

6.4 Organisms - Responses to their environment (A-Level Only) - Homeostasis 2 – Questions

Q1.

- (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 $P \text{ g cm}^{-3}$
the concentration of a substance in the urine is $U \text{ g cm}^{-3}$
the volume of urine produced is $V \text{ cm}^3 \text{ per minute}$

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

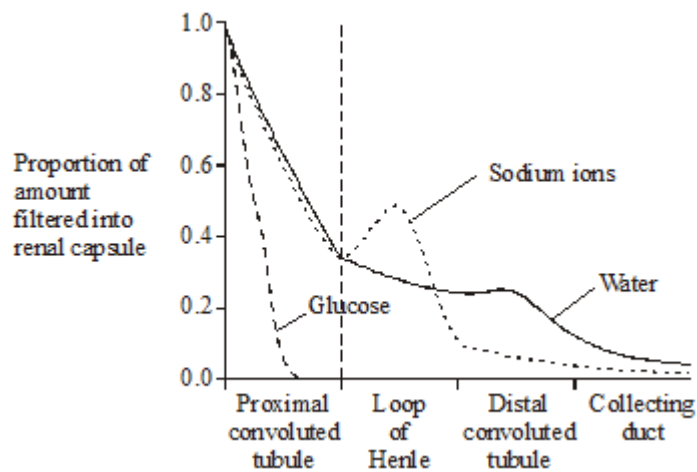
(1)

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

(3)
(Total 9 marks)

Q2.

The graph shows changes in the amounts of water, glucose and sodium ions as fluid passes along a kidney tubule from the renal capsule to the collecting duct



- (a) Which hormone causes the decrease in the water content in the distal convoluted tubule?

(1)

- (b) Explain the change in the amount of glucose.

(2)

- (c) Explain the shape of the curve for sodium ions in the loop of Henle.

(3)
(Total 6 marks)

Q3.

Exenatide is a drug used for treating Type 2 diabetics. Scientists investigated the effects of exenatide on insulin production.

The scientists used three groups of volunteers who were treated in the following ways.

Group 1: healthy, non-diabetics who were injected with exenatide in salt solution

Group 2: Type 2 diabetics who were injected with exenatide in salt solution

Group 3: Type 2 diabetics who were injected with salt solution.

Three hours after these injections, the scientists injected the same amount of glucose into the blood of each volunteer.

The scientists measured the rate of insulin production by each person before and after injecting the glucose.

- (a) (i) **Group 1** and **Group 3** were control groups in this investigation.

Explain why each group was used.

Group 1 _____

Group 3 _____

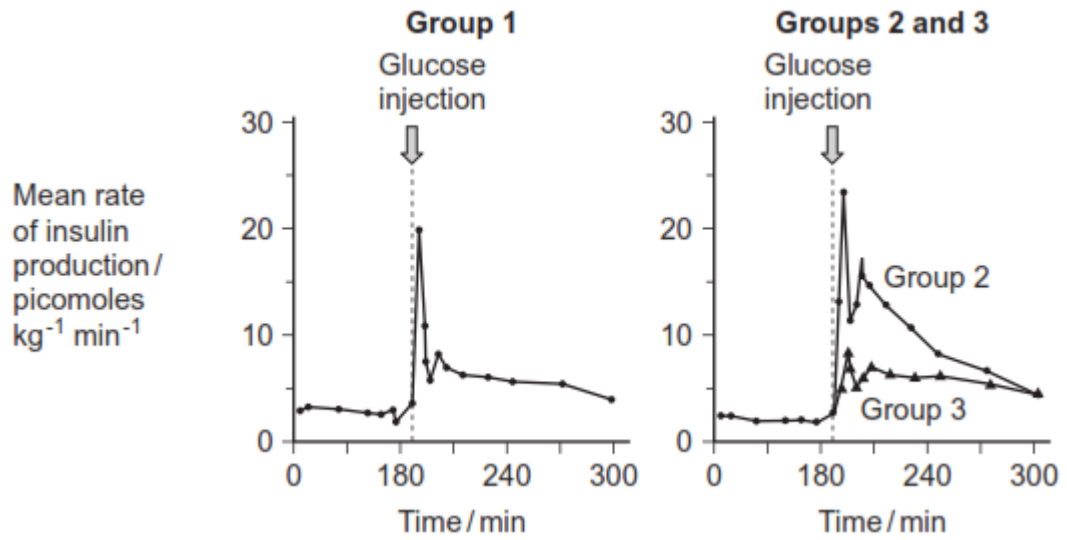
(2)

- (ii) The scientists measured the rates of insulin production per unit body mass.

Explain why.

(1)

- (b) The graphs show the mean rates of insulin production for each group.



Suggest how exenatide could help people with Type 2 diabetes.

(Extra space)

(3)
(Total 6 marks)

Q4.

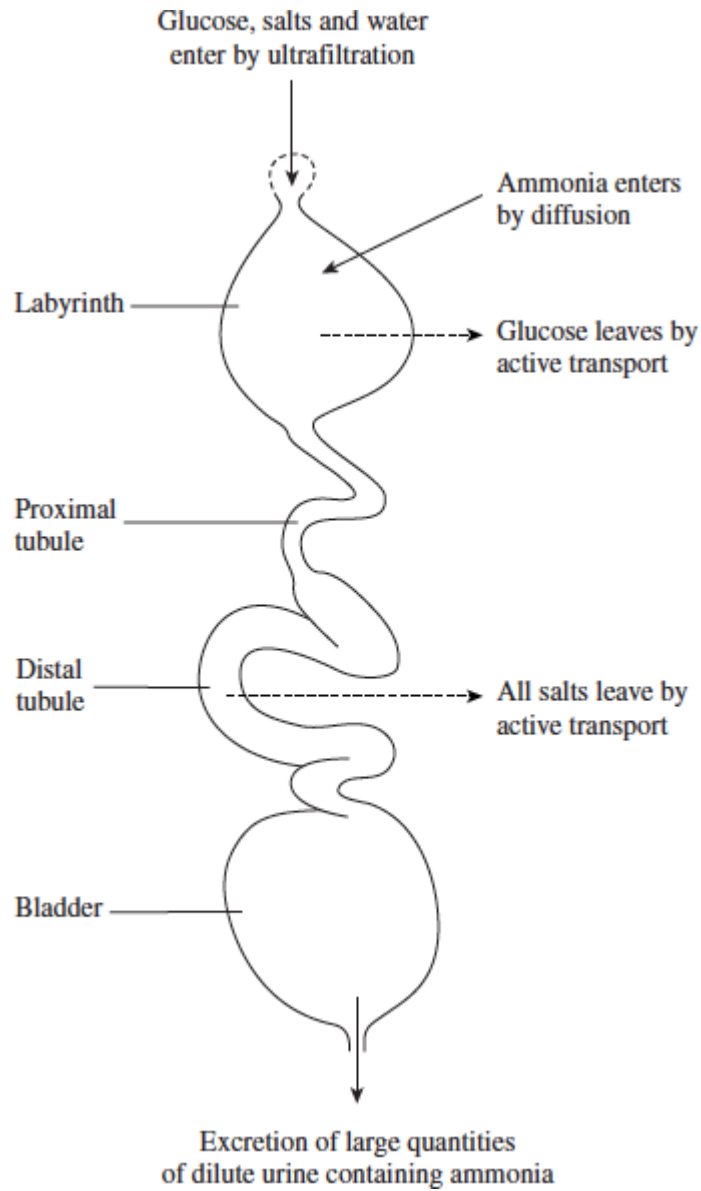
- (a) Humans can produce urine which is more concentrated than their blood plasma.
- (i) Explain the role of the loop of Henle in the absorption of water from the filtrate.

(6)

(ii) Explain the role of ADH in the production of concentrated urine.

(4)

(b) A species of crayfish lives in fresh water. This crayfish does not have kidneys but it does have an organ which excretes nitrogenous waste and controls the amount of water in its body. The diagram shows this excretory organ.



- (i) Describe how excretion in this organ differs from excretion in a human nephron.

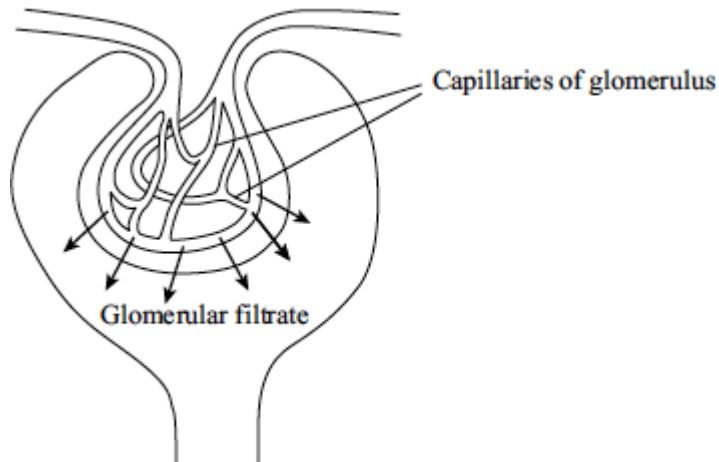
(3)

- (ii) Suggest how the production of large amounts of dilute urine enables the crayfish to survive in fresh water.

(2)
(Total 15 marks)

Q5.

The diagram shows a renal capsule where ultrafiltration occurs in the kidney.



- (a) Apart from water and glucose, name **two** substances which will be present in the glomerular filtrate.

1. _____
2. _____

(1)

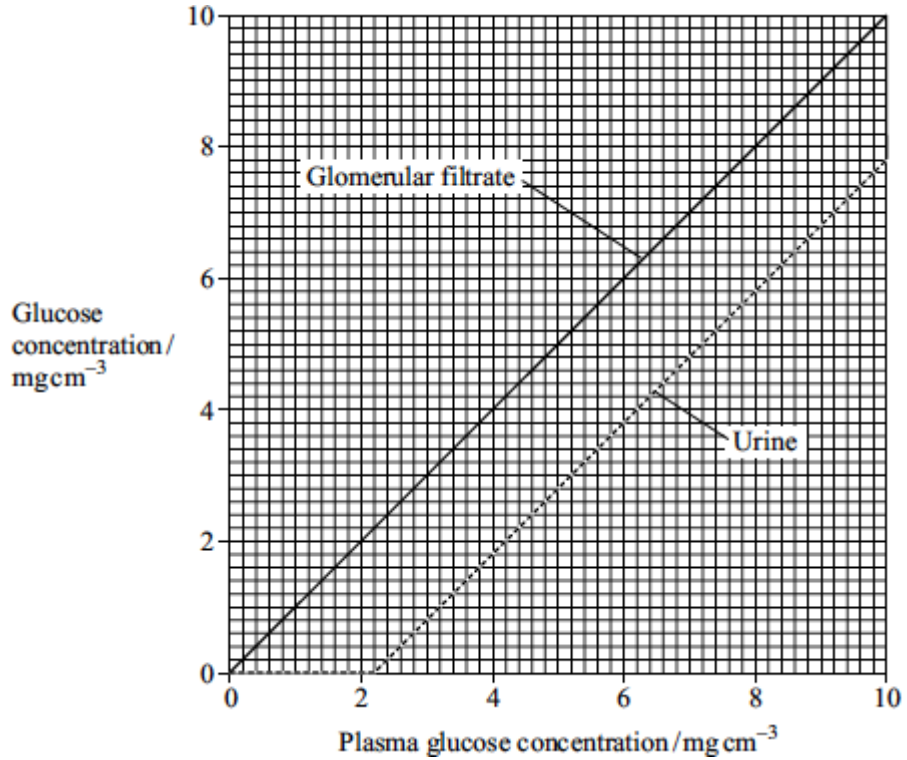
- (b) The glomerular filtration rate is the total volume of filtrate formed per minute. Explain the effect on the glomerular filtration rate of a large loss of blood from the body.

(2)

- (c) Selective reabsorption from the glomerular filtrate occurs in the proximal convoluted tubule. Explain **two** ways in which the cells of the proximal convoluted tubule are adapted for reabsorption.

1. _____
2. _____

- (d) The threshold value is the maximum plasma glucose concentration at which all the glucose can be reabsorbed from the filtrate. An investigation was carried out to determine the threshold value for glucose reabsorption in the kidneys of a mammal. The graph shows the results.



- (i) Explain the change in the glucose concentration in the urine as the plasma glucose concentration increases from 0 to 4 mg cm⁻³.

(2)

- (ii) A person with diabetes may have a plasma glucose concentration greater than the threshold value for glucose reabsorption. Explain what causes this raised plasma glucose concentration.

(1)

(Total 8 marks)

Q6.

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

(1)

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

(2)

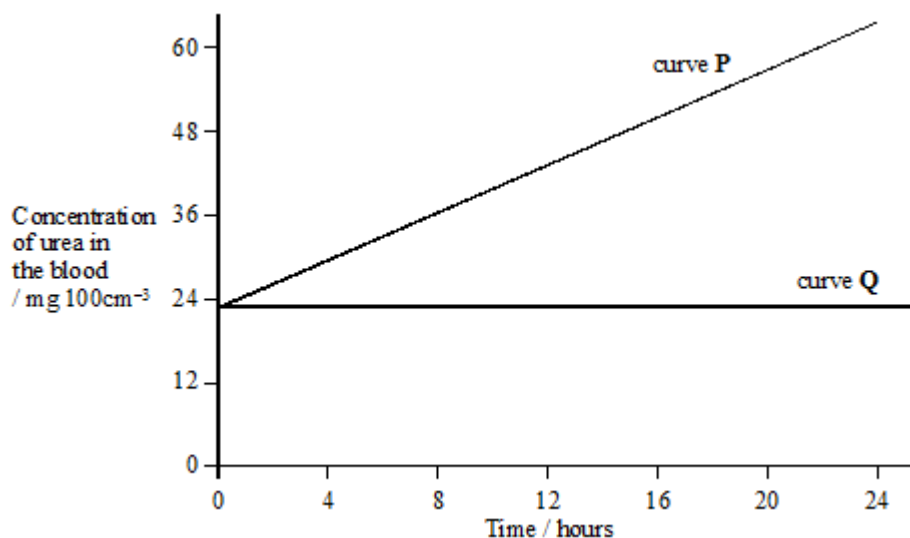
(b) Cross-channel swimmers may suffer from muscle fatigue during which the contraction mechanism is disrupted. One factor thought to contribute to muscle fatigue is a decrease in the availability of calcium ions within muscle fibres. Explain how a decrease in the availability of calcium ions could disrupt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

(3)

(Total 6 marks)

Q7.

The graph shows the concentration of urea in the blood of a mammal after the kidneys stopped working (**P**) and after both the kidneys and the liver stopped working (**Q**).



(a) Explain how the evidence from the graph shows **one** function of

(i) the kidneys;

Function _____

Evidence from graph _____

(1)

(ii) the liver.

Function _____

Evidence from graph _____

(1)

(b) On the graph, draw the curve you would expect if the liver stopped working at time 0, and the kidneys stopped working 12 hours later.

(2)

(Total 4 marks)

Q8.

(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)

Q9.

Diabetes is a disorder affecting the ability to control blood glucose concentration. One type of diabetes can be due to an abnormality of the insulin receptors in the cell surface membranes of cells in the liver and muscles. A high blood glucose concentration and the presence of glucose in the urine are signs of this type of diabetes.

- (a) (i) Suggest **one** way in which the insulin receptors might be abnormal.

(1)

- (ii) Explain how the presence of abnormal insulin receptors results in a high blood glucose concentration.

(2)

- (iii) Explain how the kidneys normally prevent glucose appearing in the urine of a non-diabetic person.

(3)

- (b) Twin studies have been used to determine the relative effects of genetic and environmental factors on the development of this type of diabetes. The table shows the concordance (where both twins have the condition) in genetically identical and genetically non-identical twins.

Concordance in genetically identical twins / %	Concordance in genetically non-identical twins /%
85	35

- (i) What do the data show about the relative effects of environmental and genetic factors on the development of diabetes?

(1)

- (ii) Suggest **two** factors which should be taken into account when collecting the data in order to draw valid conclusions.

1. _____

2. _____

(2)

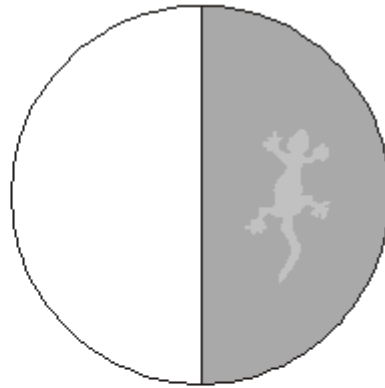
(Total 9 marks)

Q10.

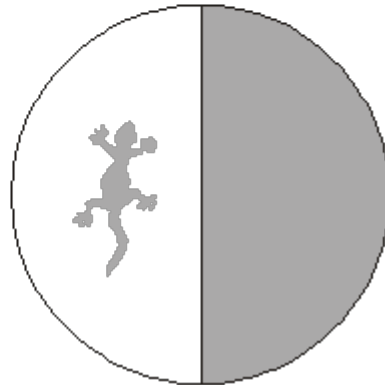
The body temperature of desert-living lizards is greatly affected by the temperature of their environment. A lizard was placed in a chamber where one half was maintained at 20 °C and the other at 40 °C. The lizard was free to move from one half to the other. The lizard's behaviour was observed using 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.

40°C side 20°C side

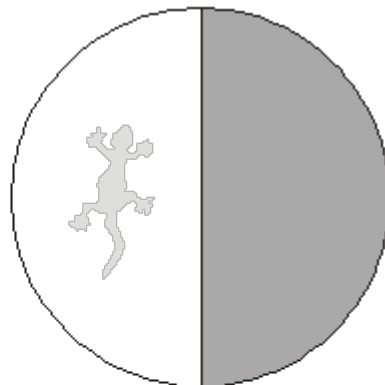
Photograph 1
The lizard had been in the
20°C side for several minutes



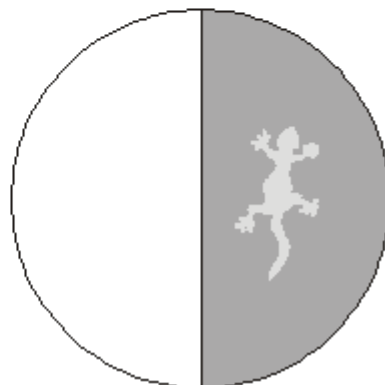
Photograph 2
The lizard then moved
to the 40°C side



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)

Q11.

Essay

You should write your essay in continuous prose.

Your essay will be marked for its scientific accuracy.

It will also be marked for your selection of relevant material from different parts of the specification and for the quality of your written communication.

The maximum number of marks that can be awarded is

Scientific	16
Breadth of knowledge	3
Relevance	3
Quality of written communication	3

Write an essay on the following topic:

Negative feedback in living organisms.

(Total 25 marks)

Q12.

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

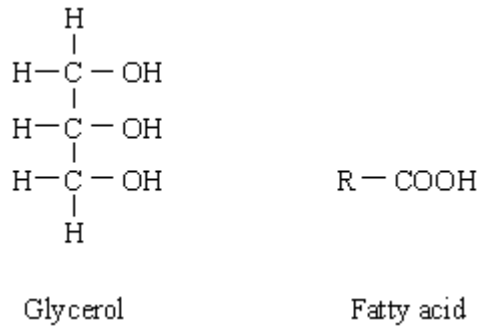


Figure 1

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

- (b) Explain why triglycerides are **not** considered to be polymers. (2)

- (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. (1)

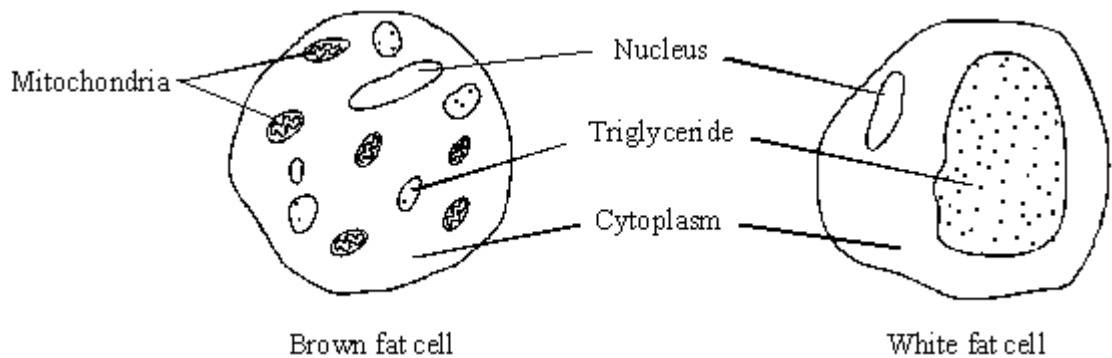


Figure 2

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)

Q13.

- (a) Explain how insulin lowers the concentration of blood glucose.

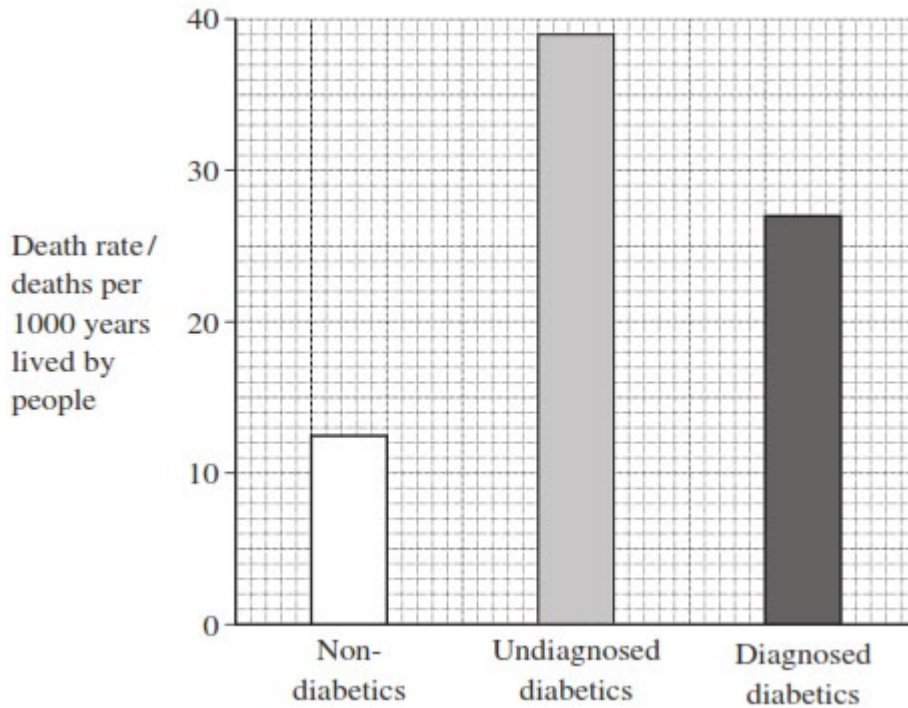
(Extra space) _____

(3)

- (b) Doctors studied a large group of people. They recorded the death rates for non-diabetic people, undiagnosed diabetics and diagnosed diabetics.

They gave the death rates as deaths per 1000 years lived by people.

The graph shows these death rates.



- (i) Calculate the ratio of the death rate of diagnosed diabetics to undiagnosed diabetics.

Ratio _____

(2)

- (ii) People with undiagnosed diabetes were not receiving treatments, such as insulin injections. Suggest **one** reason for the difference in death rates for undiagnosed and diagnosed diabetics.

(2)

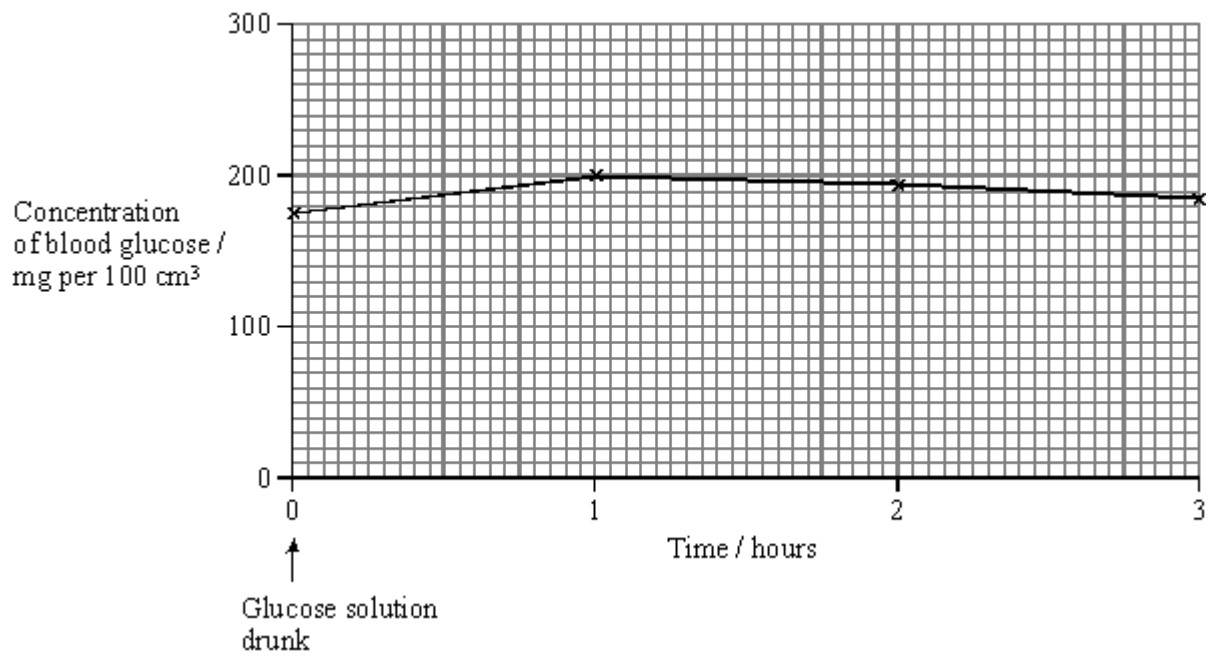
(Total 7 marks)

Q14.

- (a) Describe how insulin reduces the concentration of glucose in the blood.

(3)

Some people produce no insulin. As a result they have a condition called diabetes. In an investigation, a man with diabetes drank a glucose solution. The concentration of glucose in his blood was measured at regular intervals. The results are shown in the graph.



(b) Suggest **two** reasons why the concentration of glucose decreased after 1 hour even though this man's blood contained no insulin.

1. _____

2. _____

(2)

(c) The investigation was repeated on a man who did not have diabetes. The concentration of glucose in his blood before drinking the glucose solution was 80 mg per 100 cm³. Sketch a curve on the graph to show the results you would expect.

(1)

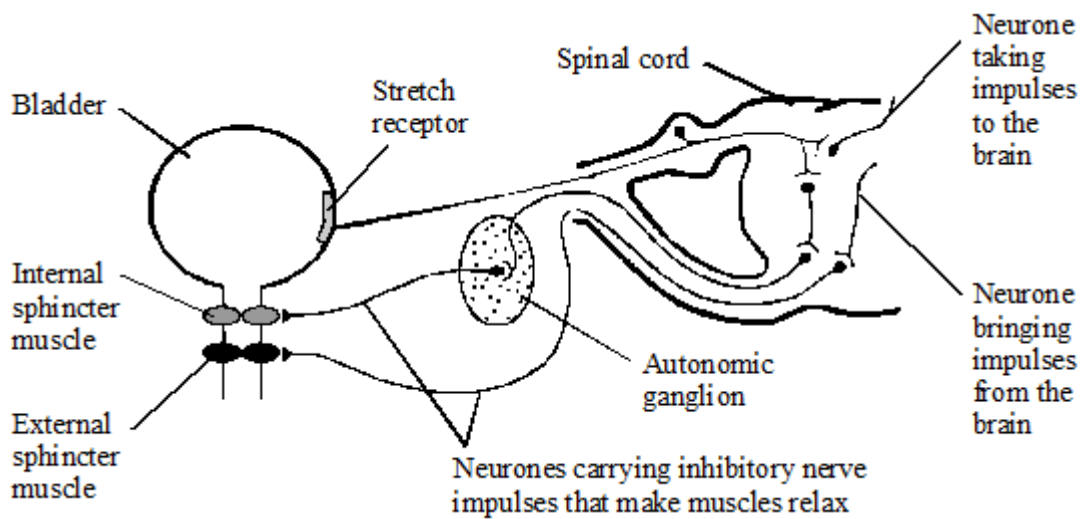
(d) The diabetic man adopted a daily routine to stabilise his blood glucose concentration within narrow limits. He ate three meals a day: breakfast, a midday meal and an evening meal. He injected insulin once before breakfast and once before the evening meal.

The injection he used before breakfast was a mixture of two types of insulin. The mixture contained slow-acting insulin and fast-acting insulin.

(b) Explain how ADH is involved in the control of the volume of urine produced.

(4)

(c) The diagram shows the systems involved in controlling the emptying of the bladder. In babies, emptying of the bladder is controlled by an autonomic reflex involving the internal sphincter muscle. Conscious control is learnt between the ages of two and three and involves the external sphincter as well.



Using information in the diagram, explain how the autonomic reflex arc is different from a simple reflex arc involving voluntary muscle;

(2)

(Total 11 marks)