AQA A-LEVEL · 7402

BIOLOGY



EXAM QUESTION PACK

3.6.4.1 PRINCIPLES AND NEGATIVE FEEDBACK

SCORE	PERCENTAGE
/103	%

STEMUP

These questions belong to AQA, not to us.

The examination questions, mark schemes and examiner reports in this pack were written and published by AQA. They are past assessment materials, reproduced here so that students can revise from them.

What we do not own

STEMUP is not affiliated with AQA and does not own, and makes no claim to own, any of the question, mark scheme or examiner report material in this pack. AQA has not endorsed, approved or been involved in the production of it. AQA and the qualification titles used here belong to their respective owners and appear for identification only.

Where to find the originals

AQA publishes its past papers, mark schemes and examiner reports free of charge. Always check the current specification at aqa.org.uk before you revise, because content and wording can change between series.

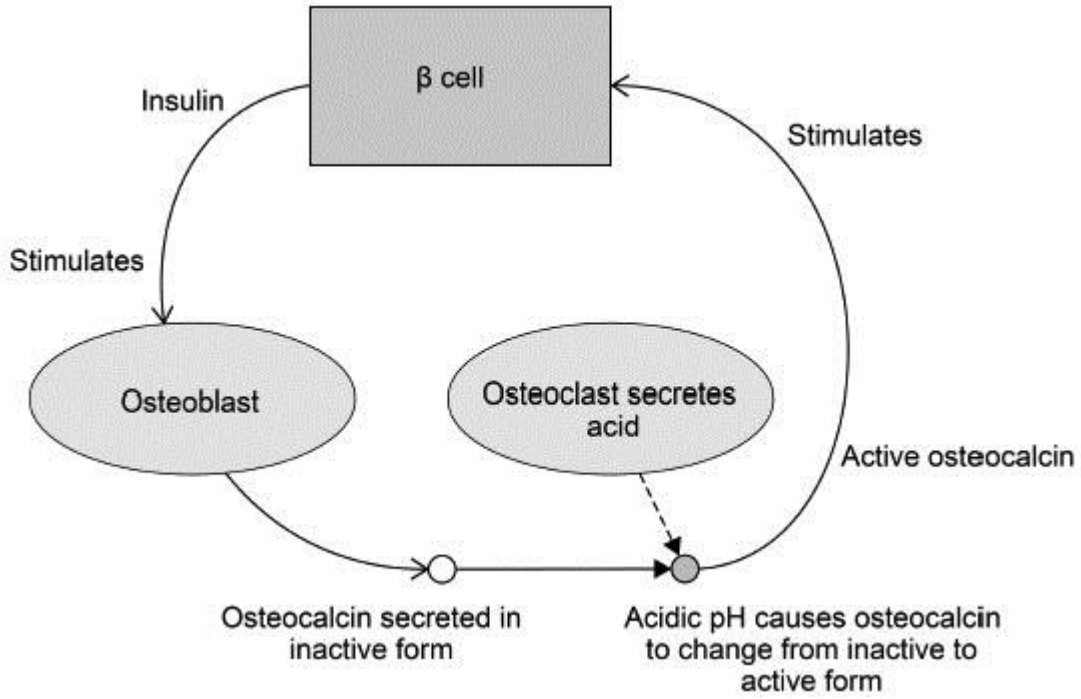
If you hold the rights to any material in this pack and would like it amended or removed, contact admin@stemup.co.uk and we will act on it.

Q1.

Broken bones are repaired by cells called osteoclasts and osteoblasts.

Osteoblasts secrete a hormone called osteocalcin in an inactive form. Osteocalcin is a protein. The active form of osteocalcin binds to a receptor on beta (β) cells in the pancreas, stimulating them to release insulin. Osteoblasts have receptors for insulin.

The diagram shows how the production of osteocalcin by osteoblasts is controlled by positive feedback.



(a) The secretion of osteocalcin (in an inactive form) by osteoblasts is controlled by positive feedback.

Use information from the diagram to explain why this is positive feedback.

_____

_____

_____

_____

_____

_____

_____

_____

_____

(2)

(b) The acidic pH conditions created by osteoclasts cause the inactive form of the protein osteocalcin to change into the active form of osteocalcin.

Suggest how.

(2)

(c) Binding of insulin leads to an increase in the rate of respiration in cells such as osteoblasts.

Explain how.

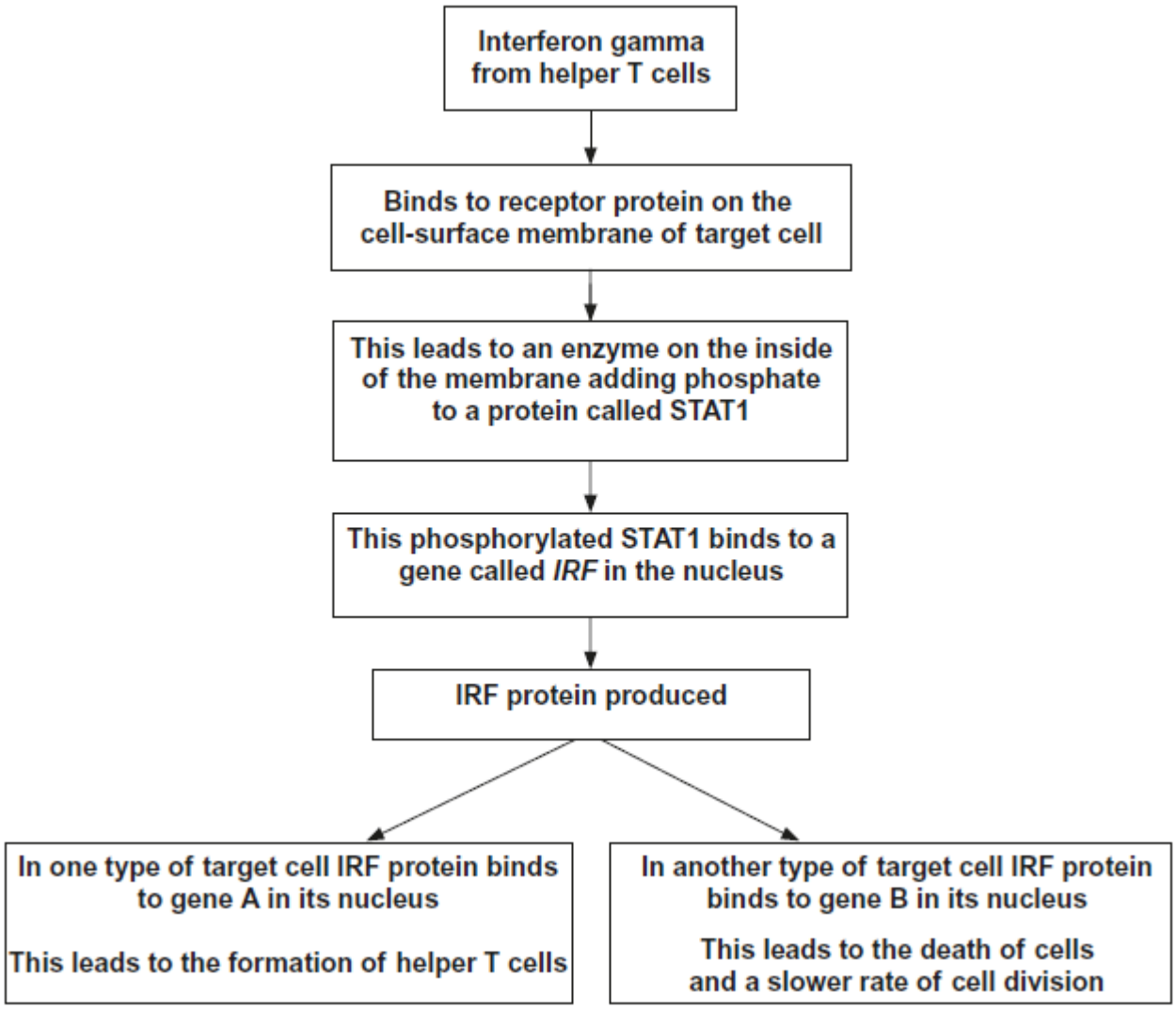
(2)

(Total 6 marks)

Q2.

Interferon gamma is a substance secreted by some types of white blood cells, including helper T cells. It regulates the production of a number of proteins by target cells. Which protein is produced depends on the type of target cell.

The diagram shows how interferon gamma regulates three genes.



(a) Use information in the diagram to suggest how the binding of interferon gamma to its receptor protein leads to the production of phosphorylated STAT1.

_____

_____

_____

_____

(2)

(b) Name the **two** transcription factors in the diagram.

1. _____

2. _____

(2)

(c) The regulation of the formation of helper T cells by interferon gamma is an example of positive feedback.

Explain why it is an example of positive feedback.

_____

_____

_____

_____

(2)

(d) The *IRF* gene can be a tumour suppressor gene.

Use the information in the diagram to explain how the *IRF* gene acts as a tumour suppressor gene.

_____

_____

_____

_____

_____

_____

(3)

(Total 9 marks)

Q3.

Scientists investigated the control of blood glucose concentration in mice. They kept a group of normal mice without food for 48 hours. After 48 hours, the blood glucose concentrations of the mice were the same as at the start of the experiment.

(a) Explain how the normal mice prevented their blood glucose concentration falling when they had **not** eaten for 48 hours.

_____

_____

_____

_____

_____

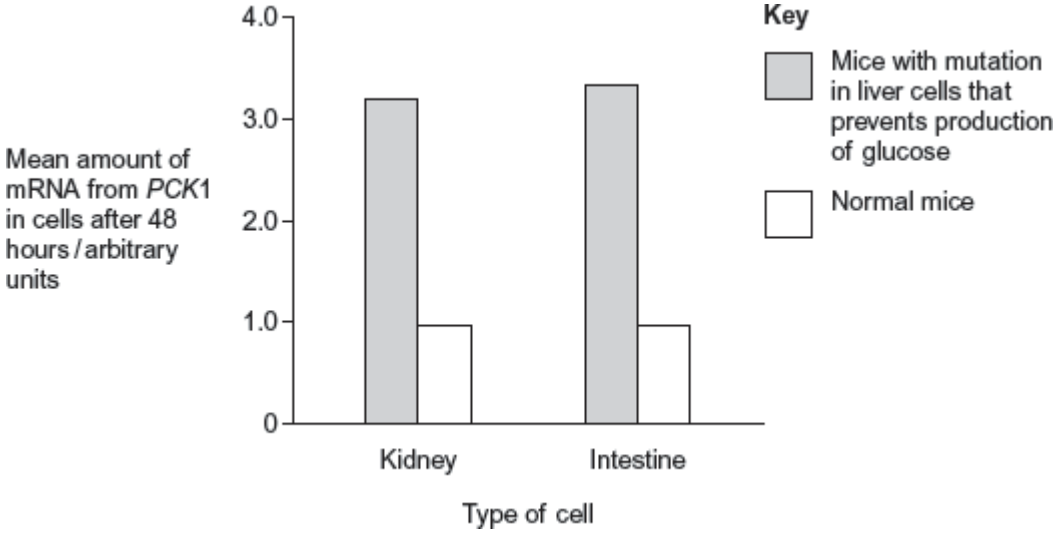
_____

(3)

The scientists then investigated mice with a mutation that prevents their liver cells making glucose. They kept a group of these mice without food for 48 hours. After 48 hours, the mean blood glucose concentrations of the mutant mice and the normal mice were the same.

The scientists investigated how blood glucose concentration is controlled in these mutant mice. An enzyme required for synthesis of glucose is coded for by a gene called *PCK*1. The scientists measured the mean amount of mRNA produced from this gene in cells from the kidneys and intestines of normal mice and mutant mice. They did this with mice that had previously been without food for 48 hours.

The scientists' results are shown in the graph.



(b) Use information from the graph to suggest how blood glucose concentration is controlled in the mutant mice, compared with the normal mice.

_____

_____

_____

_____

_____

_____

(3)

(c) The scientists performed statistical tests on the data shown in the graph, to see whether the differences in the amount of mRNA in cells from normal and mutant mice were significant. Both the probability values they obtained were $p<0.01$.

Explain what this means about the differences in the amounts of mRNA produced.

_____

_____

_____

_____

_____

(2)

(Total 8 marks)

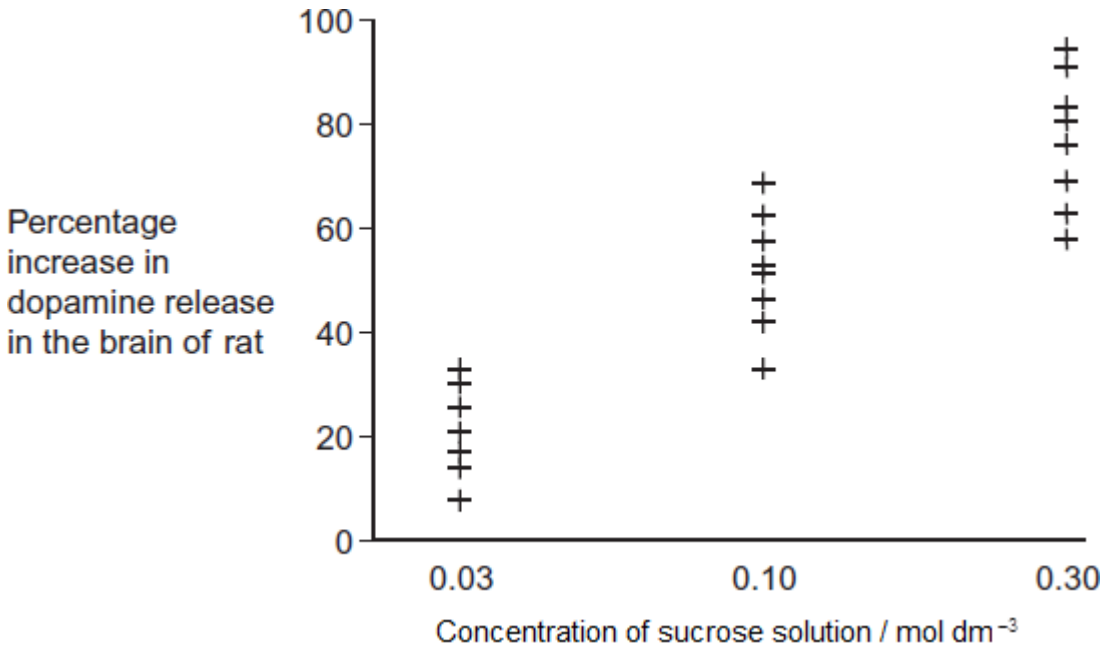
Q4.

The release of a substance called dopamine in some areas of the brain increases the desire to eat.

Scientists measured increases in the release of dopamine in the brains of rats given different concentrations of sucrose solution to drink.

Sucrose stimulates taste receptors on the tongue.

The graph shows their results. Each point is the result for one rat.



(a) The scientists concluded that drinking a sucrose solution had a positive feedback effect on the rats' desire to eat.

How do these data support this conclusion?

_____

_____

_____

_____

_____

_____

(3)

(b) In this investigation, the higher the concentration of sucrose in a rat's mouth, the higher the frequency of nerve impulses from each taste receptor to the brain.

If rats are given very high concentrations of sucrose solution to drink, the refractory period makes it impossible for information about the differences in concentration to reach the brain. Explain why.

_____

_____

_____

_____

_____

(2)

(c) In humans, when the stomach starts to become full of food, receptors in the wall of the stomach are stimulated. This leads to negative feedback on the desire to eat. Suggest why this negative feedback is important.

_____

_____

_____

_____

_____

(3)

(Total 8 marks)

Q5.

Different substances are involved in coordinating responses in animals.

(a) Synapses are unidirectional. Explain how acetylcholine contributes to a synapse being unidirectional.

_____

_____

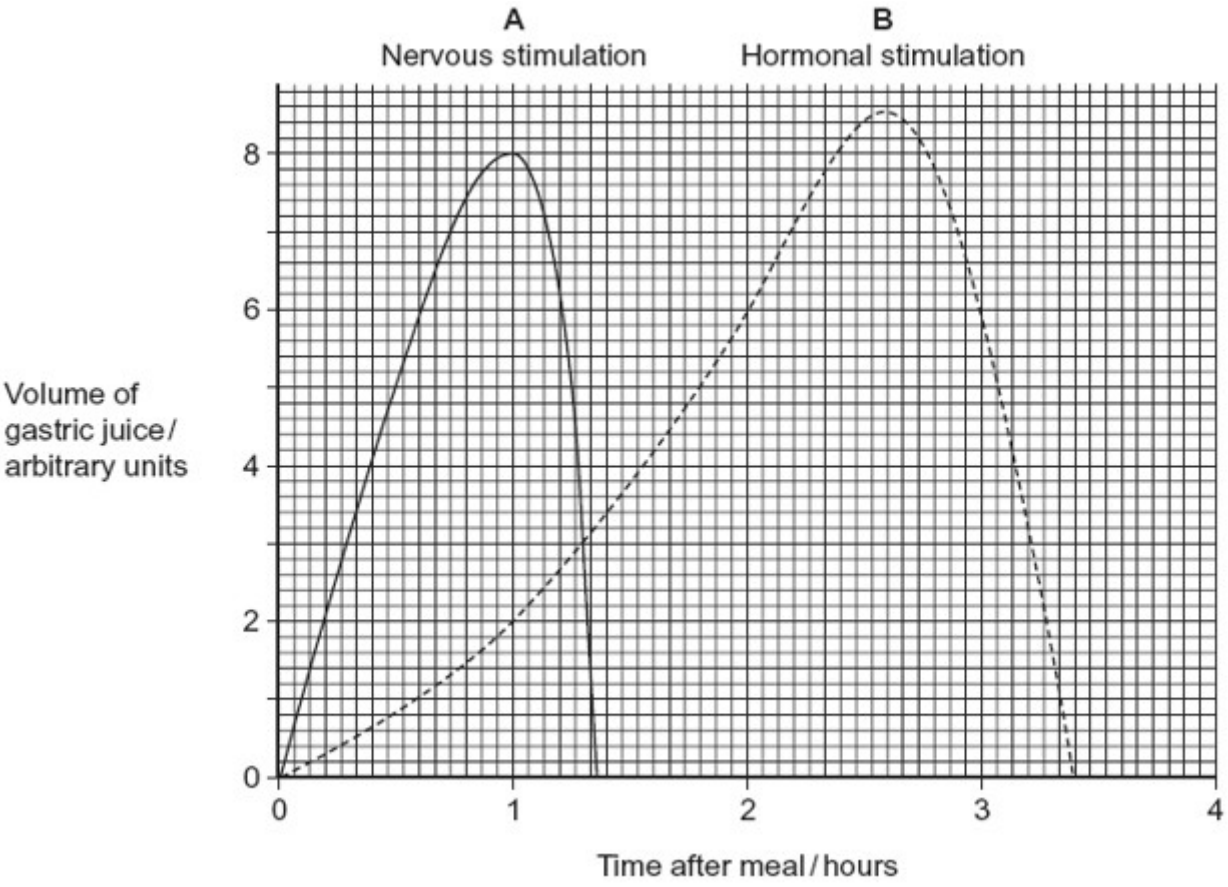
_____

_____

_____

(2)

(b) Cells in the stomach wall release gastric juice after a meal. The graph shows how the volumes of gastric juice produced by nervous stimulation and by hormonal stimulation change after a meal.



(i) Describe the evidence from the graph that curve **A** represents the volume of gastric juice produced by nervous stimulation.

_____

_____

_____

_____

(2)

(ii) Complete the table to show the percentage of gastric juice produced by nervous stimulation at the times shown.

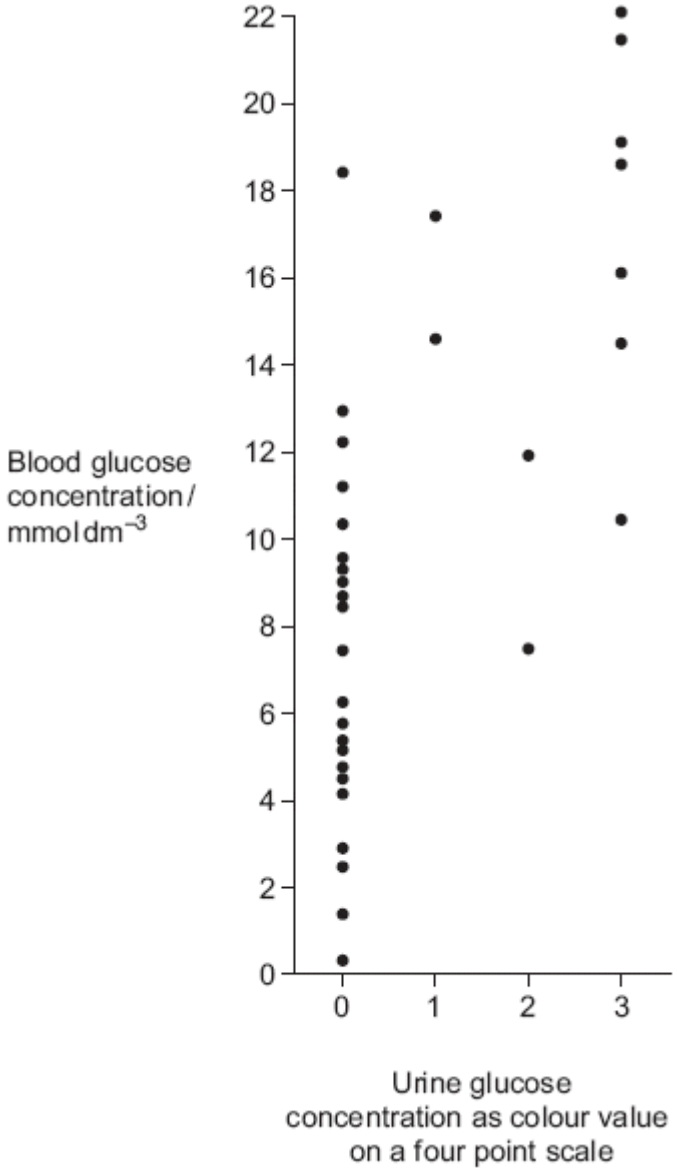
	Time after meal / hours		
	1	**2**	**3**
Percentage of gastric juice produced by nervous stimulation			

(1)

(Total 5 marks)

Q6.

(a) Technicians in a hospital laboratory tested urine and blood samples from a girl with diabetes at intervals over a one-year period. Each time the technicians tested her urine, they also measured her blood glucose concentration. Their results are shown in the graph.



(i) The girl who took part in this investigation was being successfully treated with insulin. The graph shows that on some occasions, the concentration of glucose in her blood was very high. Suggest why.

_____

_____

_____

_____

(2)

(ii) Use the graph to evaluate the use of the urine test as a measure of blood glucose concentration.

_____

_____

_____

_____

_____

_____

(3)

(b) Diabetic people who do not control their blood glucose concentration may become unconscious and go into a coma. A doctor may inject a diabetic person who is in a coma with glucagon. Explain how the glucagon would affect the person's blood glucose concentration.

_____

_____

_____

_____

(2)

(Total 7 marks)

Q7.

(a) The control of water balance in the body involves negative feedback.

(i) Describe what is meant by *negative feedback*.

_____

_____

_____

(1)

(ii) Water is removed from the body via the kidneys. Give **two** other ways in which water is removed from the body.

1. _____

2. _____

(2)

(iii) Name the part of the brain which acts as the coordinator in the control of water balance.

_____

(1)

(b) **Figure 1** shows the cells lining the collecting duct in a human kidney. ADH molecules bind to the receptor proteins and this triggers the vesicles containing

aquaporins to bind with the plasma membrane next to the lumen. **Figure 2** shows an aquaporin which is a large channel protein.

Figure 1

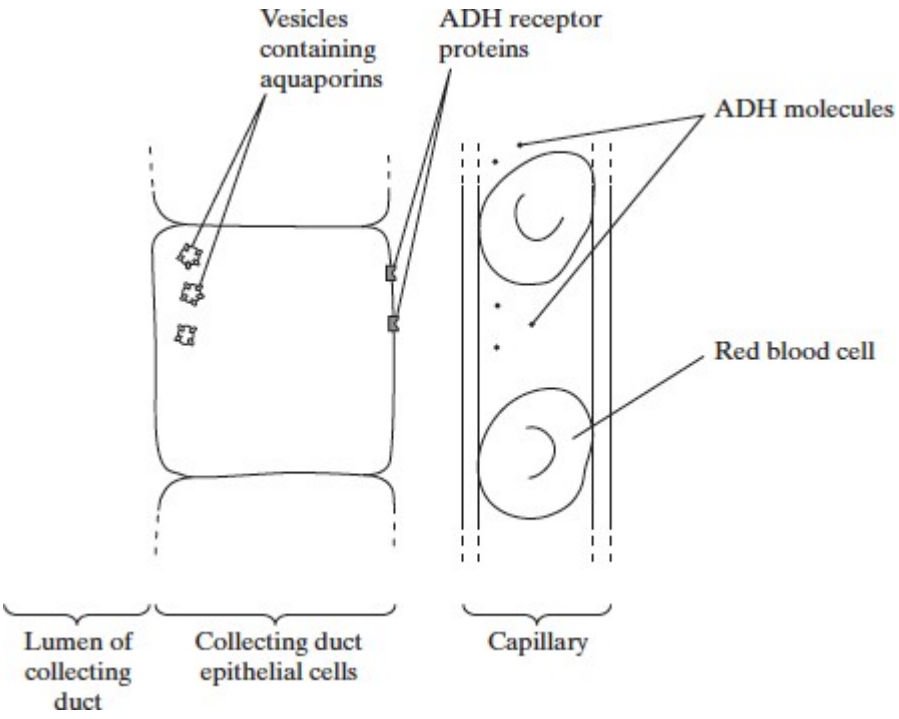
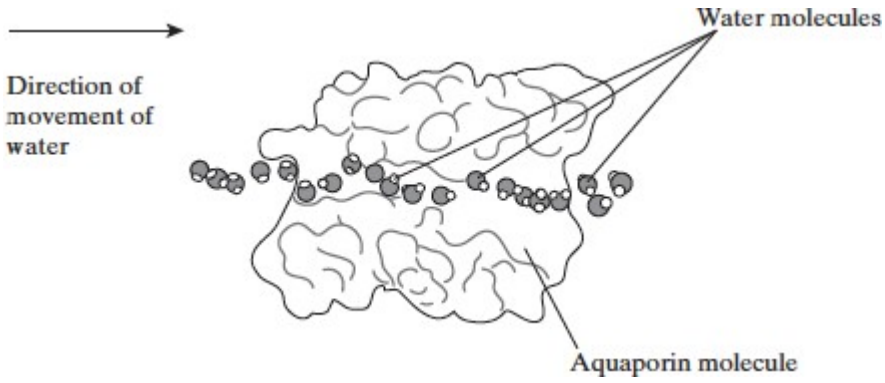


Figure 2



(i) From which gland is ADH released?

_____

(1)

(ii) Use the information given to explain how ADH increases the movement of water from the lumen of the collecting duct into the blood.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(c) The gene for the ADH receptor proteins is found on the X chromosome. One allele of this gene causes a non-functioning receptor protein to be made. This allele is recessive and is one cause of the condition called diabetes insipidus.

(i) What would be the most obvious symptom of diabetes insipidus?

_____

(1)

(ii) Suggest why diabetes insipidus is more common in males.

_____

_____

_____

_____

(2)

(iii) A recessive allele which has harmful effects is able to reach a higher frequency in a population than a harmful dominant allele. Explain how.

_____

_____

_____

_____

_____

_____

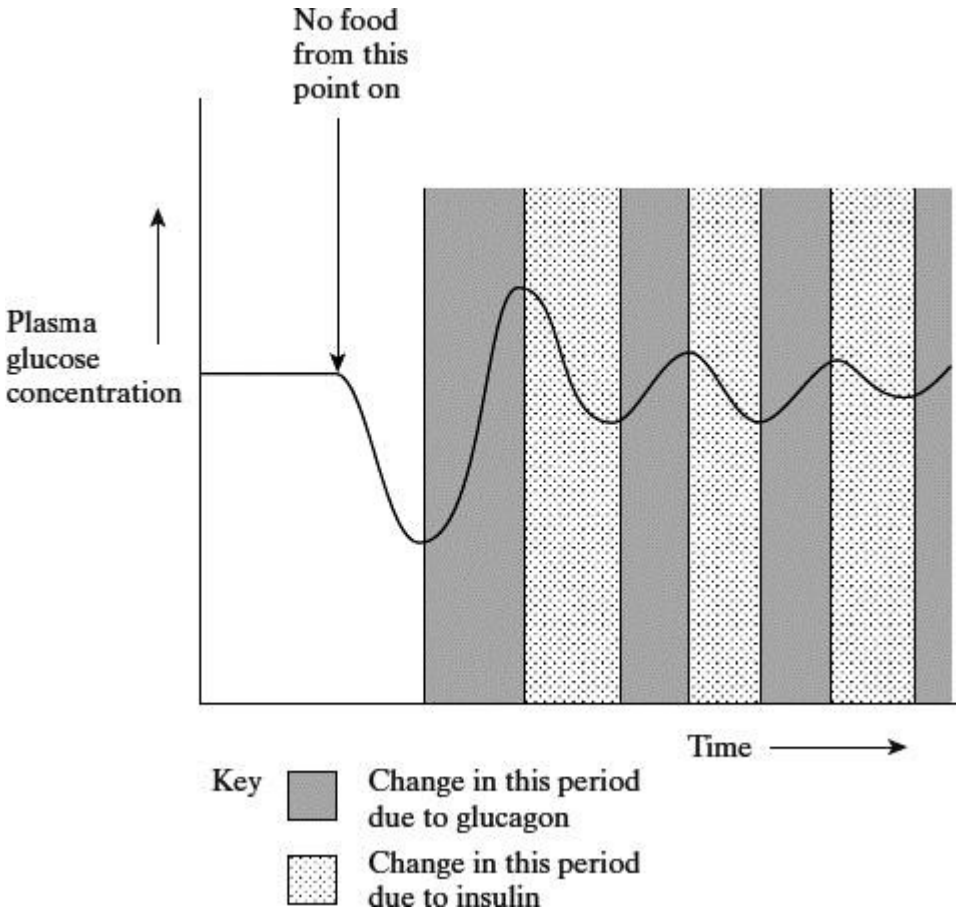
(3)

(Total 15 marks)

Q8.

Homeostatic mechanisms maintain a constant environment in the body.

(a) The graph shows changes in plasma glucose concentration that occurred in a person who went without food for some time.



Use evidence from the graph to explain the role of negative feedback in the control of plasma glucose concentration.

(5)

(b) How does maintaining a constant body temperature allow metabolic reactions in cells to proceed with maximum efficiency?

(5)

(Total 10 marks)

Q9.

(a) What is homeostasis?

(1)

(b) Describe the role of the hormone glucagon in the control of blood sugar concentration.

(4)

(c) The kidney removes various substances from the blood plasma. The clearance value for a substance is the volume of blood cleared of that substance by the kidney in one minute. This clearance value can be calculated using the equation.

$$C = \frac{U \times V}{P}$$

where the concentration of a substance in the blood is P g cm^{-3}
the concentration of a substance in the urine is U g cm^{-3}
the volume of urine produced is

V cm^3 per minute

(i) Use the equation to work out the clearance value of glucose.

_____

_____

(1)

(ii) Explain how the activity of the kidney results in this clearance value for glucose.

_____

_____

_____

_____

_____

_____

(3)

(Total 9 marks)

Q10.

(a) (i) What is meant by homeostasis?

_____

_____

(1)

(ii) Giving **one** example, explain why homeostasis is important in mammals.

_____

_____

_____

_____

(2)

(b) Cross-channel swimmers may suffer from muscle fatigue during which the contraction mechanism is disrupted. One factor thought to contribute to muscle fatigue is a decrease in the availability of calcium ions within muscle fibres. Explain how a decrease in the availability of calcium ions could disrupt the contraction mechanism in muscles.

_____

_____

_____

_____

_____

_____

(3)

(Total 6 marks)

Q11.

(a) *Salmonella typhimurium* causes food poisoning in humans but not in other mammals. Explain why these bacteria attach to human cells but not to the cells of other mammals.

_____

_____

_____

_____

(2)

(b) Salmonella bacteria release toxins that cause the body temperature to rise. Although a small increase in body temperature can be beneficial, a large increase can cause serious harm.

Explain how a large increase in a person's body temperature can cause harm.

_____

_____

_____

_____

(2)

(c) Some species of bacteria, which live in soil and decompose organic material, release exotoxins. Suggest how the release of exotoxins benefits the bacteria.

_____

_____

(1)

(d) Washing hands with anti-bacterial soap reduces the risk of transmission of the bacteria that cause food poisoning. Tea tree oil is a plant extract used in soaps. It is claimed to have anti-bacterial properties. Outline a method for investigating this claim.

_____

_____

_____

_____

_____

_____

_____

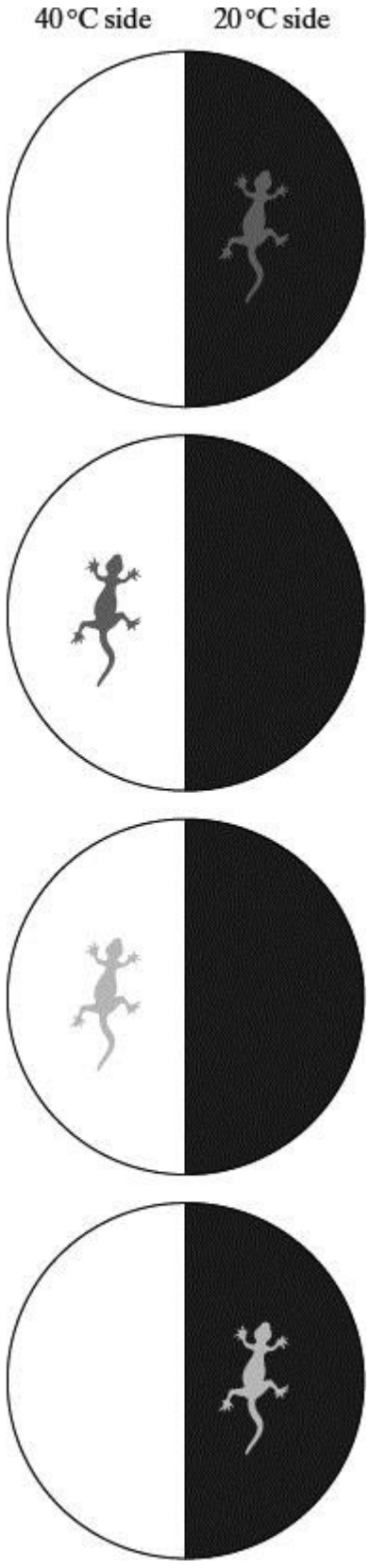
_____

(4)

(Total 9 marks)

Q12.

The body temperature of desert-living lizards is greatly affected by the temperature of their environment. A lizard was placed in a chamber where one half was maintained at 20 °C and the other at 40 °C. The lizard was free to move from one half to the other. The lizard's behaviour was observed using an infra-red camera, which records 20 °C surfaces as black and 40 °C surfaces as white. Temperatures between 20 °C and 40 °C appear as shades of grey. A series of photographs was taken.



Photograph 1
The lizard had been in the 20 °C side for several minutes

Photograph 2
The lizard then moved to the 40 °C side

Photograph 3
The lizard had been in the 40 °C side for several minutes

Photograph 4
The lizard then moved to the 20 °C side

(a) The position and appearance of the lizard, as recorded by the infra-red camera, changed during the experiment. Describe and explain these changes.

_____

_____

_____

_____

_____

_____

(3)

(b) Suggest the advantage to the lizard of the behaviour shown.

_____

_____

_____

_____

(2)

(Total 5 marks)

Q13.

(a) **Figure 1** shows the structure of a molecule of glycerol and a molecule of fatty acid.

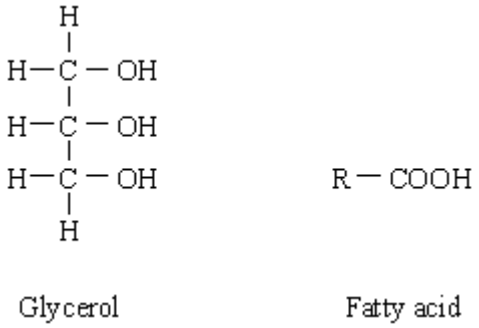


Figure 1

Draw a diagram to show the structure of a triglyceride molecule.

(2)

(b) Explain why triglycerides are **not** considered to be polymers.

_____

_____

(1)

(c) **Figure 2** shows two types of fat storage cell. Mammals living in cold conditions have more brown fat cells than mammals living in tropical conditions.

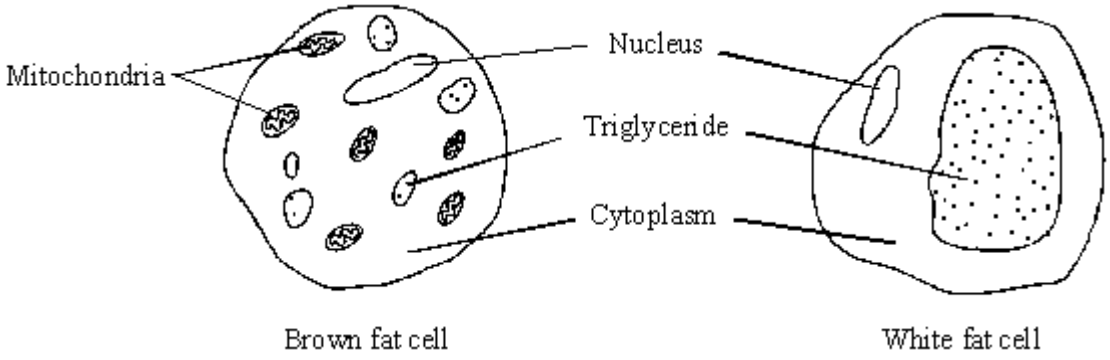


Figure 2

Using evidence from **Figure 2** to support your answer, suggest how the function of brown fat cells differs from that of white fat cells.

_____

_____

_____

_____

_____

_____

(3)

(Total 6 marks)