

Past-paper walk-through

Homeostasis in mammals ■ 14.1

eXercise

Questions in this set

- 9700/41 N25 Q5 ■ 13 marks
- 9700/41 N25 Q9 ■ 6 marks
- 9700/42 N25 Q6 ■ 11 marks
- 9700/44 N25 Q6 ■ 13 marks
- 9700/41 J25 Q6 ■ 9 marks
- 9700/41 J25 Q7 ■ 10 marks

Reading the mark scheme

- **B1** a mark that stands on its own – the point is either made or not.
- **M1** a *method* mark: the right approach, even if the number is wrong.
- **A1** an *answer* mark, and it usually needs its M mark first.
- **C1** a working mark on the way to the answer.
- **//** separates answers the examiner accepts equally.
- **ecf** = error carried forward: a later part is marked on your own earlier answer.
- **owtte** = “or words to that effect” – the wording need not match.

Question 5

9700/41 N25 ■ Q5 ■ 13 marks

5 The endocrine system and the nervous system both coordinate responses in mammals.

- (a)** Complete Table 5.1 to show the features of three cell-signalling molecules of the endocrine system: antidiuretic hormone (ADH), glucagon and insulin.

Use a tick (✓) if the molecule has the feature and a cross (✗) if the molecule does **not** have the feature.

Put a tick (✓) or a cross (✗) in every box.

Table 5.1

feature	ADH	glucagon	insulin
binds to receptors on cell surface membranes			
results in molecules			

Question 5

results in molecules moving from cells into the blood			
is secreted as a result of detection by osmoreceptors			

[3]

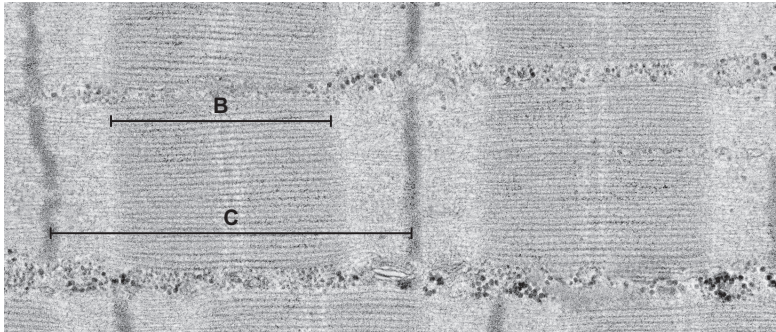
- (b) The endocrine system has a slower transmission speed than the nervous system.

Describe **other** ways in which the endocrine system and the nervous system differ.

Question 5

- (c) The endocrine system and the nervous system can affect muscle function.

Fig. 5.1 shows a transmission electron micrograph of a longitudinal section of striated muscle tissue that is in a relaxed state.



Question 5



Question 5

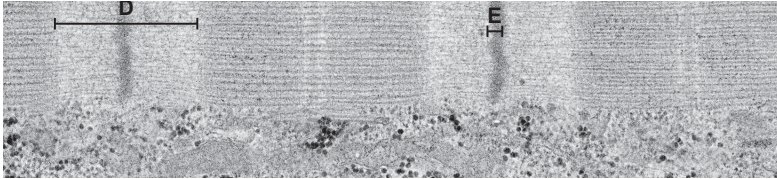


Fig. 5.1

- (i) State the letter on Fig. 5.1 that indicates the length of a sarcomere.

Question 5

- (ii) State the letter on Fig. 5.1 that indicates a region where actin and myosin overlap.

Question 5

- (iii) Describe **and** explain how the region labelled **D** on Fig. 5.1 changes during muscle contraction.

Question 5

[Total: 13]

Solution 5

(a) Mark scheme

- feature
- ADH
- glucagon
- insulin
- binds to receptors on cell surface
- membranes
-
-

Solution 5

-
- ;
- results in molecules moving from
- cells into the blood
-
-
-]
- ;
- is secreted as a result of detection by
- osmoreceptors

Solution 5

-
-]
-]
- ;
- 3

Solution 5

(b) Mark scheme

- any four from:
- 1
- impulses / action potentials / neurotransmitters, in nervous system and hormones in endocrine system ;
- 2
- electrical in nervous system and chemical in endocrine system ;
- 3
- neurones / nerve cells, in nervous system and blood in endocrine system ;

Solution 5

- 4
- effects are / target is, specific / localised, in nervous system and (can be) widespread in endocrine system ;
- 5
- effect / response, happens quickly in nervous system and slowly in endocrine system ;
- 6
- effect / response, lasts a short time in nervous system and long time in endocrine system ;
- 7
- AVP ;

Solution 5

■ 4

Solution 5

(c)(i)

Mark scheme

- C ;
- 1

Solution 5

(c)(ii)

Mark scheme

- B ;
- 1
- 9700/41
- October/November 2025

Solution 5

(c)(iii) Mark scheme

- 1
- (D / it), shortens / contracts / decreases ;
- and any three from:
- 2
- calcium ions / Ca^{2+} , bind to troponin ;
- 3
- tropomyosin, moves / shifts position / exposes binding sites on actin ;
- 4

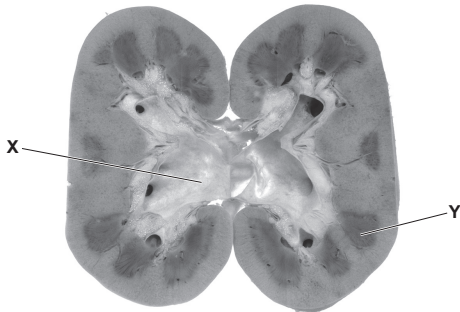
Solution 5

- myosin (head) binds to actin / myosin-actin cross-bridges form ;
- 5
- power stroke / myosin head, pulls actin ;
- 6
- more actin, enters / overlaps with, A band / B
- or
- more overlap between actin and myosin ;
- 4

Question 9

9700/41 N25 ■ Q9 ■ 6 marks

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



Question 9

Fig. 9.1

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

Question 9

Question 9

[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.

Question 9

[Total: 6]

Solution 9

(a)

Mark scheme

- (X =) (renal) pelvis ;
- (Y =) medulla ;
- 2

Solution 9

(b) Mark scheme

- any four from:
- 1
- glucose oxidase (present / immobilised, in sensor / on strip) ;
- 2
- glucose $\rightarrow$ hydrogen peroxide ;
- 3
- hydrogen peroxide (oxidised) $\rightarrow$ oxygen / electrons ;
- 4

Solution 9

- (magnitude of) e^- flow / current / voltage, (generated) is proportional to, hydrogen peroxide / glucose, concentration ;
- 5
- digital / numerical / quantitative, reading / result / value (on screen) ;
- 6
- AVP ;
- 4
- 9700/41
- October/November 2025
- 10

Solution 9

- marks from any two groups of mark points to max 6:
- 1
- mutant TYR gene codes for non-functioning tyrosinase ;
- 2
- albinism / albino, recessive (disorder / allele) ;
- 3
- lack of melanin / no melanin produced ;
- 4
- giving, pale / fair, skin / hair or giving, transparent / pink, iris ;
- 5

Solution 9

- mutant HBB gene codes for, abnormal (β) globin / haemoglobin S ;
- 6
- sickle cell, anaemia / disease, codominant (disorder / allele) ;
- 7
- less soluble / sticky / rod-forming, haemoglobin makes red blood cells sickle ;
- 8
- sickle cells, block capillaries / cause pain (in low O₂ conditions) ;
- 9
- mutant F8 gene codes for non-functional factor VIII ;
- 10

Solution 9

- haemophilia, recessive / sex -linked / on X chromosome ;
- 11
- fibrinogen not changed to fibrin ;
- 12
- blood clotting problem / risk of excessive bleeding ;
- 13
- mutant HTT gene codes for abnormal huntingtin protein ;
- 14
- Huntington's disease dominant (disorder / allele) ;
- 15

Solution 9

- ref. to additional / number of, CAG repeats ;
- 16
- cognitive / movement, difficulty ;
- other human genetic conditions (max 2 conditions with 4 possible marks each)
- 17
- mutant named gene codes for abnormal named protein ; ;
- 18
- type of allele that causes named condition ; ;
- 19
- biochemical detail re. gene / protein / molecule ; ;

Solution 9

- 20
- physiological effect ; ;
- 6

Question 6

9700/42 N25 ■ Q6 ■ 11 marks

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

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

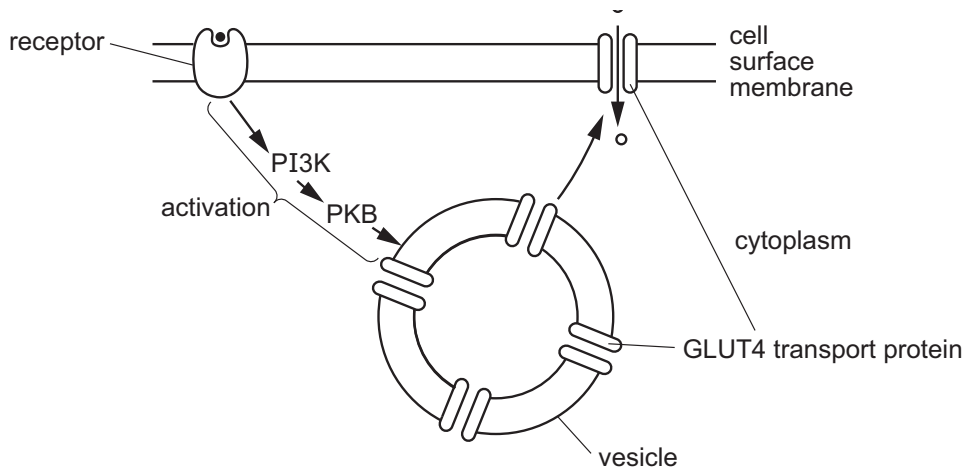
Fig. 6.1

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. [4]

(b) Describe how a biosensor can be used to measure blood glucose concentration. [7]

Question 6



Solution 6

(a)

Mark scheme

any four from :

- 1 less / no, PKB, activated / stimulated ;
- 2 fewer / no, vesicles, move to / fuse with, cell surface membrane ;
- 3 fewer / no, GLUT4 (transport proteins) added to (cell surface) membrane **or** (cell surface) membrane, less / not, permeable to glucose ;
- 4 less / no, glucose taken up by facilitated diffusion (into muscle cells) ;
- 5 blood glucose concentration, (remains) high(er) / does not decrease ;

Solution 6

(b) Mark scheme

any seven from :

- 1 (biosensor has) glucose oxidase (immobilised on recognition layer) ;
- 2 blood sample added ;
- 3 glucose (in blood) passes through, partially / selectively, permeable membrane ;
- 4 glucose oxidase, oxidises glucose / converts glucose / catalyses glucose reaction ;
- 5 gluconic acid and hydrogen peroxide formed ;
- 6 reaction converted to a current (by transducer) ;
- 7 current is amplified ;
- 8 digital / numerical / quantitative, reading ;
- 9 size of current is proportional to glucose concentration ;
- 10 instant result / accurate ;

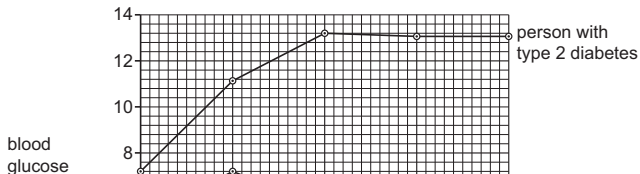
Question 6

9700/44 N25 ■ Q6 ■ 13 marks

- 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.



Question 6

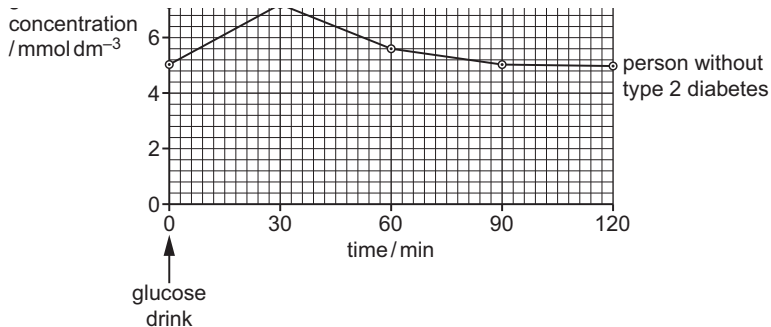


Fig. 6.1

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

Question 6

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

Question 6

- (iii) Suggest ways in which people with type 2 diabetes can help to control their condition.

Question 6

(b) Glucagon has a role in the control of blood glucose concentration.

Describe the cell signalling pathway involving glucagon, and describe how this pathway leads to a change in the blood glucose concentration.

Question 6

[Total: 13]

Solution 6

(a)(i)

Mark scheme

- 1
- blood glucose concentration increases until 30 minutes ;
- 2
- decreases to original value / returns to 5 mmol dm^{-3} , by 90 minutes ;
- 2

Solution 6

(a)(ii)

Mark scheme

- 83.3 ; ;
- 2

Solution 6

(a)(iii) Mark scheme

- any two from:
 - 1
 - reduce intake of (named) carbohydrate ;
 - 2
 - physical exercise ;
 - 3
 - inject insulin ;
 - 4

Solution 6

- AVP ;
- 2
- 9700/44
- October/November 2025

Solution 6

(b) Mark scheme

- any seven from :
- 1
- glucagon is, cell-signalling molecule / ligand / first messenger ;
- 2
- binds to receptor on liver cell (surface) membrane ;
- 3
- G-protein activated ;
- 4

Solution 6

- aden(yl)yl cyclase activated / formation of cAMP ;
- 5
- ref. to second messenger ;
- 6
- enzyme cascade / signal amplified ;
- 7
- glycogenolysis / glycogen hydrolysed to glucose ;
- 8
- gluconeogenesis / amino acids $\rightarrow$ glucose / triglycerides $\rightarrow$ glucose ;
- 9

Solution 6

- glucose released into blood ;
- 10 AVP ;
- 7

Question 6

9700/41 J25 ■ Q6 ■ 9 marks

- 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
P	amino acids, glucose and water	from nephron to blood
Q	water	from nephron to blood in the presence of antidiuretic hormone (ADH)
R	water and molecules with a molecular mass of less than 68,000	from blood to nephron

Question 6

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

Question 6

Question 6

Question 6

[3]

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

Question 6

Question 6

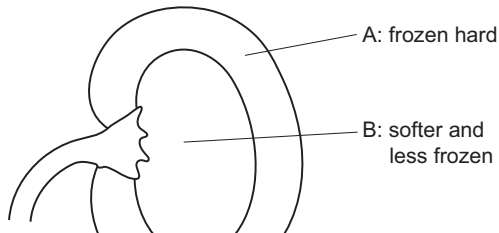
Question 6

[3]

- (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.



Question 6

\ \ / /

Question 6



Fig. 6.1

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

Question 6

[Total: 8]

Solution 6

(a)(i)

Mark scheme

- P: selective reabsorption ;
- Q: osmoregulation ;
- R: ultrafiltration ;
- 3

Solution 6

(a)(ii)

Mark scheme

- P: proximal convoluted tubule ;
- Q: collecting duct / distal convoluted tubule ;
- R: Bowman's capsule ;
- 3

Solution 6

(b) Mark scheme

- 1
- B / interstitial fluid / tissue fluid / medulla, has more, salt / sodium chloride / Na^+ / Cl^- ;
- plus one from:
- 2
- salt gradient helps reabsorb water from collecting duct ;
- 3
- AVP ;

Solution 6

■ 2

Question 7

9700/41 J25 ■ Q7 ■ 10 marks

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.

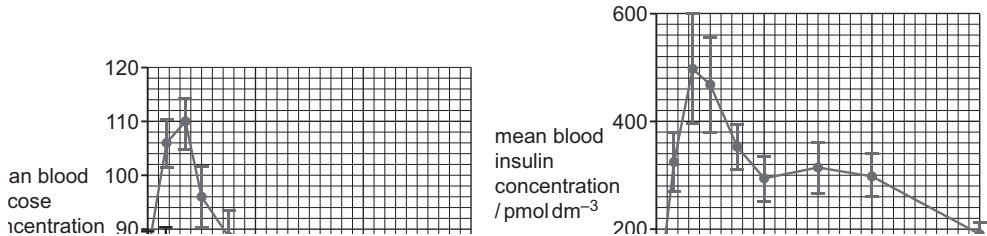
Question 7

- (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.



Question 7

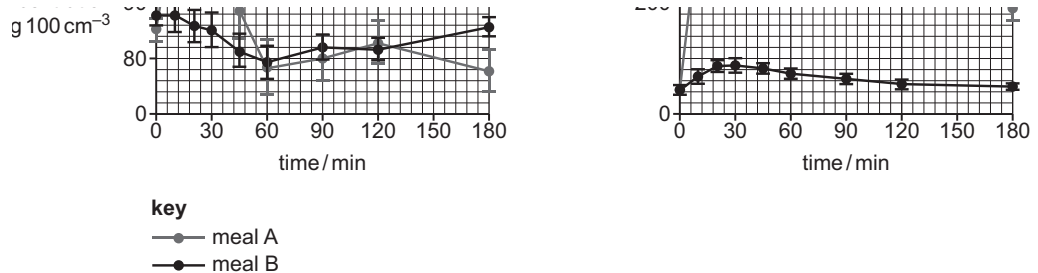


Fig. 7.1

- (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.

Question 7

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

Question 7

[Total: 11]

Solution 7

(a) Mark scheme

- any four from:
- 1
- insulin / it, is a hormone ;
- 2
- (described) stimulus causes insulin to be secreted from (named) endocrine, gland / tissue / cells ;
- 3
- insulin travels in blood ;

Solution 7

- 4
- binds to receptors on (named) target cells ;
- 5
- to cause (described) response ;
- 6
- AVP ;
- 4

Solution 7

(b)(i) Mark scheme

- any four from:
- 1
- at 21 min, blood glucose concentration / it, rises to $110 \text{ mg } 100 \text{ cm}^{-3}$;
- 2
- (high / increase in, blood glucose concentration) detected by pancreas / causes response in pancreas ;
- 3
- insulin rises to 500 pmol dm^{-3} ;

Solution 7

- 4
- (insulin) increase GLUT proteins in membrane / increases glucose uptake into cells / increases cell permeability to
- glucose
- or
- (insulin) increases rate of respiration of glucose ;
- 5
- (insulin) causes / stimulates, glycogenesis / lipogenesis ;
- 6
- (mean) blood glucose concentration / it, falls, to normal / within normal range / below starting point / to set point ;

Solution 7

- 4
- 9700/41
- May/June 2025

Solution 7

(b)(ii) Mark scheme

- any three from:
- 1
- blood glucose concentration falls as glucose is respired ;
- 2
- blood glucose concentration falls below, set point / normal ;
- 3
- insulin, secretion / release, stops ;
- 4

Solution 7

- glucagon (secreted / released / rises) ;
- 5
- glycogen, (in cells) converted to glucose
- or
- glycogenolysis ;
- 6
- (stored) protein / fat, converted to glucose
- or
- gluconeogenesis
- or

Solution 7

- (stored) protein / fat, used for respiration ;
- 3
- 8
- any six from:
 - 1
 - gibberellin binds to (gibberellin) receptor (-enzyme-complex) ;
 - 2
 - DELLA (protein) destroyed ;
 - 3
 - transcription factor / PIF, released / free / no longer bound to DELLA ;

Solution 7

- 4
- transcription factor / PIF / RNA polymerase, binds to, DNA / promoter ;
- 5
- growth / expansion / XET / xyloglucan endotransglucosylase, gene, switched on / expressed / transcribed ;
- 6
- loosens cell walls / breaks bonds between cellulose ;
- 7
- water enters (cells) by osmosis causing cell elongation ;
- 8

Solution 7

- AVP ;
- 6
- 9700/41
- May/June 2025