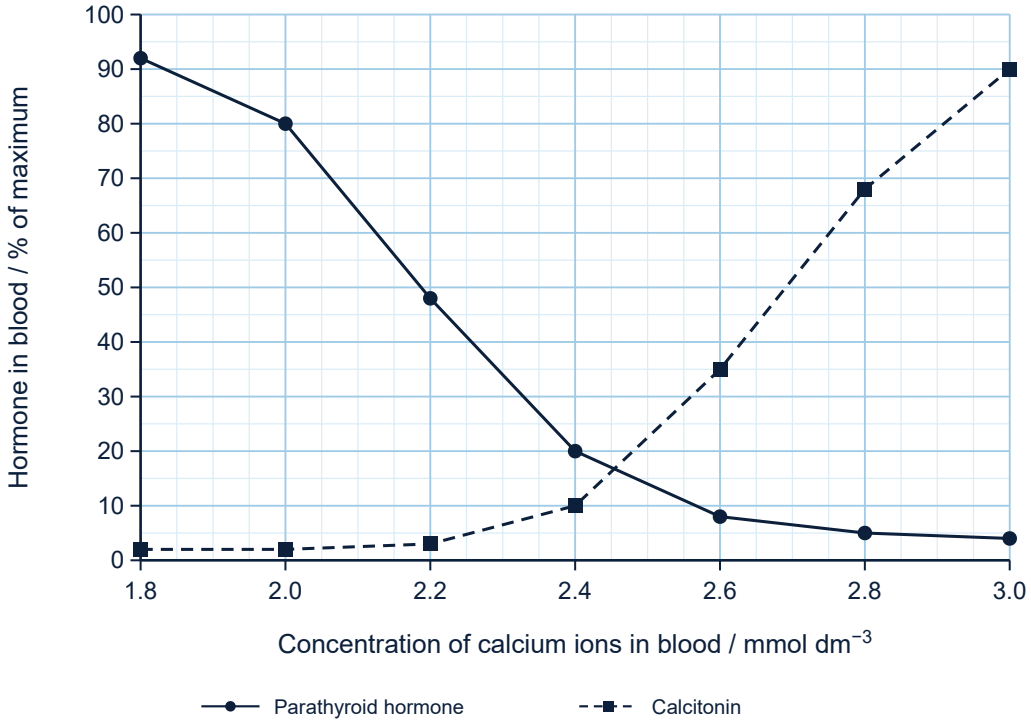
Do not write outside the box

The concentration of calcium ions in human blood is normally kept between 2.2 and 2.6 mmol dm^{-3}. Two hormones control it:

- parathyroid hormone causes the concentration of calcium ions in the blood to increase
- calcitonin causes the concentration of calcium ions in the blood to decrease.

Figure 2 shows how the concentration of each hormone in the blood changes with the concentration of calcium ions in the blood.

Figure 2



Question 2 continues on the next page

Do not write outside the box

0 2 . 1 Use Figure 2 to explain how having these two hormones gives a greater degree of control over the concentration of calcium ions in the blood than having only one of them.

[3 marks]

0 2 . 2 A person has a tumour of the cells that secrete parathyroid hormone. The tumour cells secrete parathyroid hormone at a high rate, whatever the concentration of calcium ions in the blood.
Suggest and explain the effects on the concentration of calcium ions in this person's blood and on the secretion of calcitonin.

[2 marks]

5

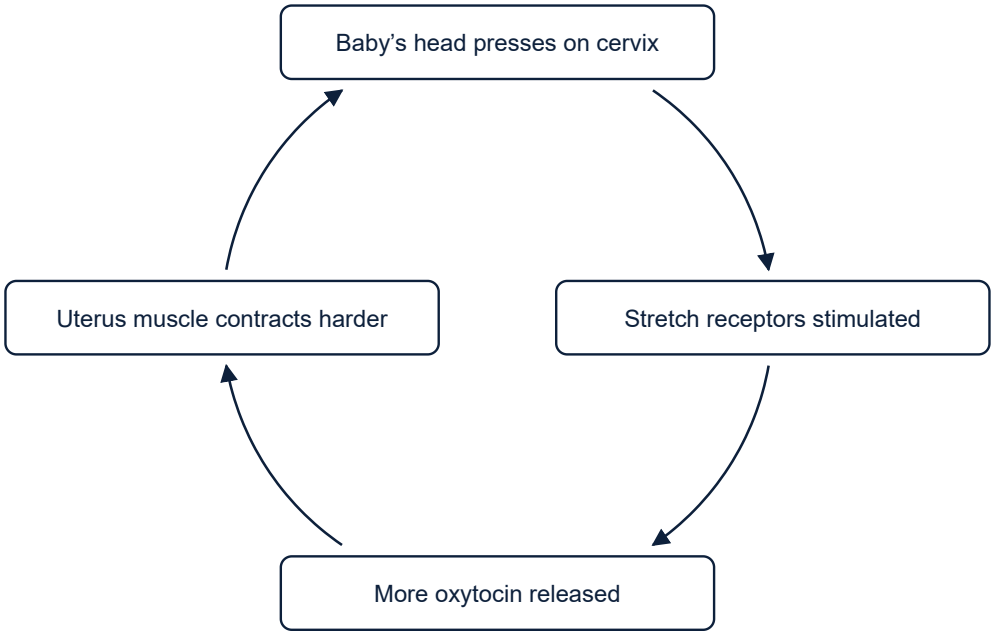
Turn over for the next question

Do not write outside the box

During the birth of a baby, the muscle in the wall of the uterus contracts. Pressure of the baby's head on the cervix stimulates stretch receptors. Nerve impulses from these receptors travel to the hypothalamus, which causes the posterior pituitary to release the hormone oxytocin. Oxytocin causes the muscle of the uterus to contract more strongly.

Figure 3 summarises this control system.

Figure 3



0 3 . 1 Explain why the control system in Figure 3 is an example of positive feedback.

[2 marks]

Question 3 continues on the next page

Do not write outside the box

0 3 . 2 Suggest what ends this positive feedback once the baby has been born.

[1 mark]

0 3 . 3 Suggest why blood glucose concentration could **not** be controlled by positive feedback. Use your knowledge of why a stable blood glucose concentration is important.

[3 marks]

6

Turn over for the next question

Do not write outside the box

Control of blood glucose concentration 3.6.4.2

The liver has a central role in controlling the concentration of glucose in the blood.

0 4 . 1 Which row correctly describes a process in the liver **and** a hormone that activates the enzymes involved in it?
Tick (✓) one box.

[1 mark]

Process	Conversion	Hormone	
Glycogenolysis	Glycogen to glucose	Insulin	☐
Gluconeogenesis	Glycogen to glucose	Glucagon	☐
Glycogenesis	Glucose to glycogen	Insulin	☐
Glycogenolysis	Glucose to glycogen	Adrenaline	☐

Question 4 continues on the next page

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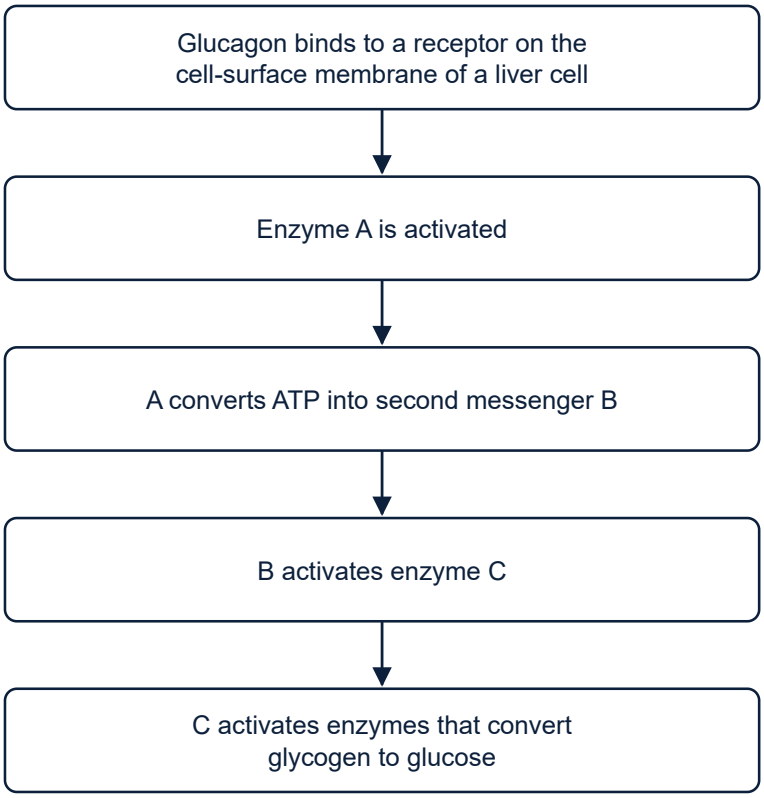
Figure 4 shows the second messenger model of glucagon action in a liver cell.

Figure 4



0 4 . 2 Name A, B and C.

[3 marks]

A .....

B .....

C .....

Question 4 continues on the next page

Do not write outside the box

0 4 . 3 In liver cells, B is broken down by an enzyme called phosphodiesterase. A drug inhibits phosphodiesterase.
Suggest and explain the effect of this drug on the blood glucose concentration of a person who has not eaten for several hours.

[3 marks]

0 4 . 4 Adrenaline also increases glycogenolysis in liver cells. Adrenaline has a different shape from glucagon.
Use Figure 4 to suggest how both hormones can cause glycogenolysis.

[2 marks]

Question 4 continues on the next page

Do not write outside the box

0 4 . 5 After a person has not eaten for 24 hours, almost all the glycogen in the liver has been used.
Explain how glucagon can still increase the concentration of glucose in the blood.

[2 marks]

11

Turn over for the next question

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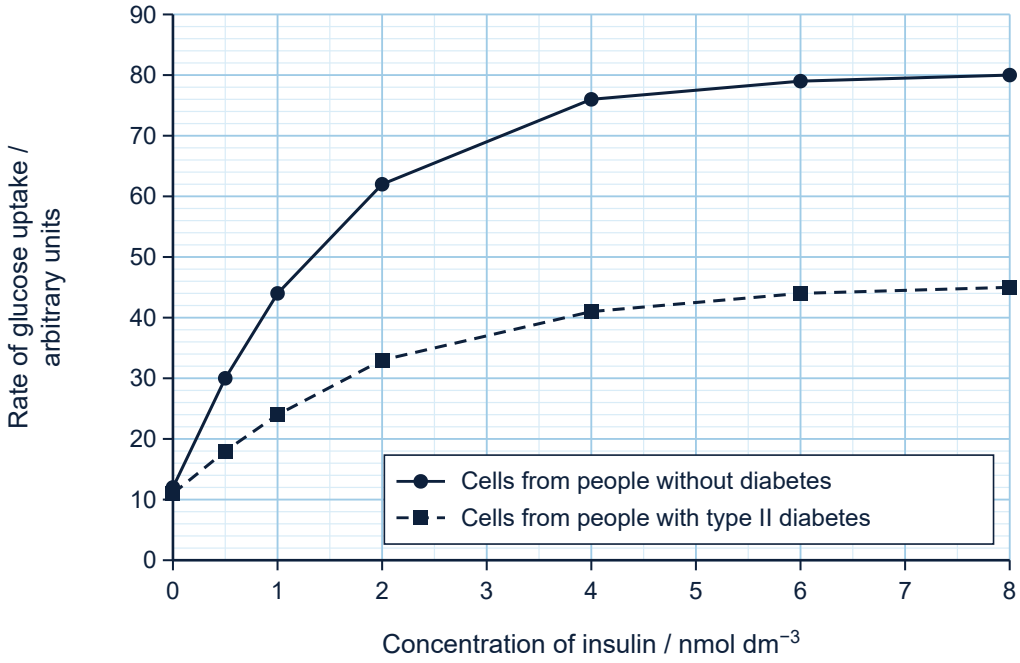
Do not write outside the box

Scientists isolated muscle cells from people without diabetes and from people with type II diabetes. They incubated samples of the cells in a glucose solution containing different concentrations of insulin. They measured the rate of glucose uptake by the cells. Figure 5 shows their results.

Figure 5



0 5 . 1 Explain the shape of the curve for cells from people without diabetes.

[3 marks]

Question 5 continues on the next page

Do not write outside the box

0 5 . 2 A scientist concluded from Figure 5 that type II diabetes is caused by cells responding less to insulin, not by a lack of insulin.
Explain how the data support this conclusion.

[2 marks]

5

Turn over for the next question

Do not write outside the box

Three people, P, Q and R, fasted overnight. Each then drank a solution containing 75 g of glucose. Their blood glucose concentration was measured every 30 minutes, and their blood insulin concentration was measured at 0 and 60 minutes. Table 1 shows the results.

Table 1

Time after glucose drink / minutes	Blood glucose concentration / mmol dm^{-3}		
	Person P	Person Q	Person R
0	4.9	11.8	7.2
30	7.8	17.5	11.9
60	6.6	20.1	14.6
90	5.6	19.6	13.8
120	5.0	18.4	12.1
Blood insulin concentration / arbitrary units			
0	40	5	95
60	310	6	420

0 6 . 1 Persons Q and R both have diabetes. One has type I diabetes and the other has type II diabetes.
Use Table 1 to identify which person has type I diabetes. Explain your answer.

[2 marks]

Question 6 continues on the next page

Do not write outside the box

0 6 . 2 Calculate the mean rate of decrease in the blood glucose concentration of person P between 30 and 120 minutes.
Give your answer in standard form.

[2 marks]

Answer ..... **mmol dm^{-3} min^{-1}**

0 6 . 3 Explain why one of persons Q and R must be treated with injections of insulin, but the other may be able to control their diabetes by manipulating the diet.

[3 marks]

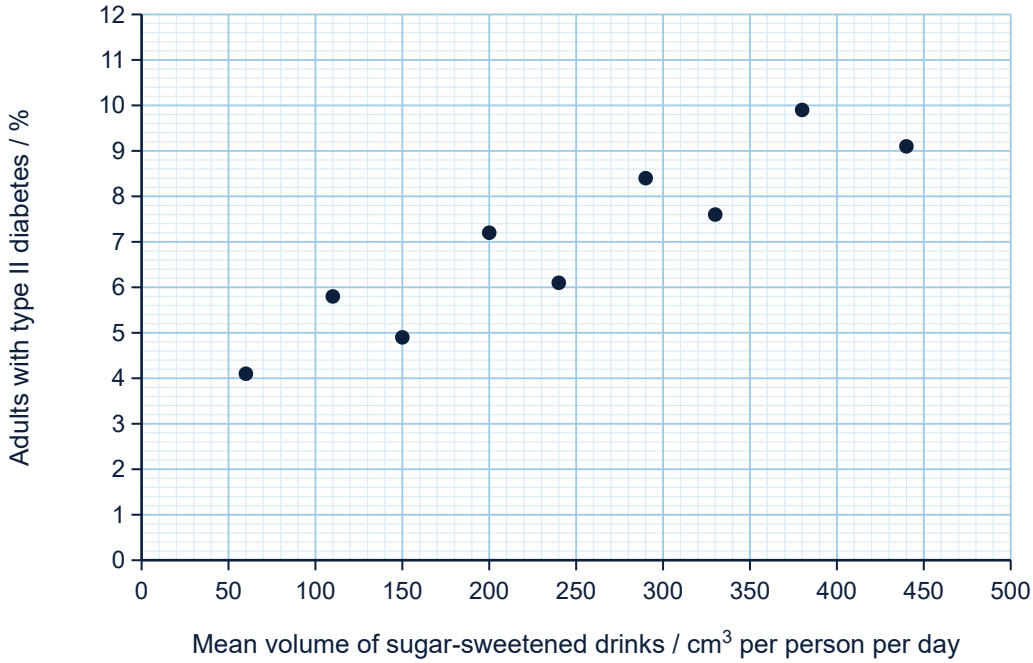
7

Turn over for the next question

Do not write outside the box

Scientists collected data from nine countries. Figure 6 shows the mean volume of sugar-sweetened drinks consumed each day and the percentage of adults with type II diabetes in each country. A statistical test showed that the correlation was significant at $P < 0.05$.

Figure 6



A health adviser said: *"Sugar-sweetened drinks are a major cause of type II diabetes. A tax on these drinks would reduce the number of people who develop it."*

A spokesperson for a drinks company said: *"These data do not prove that our drinks cause type II diabetes. People should eat less overall and take more exercise."*

Question 7 continues on the next page

Do not write outside the box

0 7 Use Figure 6 and the information given to evaluate the positions of the health adviser and the drinks company.

[5 marks]

5

Turn over for the next question

Do not write outside the box

Required practical 11: measuring glucose concentration 3.6.4.2

A student produced a calibration curve to find the concentration of glucose in an artificial 'urine' sample. She made a dilution series from a 10.0 mmol dm^{-3} glucose solution and distilled water, with a total volume of 10 cm^3 for each concentration.

She added 2 cm^3 of Benedict's reagent to 2 cm^3 of each solution and heated the tubes in a water bath at 90 °C for 5 minutes. She filtered each tube to remove the precipitate and used a colorimeter with a red filter to measure the absorbance of the remaining blue solution. The more glucose in a tube, the less blue the remaining solution.

Table 2

Concentration of glucose / mmol dm^{-3}	Volume of 10.0 mmol dm^{-3} glucose solution / cm^3	Volume of distilled water / cm^3
0	0.0	10.0
2		
4		
6		
8		
10	10.0	0.0

0 8 . 1 Complete Table 2 to show how she made 10 cm^3 of each concentration of glucose.

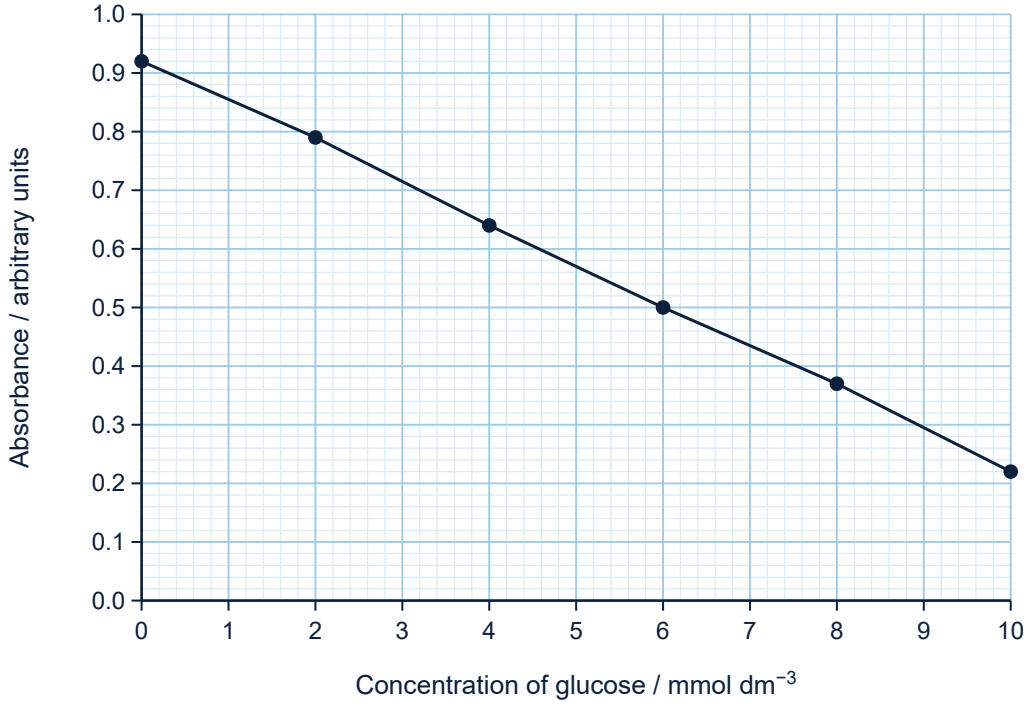
[2 marks]

Question 8 continues on the next page

Do not write outside the box

Figure 7 shows her calibration curve.

Figure 7



0 8 . 2 The undiluted urine sample gave an absorbance of 0.08. The student then mixed 1 cm^3 of the urine with 4 cm^3 of distilled water. This diluted sample gave an absorbance of 0.57.
Use Figure 7 to calculate the concentration of glucose in the undiluted urine sample.

[2 marks]

Answer ..... **mmol dm^{-3}**

Question 8 continues on the next page

Do not write outside the box

0 8 . 3 Explain why the student diluted the urine sample before using the calibration curve.

[1 mark]

.....

.....

.....

0 8 . 4 Give **two** variables, other than the volume of solution tested, that the student should keep the same when testing the diluted urine sample as when producing the calibration curve.

[2 marks]

1 .....

2 .....

0 8 . 5 Suggest **two** reasons why this method may give an inaccurate concentration of glucose for a real urine sample.

[2 marks]

1 .....

.....

2 .....

.....

9

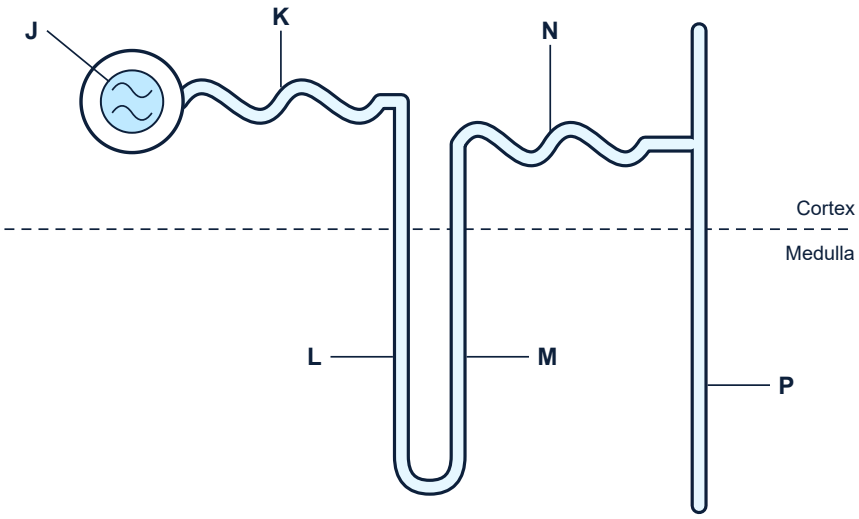
Turn over for the next question

Do not write outside the box

Control of blood water potential 3.6.4.3

Figure 8 is a simple diagram of a nephron and collecting duct.

Figure 8



0 9 . 1 Give the letter of the part where:

[2 marks]

ultrafiltration takes place .....

most glucose is reabsorbed .....

sodium ions are actively transported into the medulla .....

Question 9 continues on the next page

Do not write outside the box

Table 3 shows the concentrations of some substances in fluid at different points in a nephron.

Table 3

Substance	Concentration			
	Blood plasma entering glomerulus	**Glomerular filtrate**	**Fluid at end of proximal convoluted tubule**	**Urine**
Protein / g dm^{-3}	72	0	0	0
Glucose / mmol dm^{-3}	5.2	5.2	0	0
Urea / mmol dm^{-3}	5.0	5.0	8.6	310
Sodium ions / mmol dm^{-3}	142	142	142	105

0 9 . 2 Use Table 3 to explain why the concentration of protein falls from 72 g dm^{-3} in the blood plasma to 0 in the glomerular filtrate, but the concentrations of glucose, urea and sodium ions do not change.

[2 marks]

Question 9 continues on the next page

Do not write outside the box

0 9 . 3 The concentration of urea at the end of the proximal convoluted tubule is higher than in the glomerular filtrate. Urea is not added to the fluid in the proximal convoluted tubule.
Suggest why the concentration of urea increases.

[2 marks]

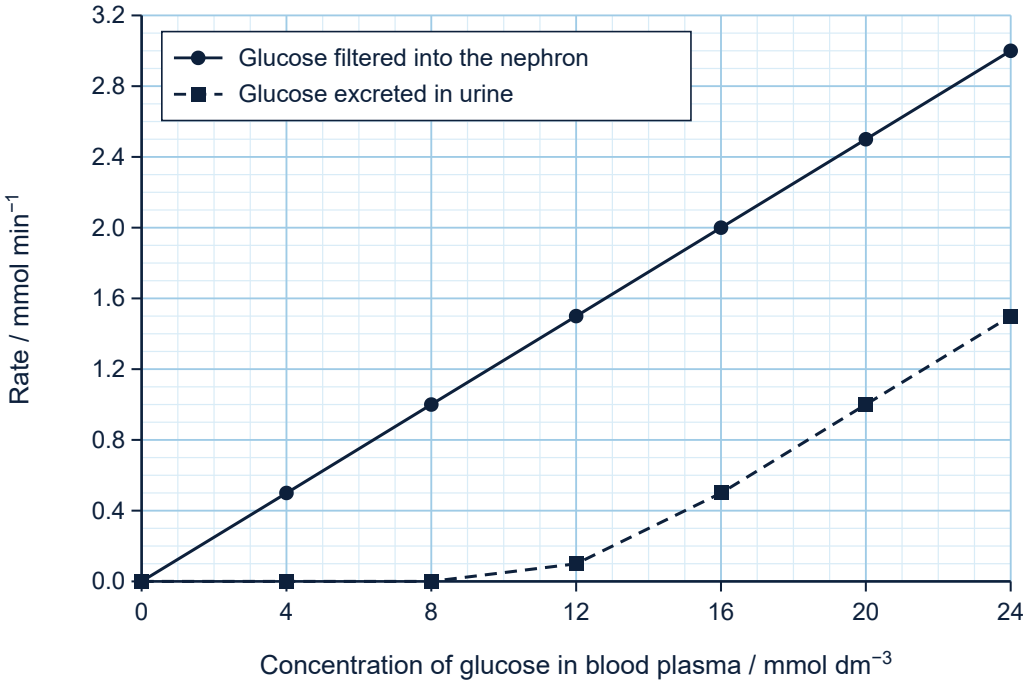
6

Turn over for the next question

Do not write outside the box

Scientists measured the rate at which glucose is filtered into the nephrons of the kidneys and the rate at which glucose is excreted in the urine, at different concentrations of glucose in the blood plasma. Figure 9 shows their results.

Figure 9



10.1 Use Figure 9 to find the rate of glucose reabsorption when the concentration of glucose in the blood plasma is 20 mmol dm^{-3}.

[1 mark]

.....

.....

Answer ..... **mmol min^{-1}**

Question 10 continues on the next page

Do not write outside the box

1 0 . 2 Explain why no glucose is excreted when the concentration of glucose in the blood plasma is below 8 mmol dm^{-3}, but glucose is excreted at higher concentrations.

[3 marks]

1 0 . 3 People with untreated diabetes often produce large volumes of urine.
Use Figure 9 to suggest why.

[2 marks]

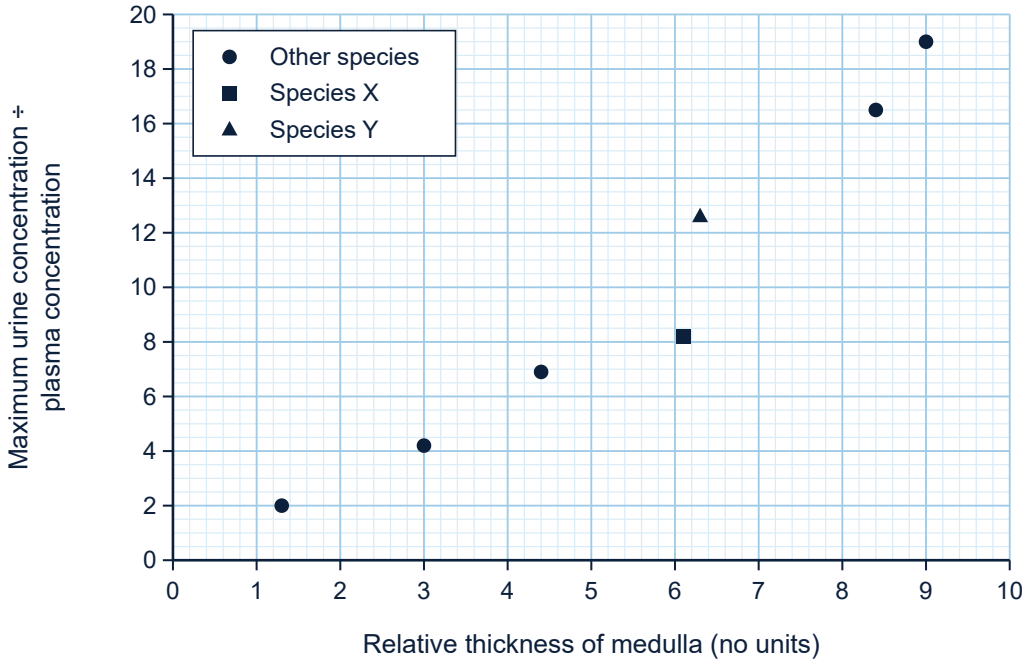
6

Turn over for the next question

Do not write outside the box

The relative thickness of the medulla is the thickness of the medulla divided by the size of the kidney. Scientists measured the relative thickness of the medulla and the maximum concentration of urine produced by seven species of mammal. Figure 10 shows their results.

Figure 10



1 1 . 1 Explain the relationship shown in Figure 10.

[4 marks]

Question 11 continues on the next page

Do not write outside the box

1 1 . 2 Species X and species Y have a similar relative thickness of medulla, but species Y produces more concentrated urine.
Suggest **two** explanations for this difference.

[2 marks]

1 .....

.....

.....

.....

2 .....

.....

.....

.....

6

Turn over for the next question

Do not write outside the box

1 2 A runner took part in a 3-hour race on a hot day. She lost 2.4 dm^3 of water in sweat but drank only 0.5 dm^3 of water.
Explain how her body responds to keep the water potential of her blood within normal limits.

[6 marks]

6

END OF QUESTIONS

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