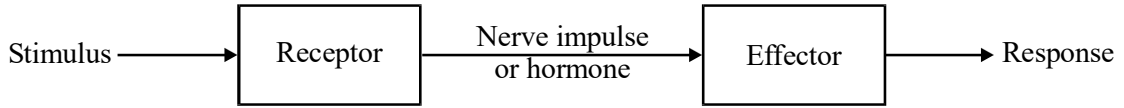


1. The diagram summarises the pathways by which blood glucose concentration and body temperature are controlled.



- (a) Complete the table to show the location of the receptors and the response of the effectors in these pathways.

Stimulus	High blood glucose concentration	Increased blood temperature
Location of receptors		
Nerve impulse or hormone	Release of insulin	Nerve impulses
Effectors	Liver cells	Arterioles in skin
Response		

(4)

- (b) Describe the part played by negative feedback in maintaining a constant blood temperature.

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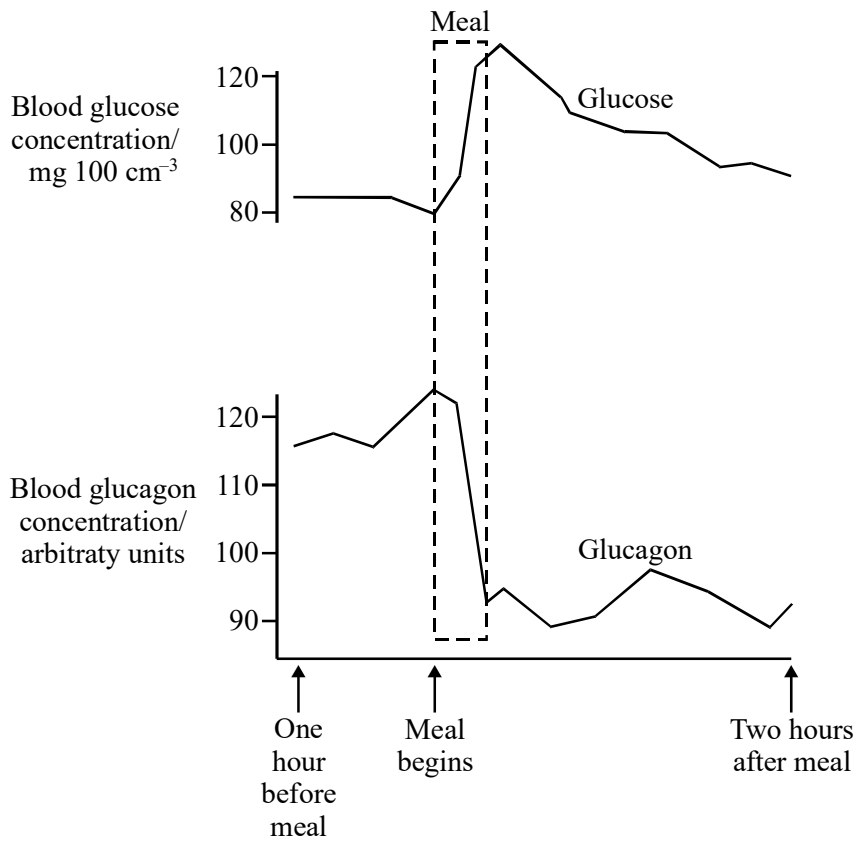
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(1)

(Total 5 marks)

2. The graph shows the blood glucose and glucagon concentrations in a healthy person during and after eating a meal.



- (a) (i) From where is glucagon secreted?

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(1)

- (ii) Explain the changes that occur in the glucagon concentration over the period on the graph.

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(2)

- (b) Explain how the information shown in the graph provides an example of negative feedback.

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(2)
(Total 5 marks)

3. *Write an essay on the topic below. Credit will be given not only for the biological content, but also for the organisation and presentation of the essay; and the use of grammar, punctuation and spelling.*

The factors which influence the concentration of glucose in the blood.

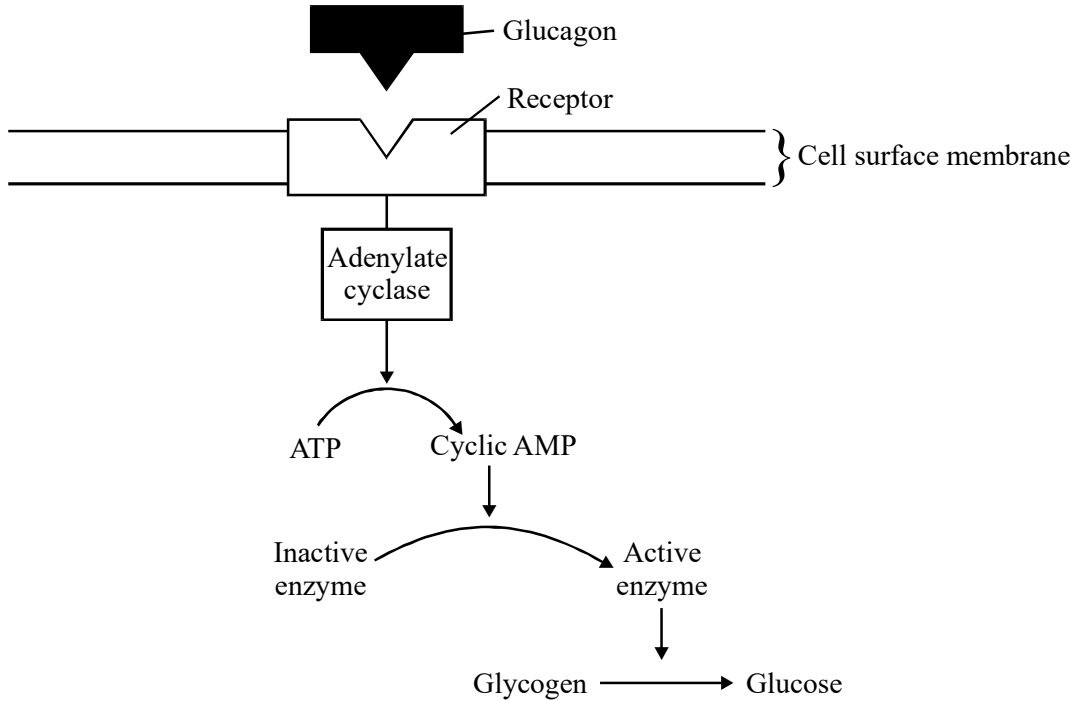
(Total 25 marks)

4. *Write an essay on the topic below. Credit will be given not only for biological content but also for the organisation and presentation of the essay, and use of grammar, punctuation and spelling.*

Maintaining constant conditions in the body.

(Total 25 marks)

5. The diagram shows the changes caused in a cell by the hormone glucagon when it combines with a receptor in the cell surface membrane.



- (a) Name **one** organ in the human body containing cells with glucagon receptors.

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(1)

- (b) (i) Using the diagram, explain how an injection of a small amount of glucagon into the body could cause a rapid increase in the concentration of glucose in the blood plasma.

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(3)

- (ii) The blood glucose concentration would return to its normal value within one hour of injecting glucagon. Explain how.

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(3)
(Total 7 marks)

6. Like many insects, honeybees cannot survive in very cold conditions. Before an individual bee can fly, the temperature of its flight muscles must be above 15 °C. It achieves this with small, rapid contractions of the flight muscles, rather like shivering in a mammal.

Honeybees live as a colony in a hive. By clustering together in the centre of the hive they can keep the temperature of this area at a constant 34 to 35 °C. In this way the bees can survive in cold conditions.

In an investigation, the diameter of the cluster formed by one colony of bees was measured at various environmental temperatures. None of the bees died during the investigation. The results are shown in **Figure 1**.

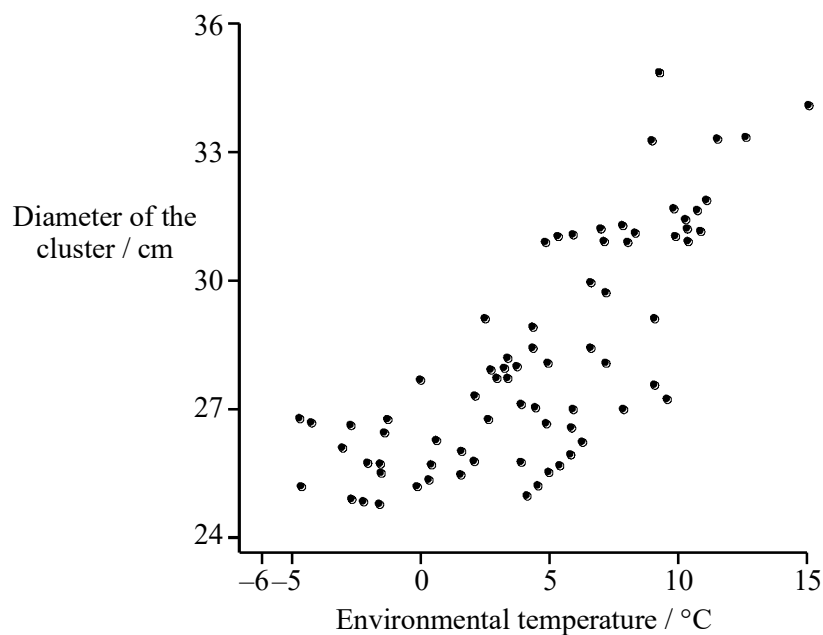


Figure 1

- (a) Describe and explain the relationship between the environmental temperature and the diameter of the cluster.

(2)

The table shows the results of a further investigation. It shows the relationship between the temperature in the centre of the cluster of bees and the sugar consumption of the bees.

Temperature in the centre of cluster/°C	Mean sugar consumption per bee/mg day⁻¹
19	49
23	32
27	24
30	12
33	15
36	18

- (b) Plot the data in the table as a suitable graph on the graph paper provided.

(4)

- (c) Explain the relationship between cluster temperature and sugar consumption:

- (i) between 30 °C and 36 °C;
(ii) between 19 °C and 30 °C.

(4)

- (d) Use the data in the table to predict the effect of cluster temperature on carbon dioxide production by the bees. Explain your answer.

(2)

The graphs in **Figures 2** and **3** show some aspects of the behaviour of bees.

Figure 2 shows the effect of an increase in carbon dioxide concentration in the hive on the number of bees which can be seen facing into the hive and fanning their wings vigorously.

Figure 3 shows how the number of bees collecting water varies over the course of a day. These bees return to the hive and spread the water in tiny droplets over the internal surface of the hive.

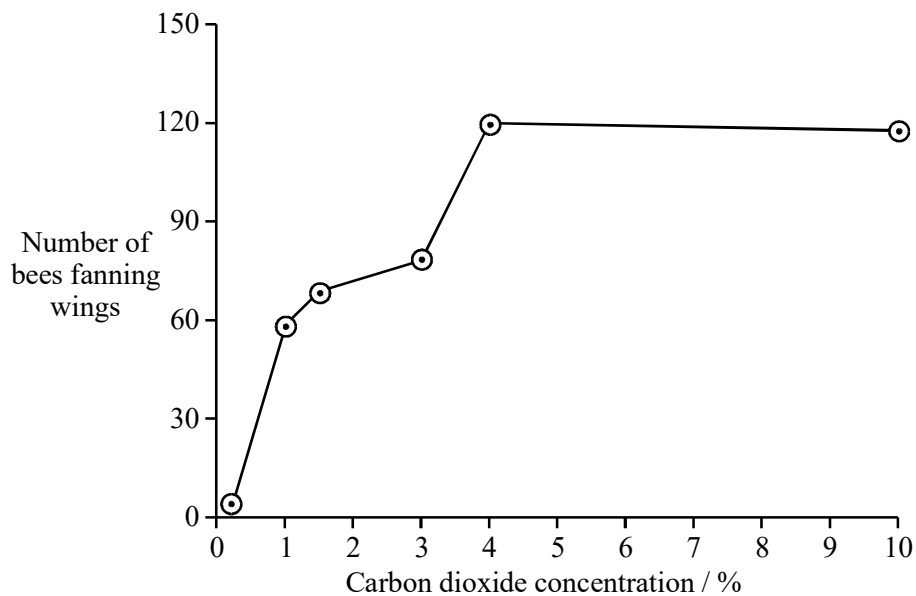


Figure 2

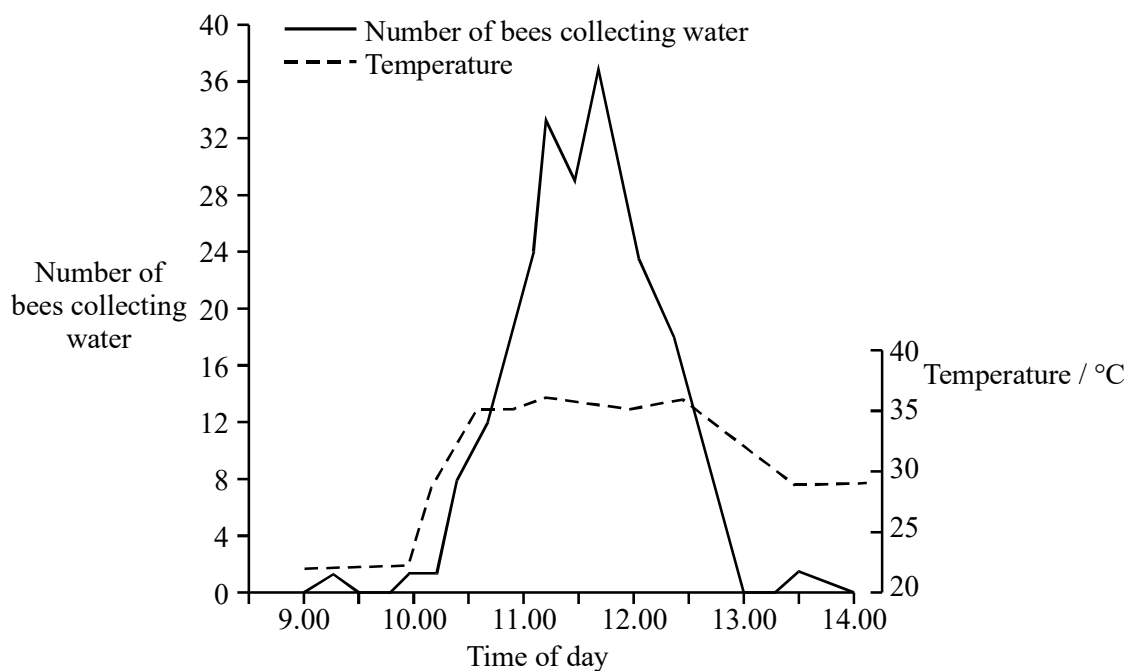


Figure 3

- (e) Use information from these graphs to explain how the internal temperature of the hive is prevented from rising on a hot day. (3)
- (f) Although all honeybees belong to the same species, there are many different varieties. One variety called the mountain bee is found at high altitudes in East Africa. It has longer „hair“ on its body than other African varieties of bee.
- (i) Suggest why this longer „hair“ may be an advantage to bees living at high altitude. (2)
- (ii) Explain how natural selection could have resulted in bees with longer „hair“. (3)
- (Total 20 marks)**

7. The table shows the concentrations of glucose and insulin in the blood plasma before and after a meal.

Time after eating meal/ minutes	Concentration of glucose in blood plasma/ mg 100 cm ⁻³	Concentration of insulin in blood plasma/ arbitrary units
0	82	19
5	88	19
10	96	28
15	106	35
20	110	44
25	108	49
30	101	52
35	93	46
40	87	41
45	82	33

- (a) Use information in the table to explain how insulin controls the concentration of blood glucose by negative feedback.

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(2)

(b) Diabetes can occur when the pancreas cells are unable to secrete insulin. In a test, a person who is suspected of suffering from diabetes is given a solution of glucose to drink. Then blood samples are taken at regular intervals and the concentration of blood glucose is measured. If the person is diabetic, the blood glucose concentration rapidly peaks before slowly returning to its original level.

S (i) The test is carried out on the same person a second time. Apart from drinking the same volume and same concentration of glucose solution, suggest **two** ways in which the test should be carried out to produce reliable results.

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(ii) The blood plasma glucose concentration falls in diabetics even when there is no insulin present in the blood plasma. Explain why.

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(1)

(Total 5 marks)

8. (a) The blood vessels in the skin play an important part in allowing a mammal to conserve heat. Describe how.

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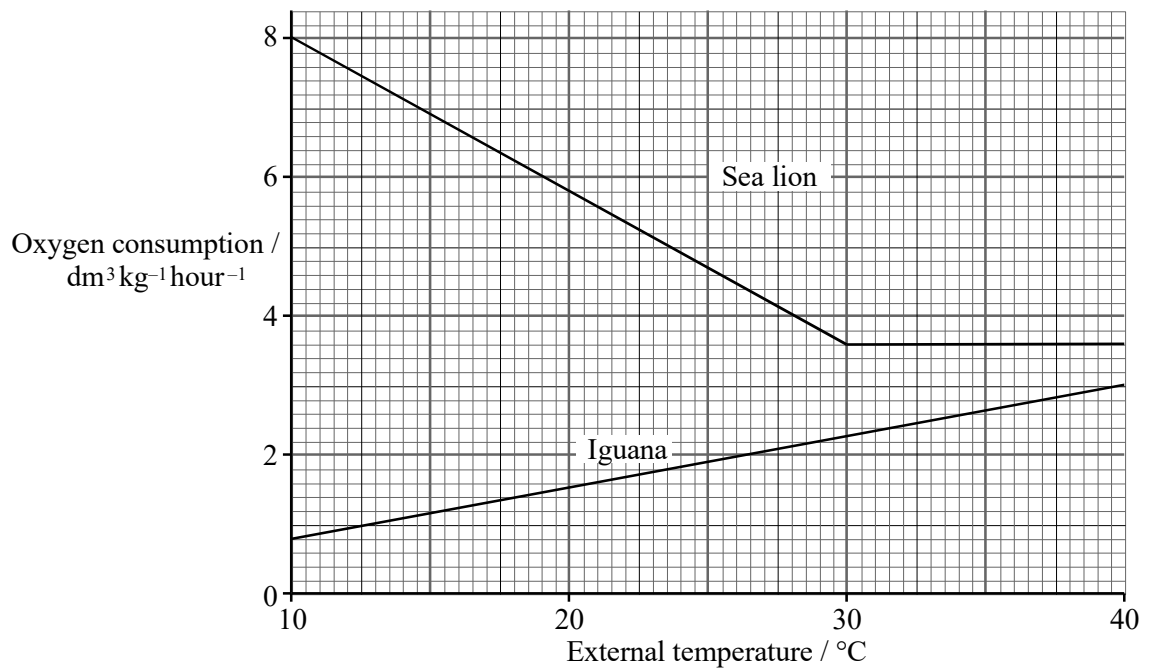
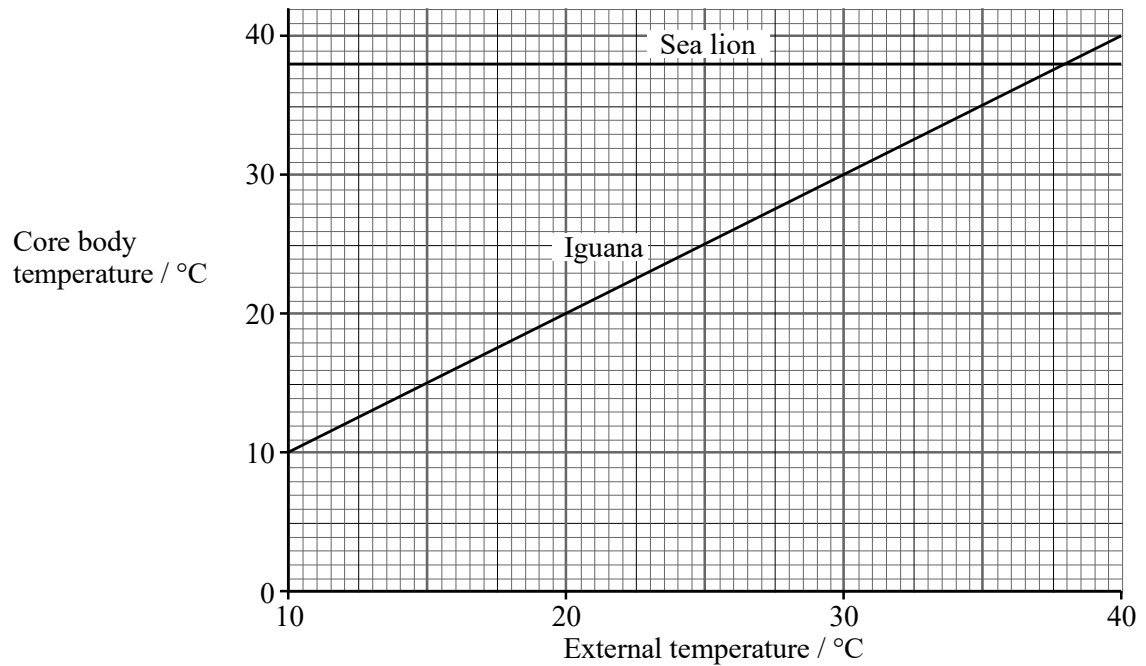
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(2)

- (b) Sea lions and iguanas feed in the sea around the tropical Galapagos Islands. Sea lions are mammals and iguanas are reptiles. Both species spend some time on land. The graphs show the core body temperature and the oxygen consumption of an iguana and a sea lion at different external temperatures.



Using information from the graphs, answer the following questions.

- (i) The mean temperature of the sea surrounding the Galapagos Islands is 21 °C while the mean air temperature during the day is higher than this. Suggest why the iguana feeds for only short periods of time in the water before returning to the land.

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- S** (ii) Explain the link between core body temperature and rate of oxygen consumption in the sea lion between the external temperatures of 10 °C and 30 °C.

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(2)

(Total 6 marks)

9. Skeletal muscle is made of bundles of fibres.

- (a) Describe the roles of calcium ions, ATP and phosphocreatine in producing contraction of a muscle fibre.

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(4)

S (b) The table shows some properties of slow and fast muscle fibres.

Property of fibre	Type I (slow fibres)	Type II (fast fibres)
Number of mitochondria per fibre	Many	Few
Concentration of enzymes regulating glycolysis	Moderate	High
Resistance to fatigue	High	Low

Endurance athletes, such as marathon runners, nearly always have a high proportion of slow fibres in their muscles. Explain the benefit of this.

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(6)

(c) During exercise, much heat is generated. Describe the homeostatic mechanisms that restore normal body temperature following vigorous exercise.

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(5)

(Total 15 marks)

10. (a) Humans are able to maintain a constant core temperature when exposed to cold external temperatures.

S Suggest

- (i) **one** advantage of this;

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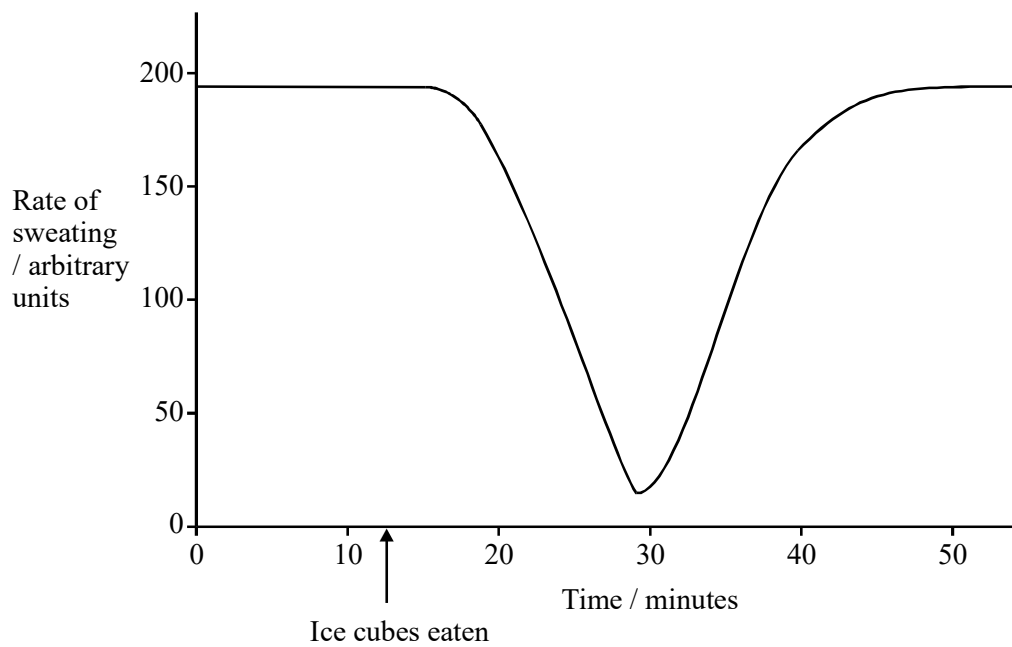
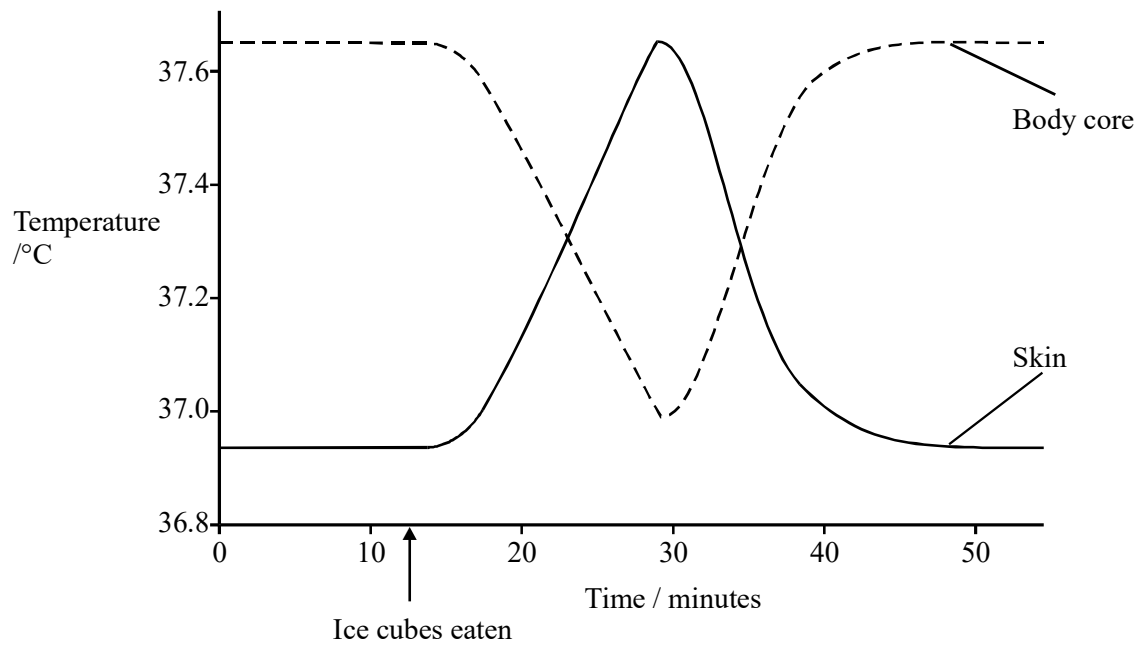
(1)

- (ii) **one** disadvantage of this.

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(1)

(b) The graphs show data collected from a volunteer who ate several ice cubes.



- (i) Explain the relationship between the rate of sweating and the temperature of the skin.

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(2)

- (ii) Use information in the graphs to explain the part played by negative feedback in the control of core temperature.

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(2)

(Total 6 marks)

11. Mammals are endotherms; reptiles are ectotherms.

- (a) Explain **two** advantages of endothermy over ectothermy.

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(2)

- (b) **Figure 1** shows how the rates of metabolic heat generation and evaporative heat loss in a reptile change with environmental temperature. Each plot is the mean of several values. The vertical bars on the graphs represent the standard deviation about the mean.

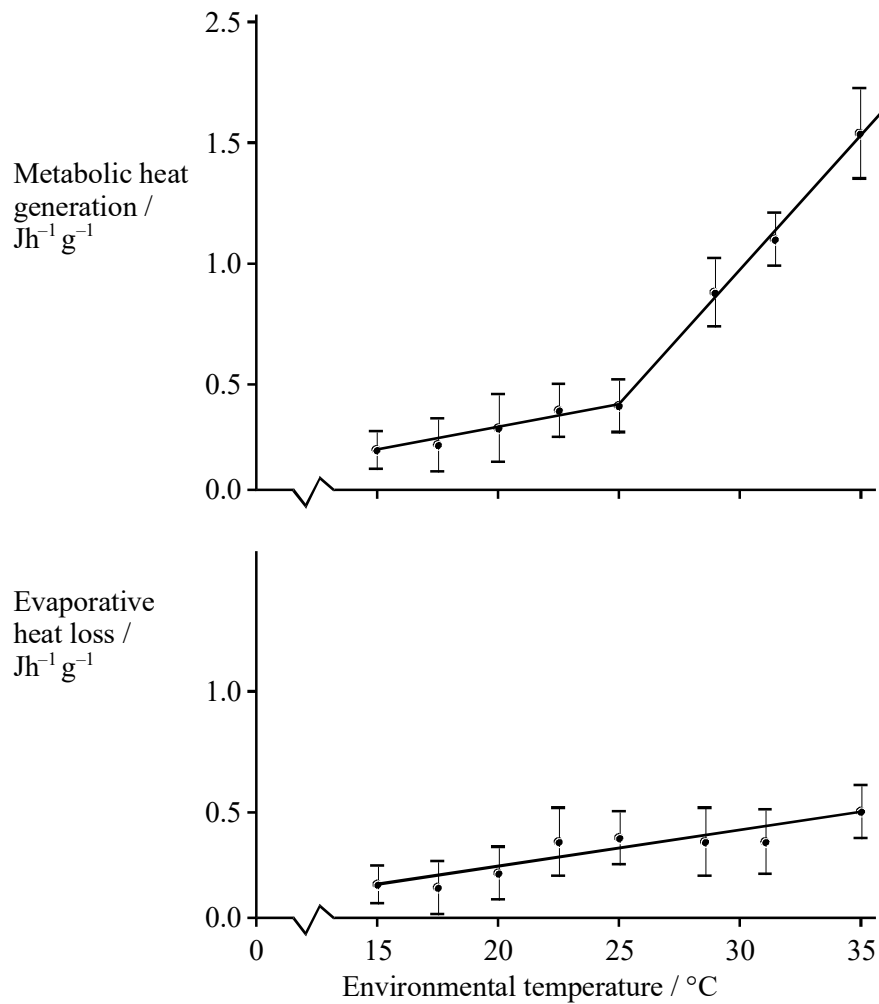


Figure 1

- S (i) Explain why it is more useful to show the standard deviation rather than the range of values.

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- (ii) Explain why the values for metabolic heat generation are given per gram of body mass.

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(2)

- (iii) Describe the relationship between metabolic heat generation and evaporative heat loss shown in the graphs.

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(2)

- (iv) Use the graphs to explain why these reptiles often seek shade when the environmental temperature rises above 25°C.

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(2)

- (c) **Figure 2** shows the relationship between metabolic heat generation and evaporative heat loss in a small mammal.

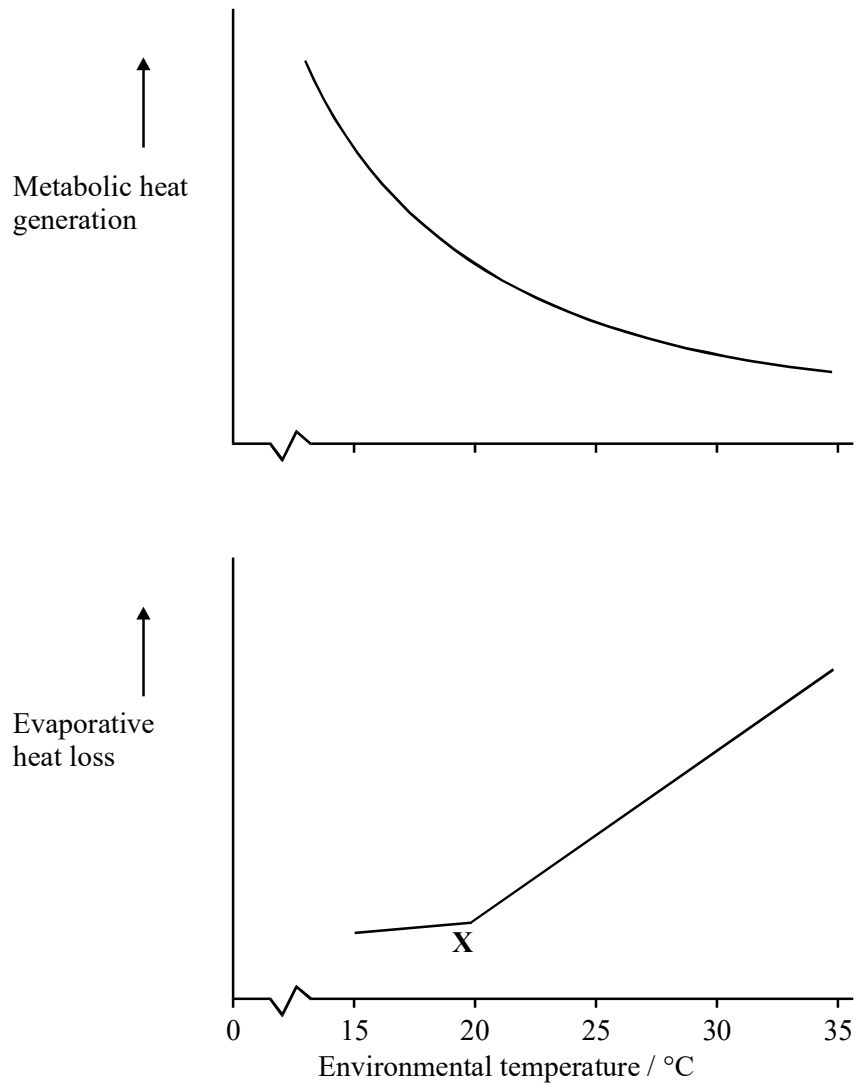


Figure 2

- (i) How is the relationship between heat generation and evaporative heat loss in a mammal different from that in a reptile?

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(1)

- (ii) Suggest an explanation for the change in the slope of the graph for evaporative heat loss at the point marked X.

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(1)

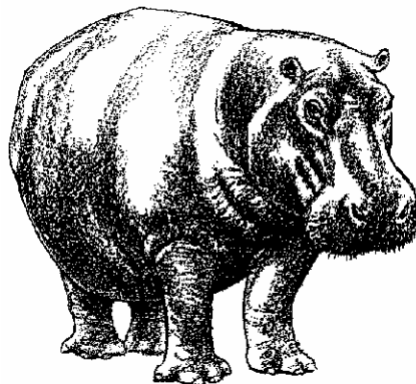
- (iii) Explain how the change in metabolic heat generation in a small mammal is brought about as environmental temperature rises.

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(3)

(Total 15 marks)

12. The hippopotamus lives in tropical Africa. It is a large mammal, the mean body mass of an adult male being about 1500kg. Hippos spend much of the daytime partly submerged in lakes and rivers. At night they come out of the water and graze on plants. The drawing shows an adult hippo.



- (a) Explain why the core temperature of a hippo would probably rise if it stayed on land during the daytime.

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(3)

- (b) During the daytime, the core temperature of a hippo is lower than the temperature of the unsubmerged skin on the back of the animal. Explain why.

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(2)

- (c) Protein is essential for the growth of young hippos. Different proteins, however, have different nutritive values. One method of measuring protein quality is to calculate its biological value from the equation:

$$\text{Biological value} = \frac{\text{Amount of protein used in maintenance and growth}}{\text{Amount of protein digested and absorbed}}$$

In order to do this, the following quantities are measured:

- I** = nitrogen intake
- F** = nitrogen in faeces
- U** = nitrogen in urine

Use the letters **I**, **F** and/or **U** to show how each of the following is calculated:

- (i) the amount of protein digested and absorbed;

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(1)

- (ii) the amount of protein used in maintenance and growth.

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(1)

- (d) When food passes through the gut of a hippo, only a certain amount of the protein it contains is digested. The rest passes out of the body in the faeces. The digestibility coefficient is one way of measuring this.

$$\text{Digestibility coefficient} = \frac{\text{Nitrogen intake} - \text{Nitrogen in faeces}}{\text{Nitrogen intake}}$$

- (i) Explain why nitrogen intake is a useful measure of protein intake.

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(2)

- (ii) Other than protein in the food which has not been digested, give **two** sources of protein in faeces.

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(2)

- (iii) The structure of the gut of a hippo is very similar to that of a ruminant animal. Use your knowledge of plant cells to explain why the digestibility coefficient for protein in plant food is higher in the hippo than in a non-ruminant animal such as a human.

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(3)

- (e) A study of disease in wild hippos was carried out in Uganda. Samples of blood were taken from animals of different ages and tested for rinderpest antibodies. Rinderpest is a serious viral disease which affects many species of herbivorous mammal. Some results of the study are shown in the table.

Estimated age of hippo / years	Number of animals tested	Number of animals positive for rinderpest antibodies
0–15	131	2
18	13	1
20	9	0
22	18	2
25	19	0
28	50	13
31	52	16
33	16	8

(i) Explain how infection with the rinderpest virus results in the formation of rinderpest antibodies in the blood.

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(2)

(ii) Give **two** hypotheses which could explain the proportions of hippos of different ages that tested positive for rinderpest antibodies.

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(2)

(iii) Before this study was carried out, there was no evidence that hippos could get rinderpest as no hippos suffering from the disease had been found. Explain the importance of this study to African cattle farmers living in areas near to rivers and lakes.

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(2)

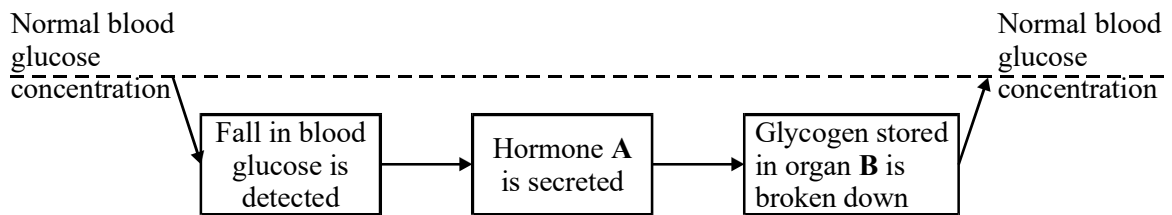
(Total 20 marks)

13. Write an essay on the following topic. You should select and use information from different parts of the specification. Credit will be given not only for the biological content, but also for the selection and use of relevant information, and for the organisation and presentation of the essay.

Cycles in biology

(Total 25 marks)

14. The diagram shows some of the events which maintain blood glucose concentration in a mammal.



(a) Name

(i) hormone **A**;

(ii) organ **B**.

(2)

(b) Explain why the events shown in the diagram can be described as an example of negative feedback.

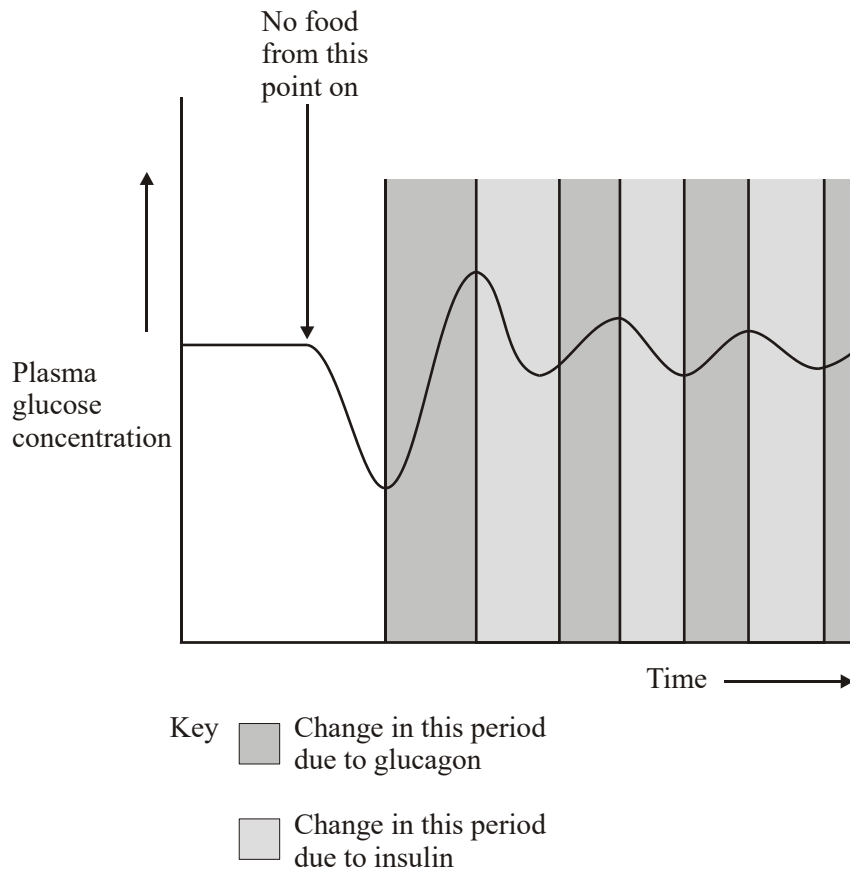
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(1)

(Total 3 marks)

15. 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.

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(5)

(b) (i) Explain how normal core body temperature is maintained when a person moves into a cold room.

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(5)

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

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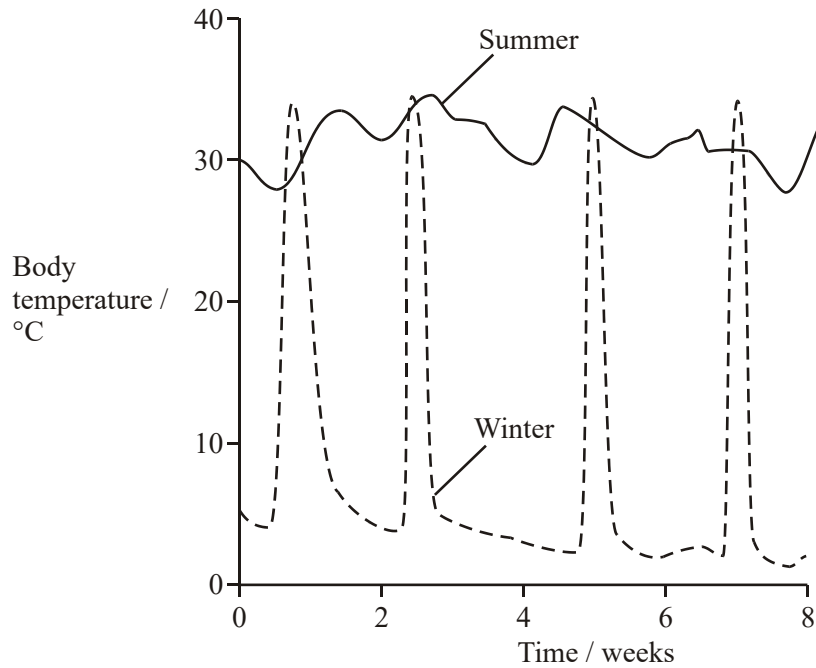
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(5)
(Total 15 marks)

16. The echidna is an Australian mammal. In winter, its body temperature falls to a temperature similar to that of its environment and it hibernates. However, during the period of hibernation, it becomes active every few weeks and at these times its temperature rises to a level similar to its summer temperature. The graph shows how the echidna's temperature varies in the summer and in the winter.



- (a) Explain how the fall in body temperature to that of the environment helps the echidna to survive the winter.

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(2)

- (b) Explain how a higher body temperature is of benefit to an active echidna.

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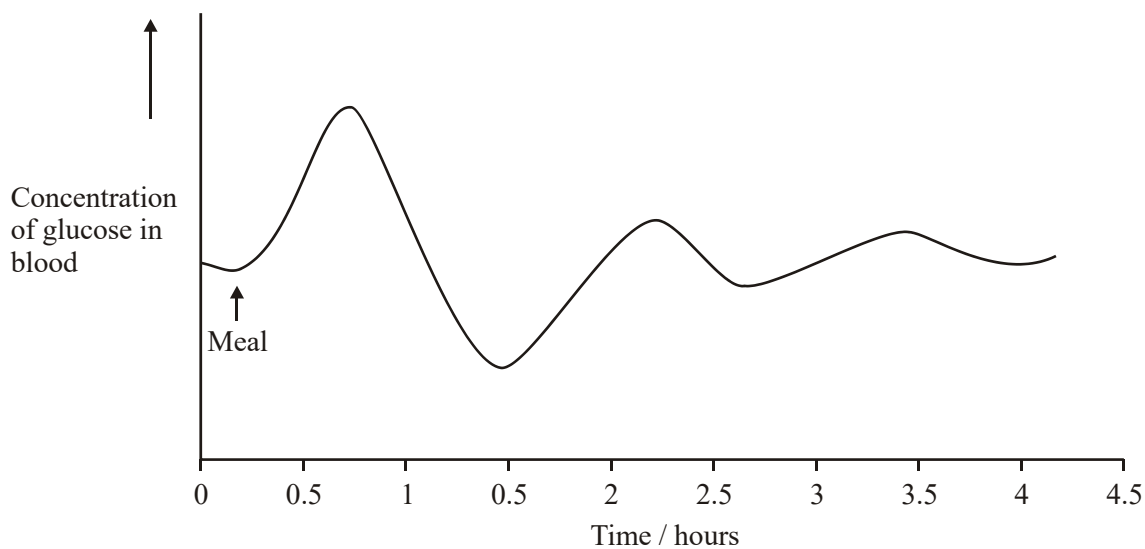
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(2)

(Total 4 marks)

17. (a) The graph shows changes in the concentration of glucose in a person's blood following a meal.



Changes in the concentration of glucose are controlled by the hormones glucagon and insulin. Write the letters **X** and **Y** on the graph to show

- X** a time when glucagon secretion would be high;
Y a time when insulin secretion would be high.

(1)

- S (b) Many diabetics require regular injections of insulin. Describe how bacteria can be genetically modified to produce human insulin.

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(4)

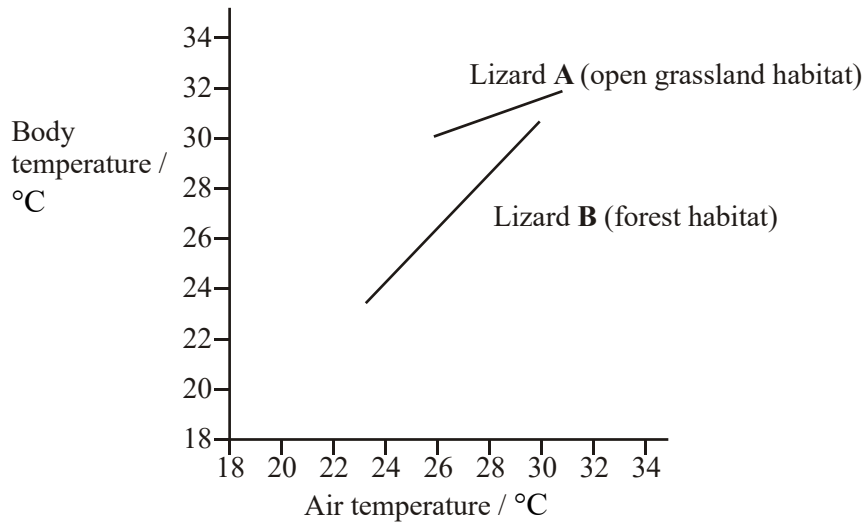
(Total 5 marks)

18. Write an essay on the following topic. You should select and use information from different parts of the specification. Credit will be given not only for the biological content, but also for the selection and use of relevant information, and for the organisation and presentation of the essay.

Negative feedback and its importance in biology.

(Total 25 marks)

19. Lizards are reptiles. The graph shows the results of an investigation into the relationship between air temperature and body temperature for two lizards living in different habitats. The investigation took place on a hot sunny day over a period of four hours.



(a) (i) Explain the relationship between the air temperature and the body temperature for lizard **B**.

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(1)

(ii) Suggest an explanation for the different pattern shown by lizard **A**.

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(1)

- S** (b) Lizard **B** moves more slowly when its body temperature is 24°C than when it is 28°C. Explain what causes the slower movements at the lower temperature.

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(2)
(Total 4 marks)

- 20.** The kangaroo rat is a small desert mammal. It takes in very little water in its food and it rarely drinks. Its core body temperature is 38 °C.

- S** (a) The kangaroo rat takes in some water by feeding and drinking. Describe another method by which the kangaroo rat could obtain water.

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(2)

- (b) At an environmental temperature of 28 °C and 100% saturation of the external air with water vapour, the temperature inside a kangaroo rat's nasal passages was 31 °C. At the same environmental temperature but 0% saturation with water vapour, the temperature in the nasal passages was 26 °C. Explain the difference in temperature of the nasal passages and suggest how the lower nasal temperature helps the kangaroo rat to survive in hot, dry conditions.

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(4)
(Total 6 marks)

(b) Describe the important differences between the nervous and hormonal co-ordination systems found in a mammal.

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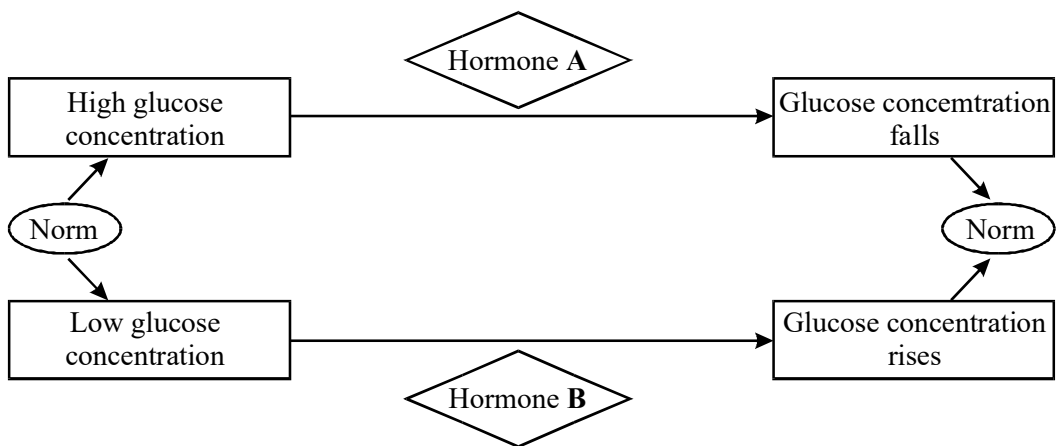
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(4)
(Total 12 marks)

22. The diagram shows how the concentration of glucose in the blood is regulated.



(a) Name

(i) hormone **A**,

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(ii) hormone **B**.

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(2)

(b) Explain how hormone **B** brings about the change shown in the diagram.

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(2)

(c) Two people fasted for 12 hours and each was then given a drink which contained 100g of glucose. Their blood glucose concentration was measured regularly for 3 hours. The results of the investigation are shown in the table.

Time after glucose drink / minutes	Blood glucose concentration / mg per 100 cm ³ of blood	
	Person X	Person Y
0	81	90
20	136	131
40	181	142
60	213	89
90	204	79
120	147	74
150	129	86
180	113	89

(i) Suggest an explanation for the changes in the blood sugar level of person **X**.

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(1)

- (ii) Explain how the concentration of hormone A in the blood would vary in person Y between 0 and 60 minutes.

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(2)

- (iii) Suggest an explanation for the results shown by person Y between 90 and 180 minutes.

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(1)

(Total 8 marks)

23. Hormones and the nervous system are involved in controlling the functions of the body.

- (a) During the oestrous cycle in a mammal, one or more follicles mature. Ovulation then takes place. Describe the part played by hormones in controlling these events.

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(6)

- (b) The ears of a rabbit play an important part in helping the animal to keep its body temperature constant. After a period of exercise, the insides of a rabbit's ears become redder in colour as the blood flow to the skin surface increases. Explain how the different components of nervous communication are involved in the process leading to the response shown by the rabbit's ears.

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(6)
(Total 12 marks)

24. A baboon is a large monkey. It normally regulates its body temperature in the same way as a human.

- (a) When a baboon's blood temperature rises, it is able to detect this rise and produce a coordinated response.

- (i) Where are the receptors that detect the rise in temperature?

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(1)

(ii) Describe how the response is coordinated.

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(2)

(b) Baboons that live in the Kalahari desert in southern Africa have to survive occasional very hot dry periods when no rain falls. During these periods, no drinking water is available.

Suggest why the body temperature of a baboon fluctuates much more during a hot dry spell when it cannot get water to drink.

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(2)

(Total 5 marks)

25. Read the following passage.

Diabetes

Diabetes mellitus is a group of disorders that all lead to an increase in blood glucose concentration (hyperglycaemia). The two major types of diabetes mellitus are type I and type II. In type I diabetes there is a deficiency of insulin. Type I diabetes is also called insulin-dependent diabetes mellitus because regular injections of insulin are essential. It most commonly develops in people younger than age twenty.

Type II diabetes most often occurs in people who are over forty and overweight. Clinical symptoms may be mild, and the high glucose concentrations in the blood can often be controlled by diet and exercise. Some type II diabetics secrete low amounts of insulin but others have a sufficient amount or even a surplus of insulin in the blood. For these people, diabetes arises not from a shortage of insulin but because target cells become less responsive to it. Type II diabetes is therefore called non-insulin-dependent diabetes mellitus.

- (a) Describe how blood glucose concentration is controlled by hormones in an individual who is **not** affected by diabetes.

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(6)

- (b) Suggest how diet and exercise can maintain low glucose concentrations in the blood of type II diabetics.

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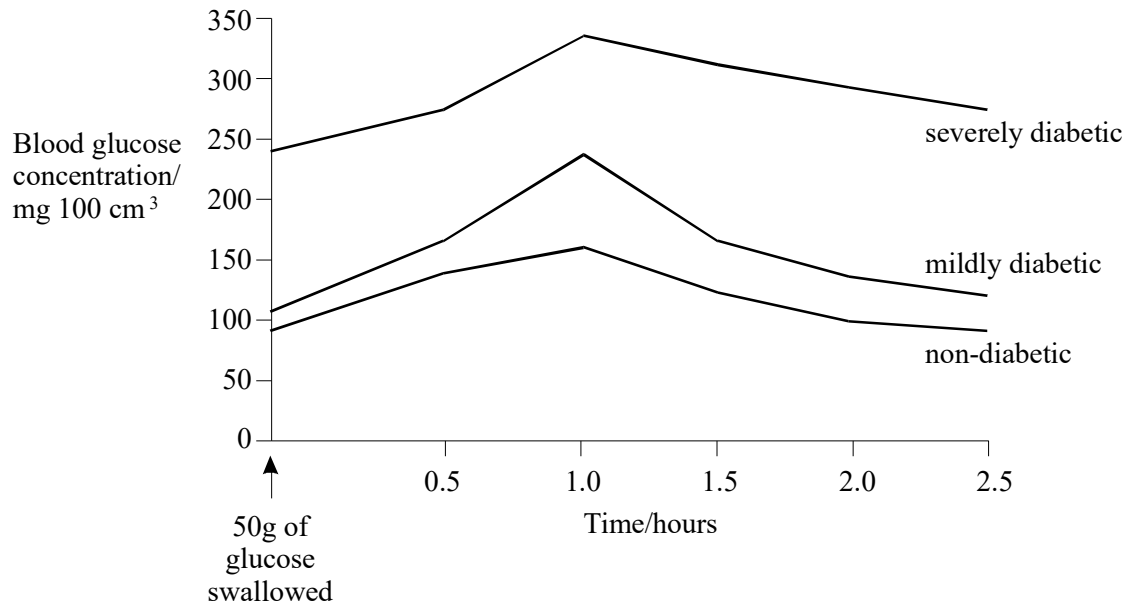
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(3)
(Total 9 marks)

26. The glucose tolerance test is used in hospitals to assess insulin production. A patient fasts for several hours before swallowing 50g of glucose in 150 cm³ water. The concentration of glucose in the patient's blood is then measured immediately and at 30-minute intervals over a period of two to three hours. The graph shows changes in the blood glucose concentration of three patients who have taken this test.



- (a) Explain why it was necessary for the patients to fast for several hours before the test was carried out.

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(1)

(b) Explain the changes which take place in the blood glucose concentration of the non-diabetic person over the period shown in the graph.

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(4)

(c) What can be concluded from the results of this test about insulin production in the two diabetic patients? Explain the evidence for your answer.

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(3)

(Total 8 marks)

27. Size matters for marathon runners. Big athletes produce more heat and find it harder to keep cool. Shape matters too - a tall, thin runner has fewer problems keeping cool than a short, tubby runner of the same body mass. A 65 kg athlete running a marathon in 2 hours 10 minutes in reasonably dry conditions can avoid overheating at air temperatures up to 37 °C, but in humid conditions the same level of performance is possible only at temperatures below about 17 °C.

(a) Explain how athletes produce heat when they run.

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(2)

(b) Why does a „tall, thin runner have fewer problems keeping cool than a short, tubby runner of the same body mass“?

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(2)

(c) Explain why runners are more likely to overheat in humid conditions.

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(3)

(d) Describe how the body responds to a rise in core body temperature.

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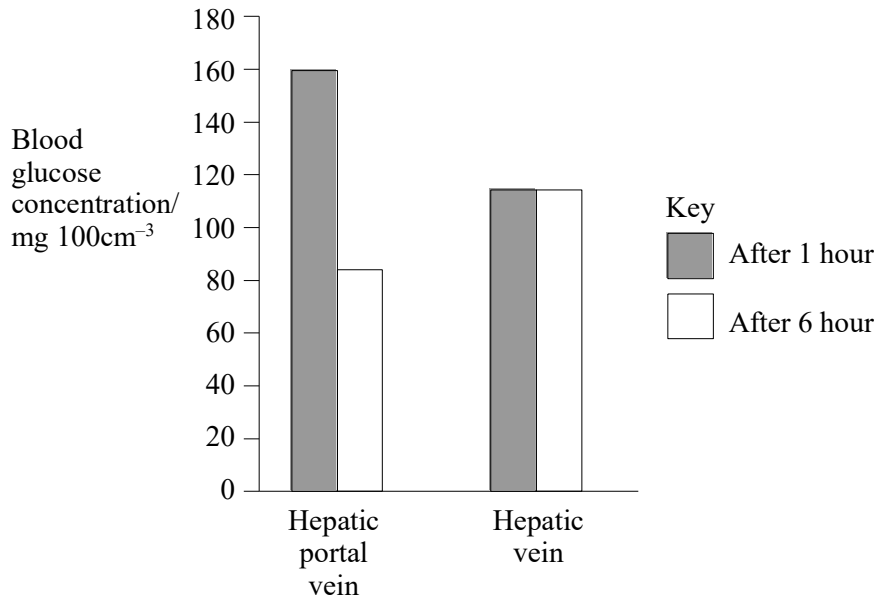
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(5)
(Total 12 marks)

28. There are two veins associated with the liver. The hepatic portal vein brings blood from the intestine to the liver while the hepatic vein takes blood from the liver. The concentration of glucose was measured in samples of blood from the hepatic portal vein and the hepatic vein. The samples were taken 1 hour and 6 hours after a meal. The results are shown in the graph.



(a) Explain the difference between the blood glucose concentration in the hepatic vein and that in the hepatic portal vein 1 hour after a meal.

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(1)

(b) Six hours after the meal, there is a higher concentration of glucose in the hepatic vein than in the hepatic portal vein. Describe the role of hormones in producing this higher concentration.

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(3)

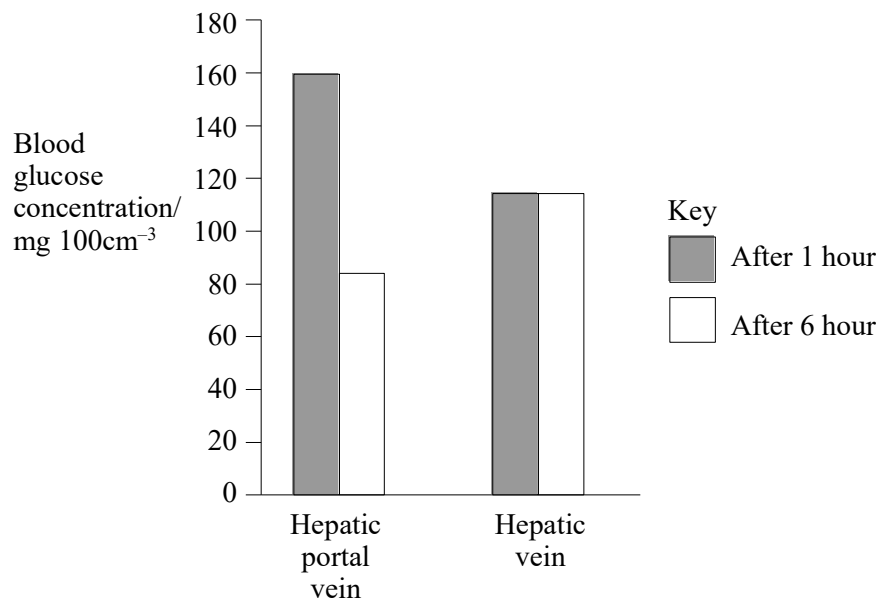
- (c) In a person who has not eaten for two days, the blood glucose concentration in the hepatic vein is still approximately $110 \text{ mg } 100\text{cm}^3$. What causes the blood glucose concentration to remain at this level?

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(1)
(Total 5 marks)

29. There are two veins associated with the liver. The hepatic portal vein brings blood from the intestine to the liver while the hepatic vein takes blood from the liver. The concentration of glucose was measured in samples of blood from the hepatic portal vein and the hepatic vein. The samples were taken 1 hour and 6 hours after a meal. The results are shown in the graph.



- (a) Explain the difference between the blood glucose concentration in the hepatic vein and that in the hepatic portal vein 1 hour after a meal.

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(1)

- (b) Six hours after the meal, there is a higher concentration of glucose in the hepatic vein than in the hepatic portal vein. Describe the role of hormones in producing this higher concentration.

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(3)

- (c) The hormones which control the concentration of glucose in the blood affect some cells in the body but not others. Use your knowledge of the structure of cell surface membranes to explain why.

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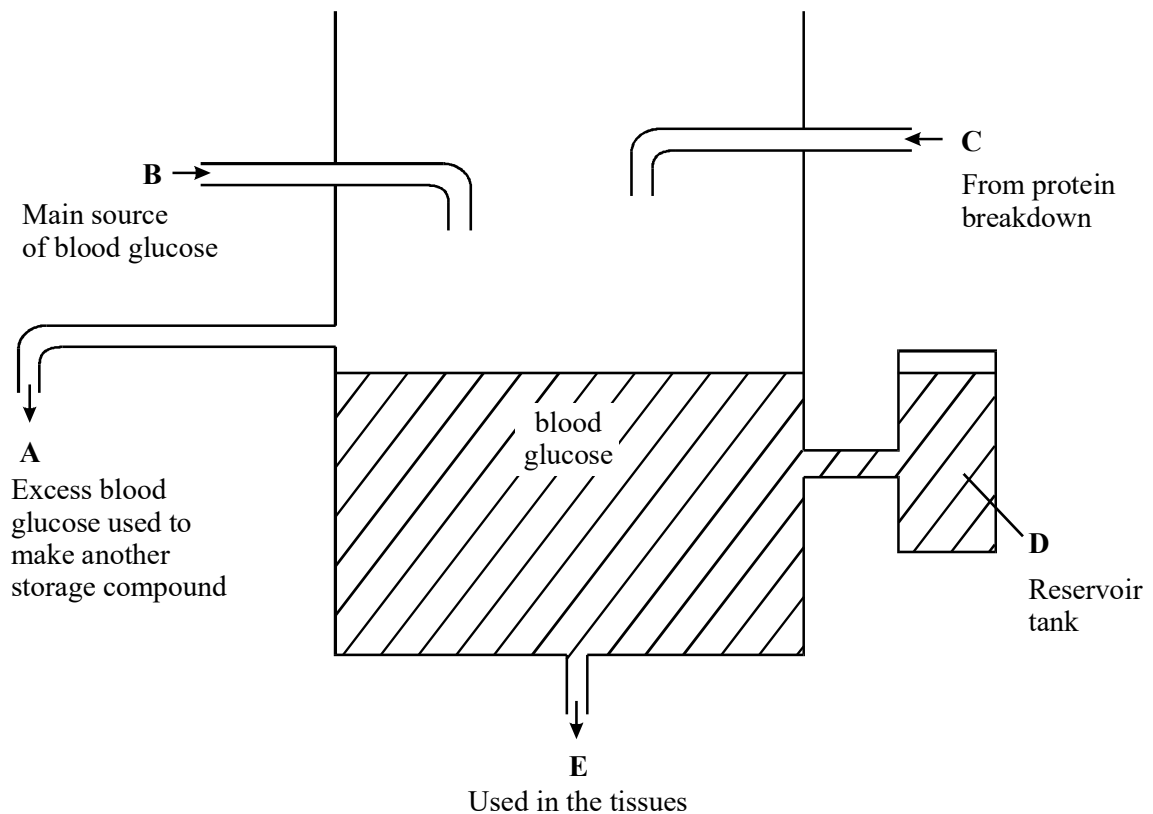
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(3)
(Total 7 marks)

30. The diagram shows a model in which blood glucose is represented as a tank of fluid. In this model

- the pipes on the diagram represent „routes“ by which glucose may be added or removed;
- the main source of glucose to the tank is through **B**;
- a smaller amount of glucose enters through **C**, from protein breakdown;
- there is an outflow from the tank to the tissues through **E**;
- the reservoir tank, **D**, contains a carbohydrate that can be reconverted into blood glucose;
- through **A**, any excess glucose can be used to produce another type of storage compound which is different from the compound stored in **D**.



(a) What is the “main source of blood glucose” entering through **B**?

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(1)

(b) In the body, insulin and glucagon are both involved in regulating the concentration of blood glucose.

(i) Name the organ that produces both of these hormones.

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(1)

(ii) Tick the appropriate boxes in the table that match a description of one or more of the effects of the hormones.

Effect of hormone	Insulin	Glucagon
Reduces the amount of storage carbohydrate in reservoir D		
Promotes the loss of blood glucose through A		
Promotes protein breakdown so more glucose enters through C .		
Increases the rate of outflow at E		

(2)

(c) (i) Name the carbohydrate stored in reservoir **D**.

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(1)

(ii) Name the storage compound into which glucose is converted at **A**.

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(1)

- (d) Adrenaline and thyroxine are two other hormones that can affect blood glucose levels.

Adrenaline acts rapidly, causing a sudden increase in the level of blood glucose.
Thyroxine acts more slowly, and influences growth through its long-term effect in increasing the rate of respiration.

For each of these two hormones, give the letter on the diagram, **A-E**, that identifies where it is most likely to exert its main effect.

Adrenaline

Thyroxine

(2)
(Total 8 marks)

31. (a) Describe the role of insulin in the control of blood glucose concentration.

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(4)

Figure 1 shows the pathway by which glycogen is broken down in liver and muscle cells.

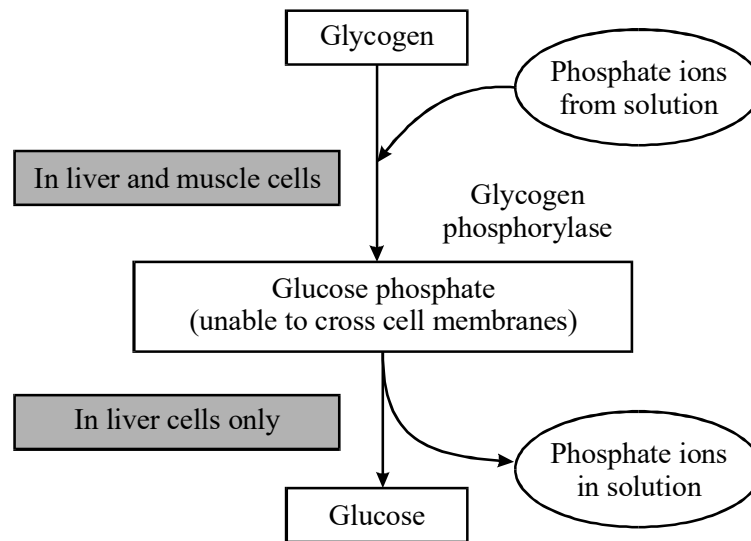


Figure 1

- (b) Suggest why it **is** important that muscle cells do **not** convert glucose phosphate to glucose.

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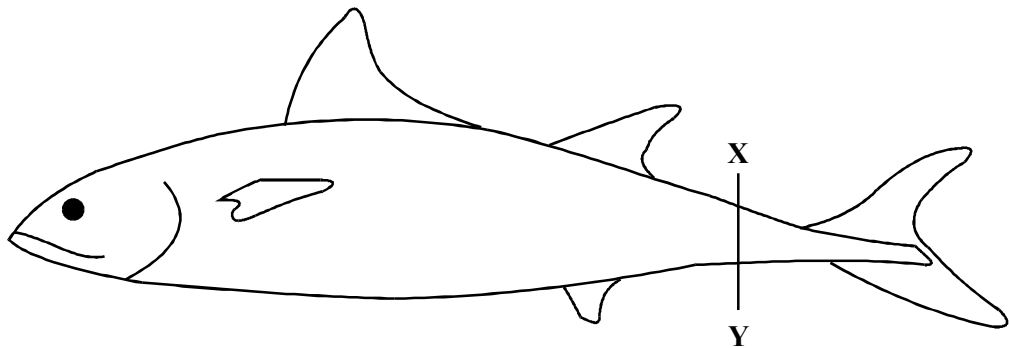
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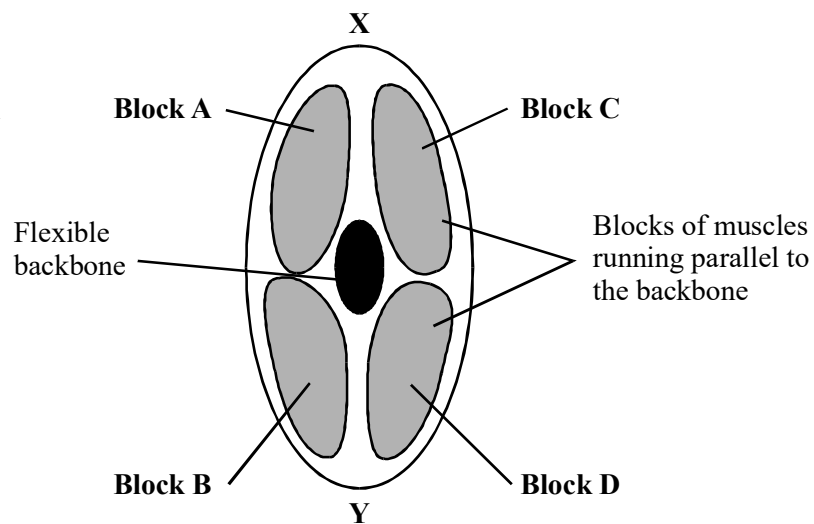
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(2)

- (d) This fish swims away from danger using powerful side-to-side movements of its tail fin to push against the water.



Enlarged cross-section through the tail of the fish



Use the information in the diagrams to explain how the blocks of muscles produce the side-to-side swimming movements of the tail.

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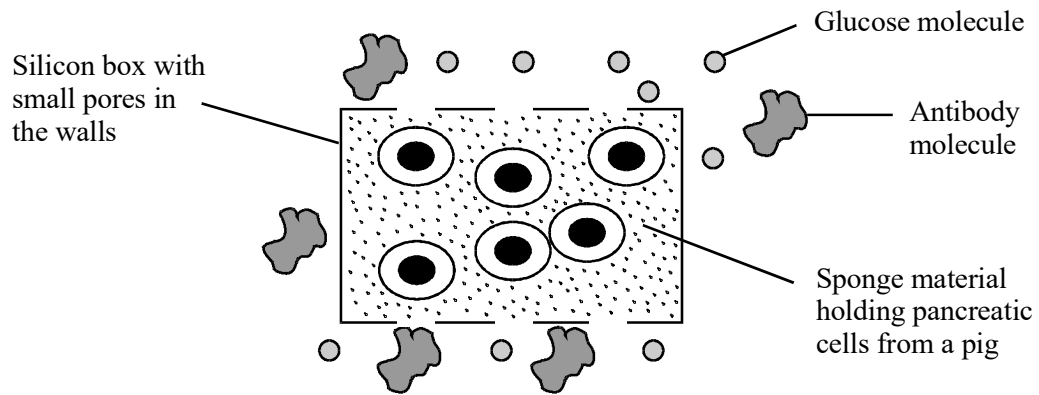
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(3)
(Total 15 marks)

32. Many diabetics inject insulin, because their pancreas has stopped producing it. Attempts have been made to transplant pancreatic cells from human embryos into diabetics but these foreign cells are often destroyed as a result of antibodies produced by the diabetic's immune system. The diagram shows a new type of transplant which has been tested in rats.



(a) (i) Explain why this transplant is not destroyed by the rat but can respond to changes in the rat's blood glucose concentration.

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(2)

(ii) Suggest why there might be controversy if this transplant was used in humans.

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(1)

- (b) Explain how the cells in the transplant control the blood glucose concentration of the rat.

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(3)
(Total 6 marks)

33. (a) An investigation was carried out to determine the effect of an increase in environmental temperature on oxygen consumption in a mammal. The table shows the results of this investigation.

Environmental temperature / °C	Oxygen consumption / arbitrary units
5	36
10	30
15	24
20	15
25	10
30	10
35	10

- (i) Describe the effect of an increase in environmental temperature on oxygen consumption in this mammal.

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(1)

- (ii) The mammal maintained a constant body temperature throughout the investigation. Explain how maintaining a constant body temperature accounts for the changes in oxygen consumption shown in the table.

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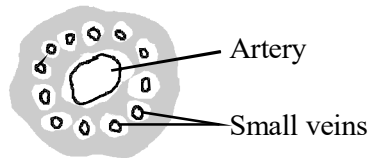
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(3)

- (b) One problem for mammals in attempting to maintain a constant body temperature is excessive heat loss from their limbs to the environment. The flippers of seals have small veins surrounding a central artery. Suggest how this arrangement, as shown in the diagram, helps to prevent excessive heat loss.



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(2)

(Total 6 marks)

34. Write an essay on the topic:

Cycles in biology

In the answer to this question you should bring together relevant principles and concepts from as many different modules as possible.

Your essay will be marked not only for its scientific accuracy, but also for the selection of relevant material.

The essay should be written in continuous prose.

The maximum number of marks that can be awarded is:

<i>Scientific content</i>	<i>16</i>
<i>Breadth of knowledge</i>	<i>3</i>
<i>Relevance</i>	<i>3</i>
<i>Quality of Written Communication</i>	<i>3</i>

(Total 25 marks)

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

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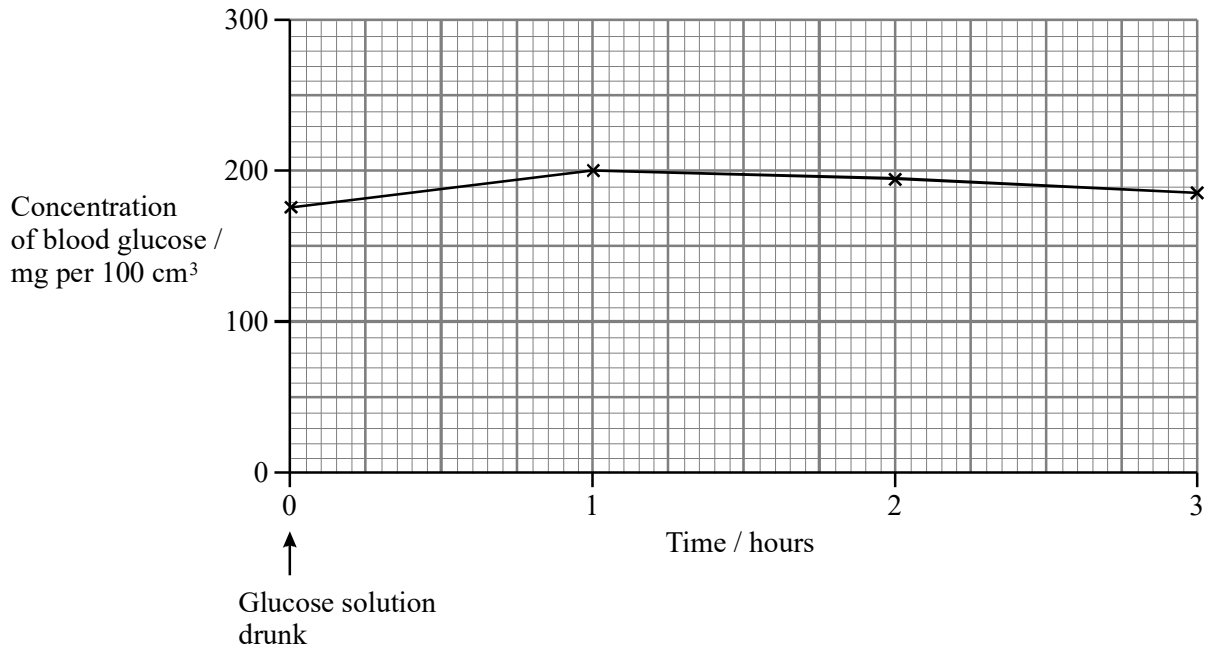
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(3)

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
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- 2
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(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.

- (i) Explain the advantage of injecting both types of insulin before breakfast.

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(2)

- (ii) One day, the man did not eat a midday meal. Suggest **one** reason why his blood glucose concentration did not fall dangerously low even though he had injected himself with the mixture of insulin before breakfast.

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(1)

(Total 9 marks)

36. (a) One effect of getting into a cold shower is a reduction in the amount of blood flowing through the capillaries near the surface of the skin. Explain how the cold water causes this response.

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(4)

(b) (i) When exercising at 30 °C, the body is more likely to overheat in humid conditions than in dry conditions. Explain why.

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(2)

(ii) Strenuous exercise leads to exhaustion more quickly in hot conditions than in cool conditions. One reason for this is a reduced blood supply to the muscles, which means that they receive less oxygen.

Suggest an explanation for the reduced blood supply to the muscles.

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(2)

(Total 8 marks)

37. **Figure 1** shows a seal which lives in the Arctic ocean. It is a mammal with a core body temperature of 37°C . It has a layer of fat (blubber) under the skin which is 50 mm thick and which insulates it from the cold.

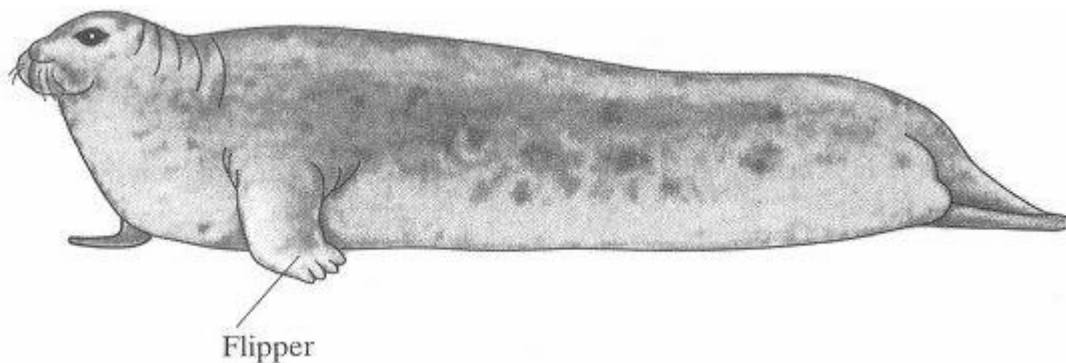


Figure 1

Figure 2 shows the temperature gradient in the surface tissues of the seal when it is in water at 0°C .

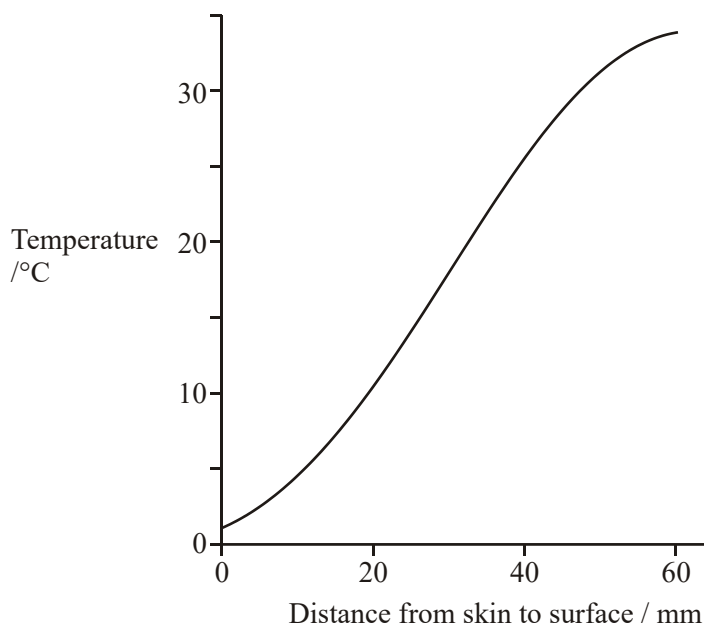


Figure 2

(a) Describe the evidence from **Figure 2** that blubber is an effective insulator.

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(2)

(b) **Figure 3** shows the arrangement of the blood vessels in the surface tissues of the seal.

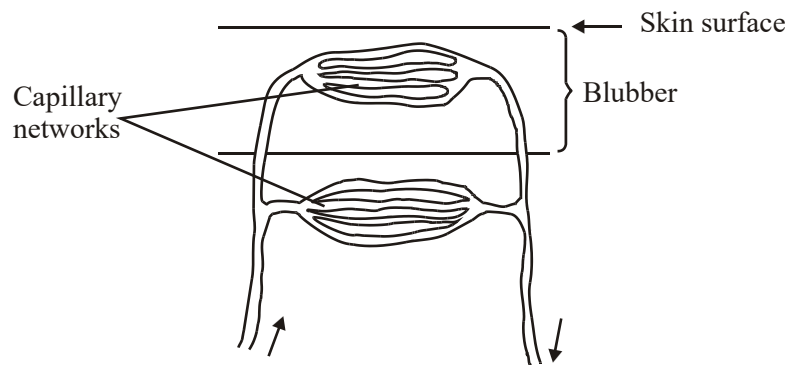


Figure 3

Explain how this arrangement of the blood vessels helps the seal to maintain a constant body temperature.

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(4)

- (c) The seal has no blubber in the flippers. Each artery carrying blood to the flipper is surrounded by veins from the flipper, as shown in **Figure 4**.

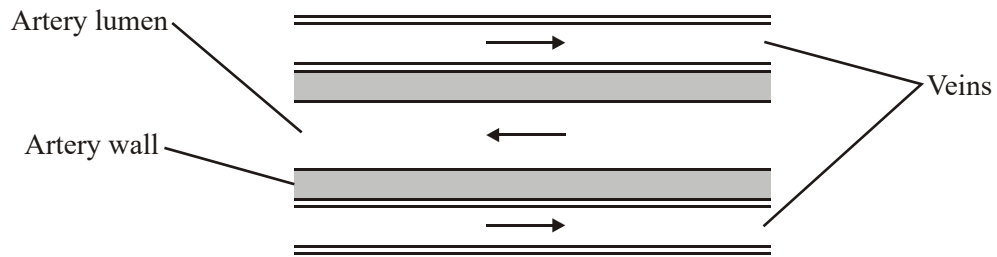


Figure 4

Explain how this arrangement of blood vessels prevents excessive heat loss.

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(3)

- (d) Like other mammals, seals produce urine which is more concentrated than their blood plasma. Explain the role of the loop of Henle in producing concentrated urine.

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(6)
(Total 15 marks)

- 38. The mule deer is a large mammal that lives in hot deserts. It is most active for a few hours around dawn and dusk each day. During the day it keeps cool by lying in the shade. Its large ears also help it to keep cool.



(a) Explain how the ears of the mule deer help it to keep cool.

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(2)

S (b) Explain **one** way in which activity during the day would raise body temperature.

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(2)

(Total 4 marks)

39. 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.

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(1)

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

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(2)

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

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(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?

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(1)

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

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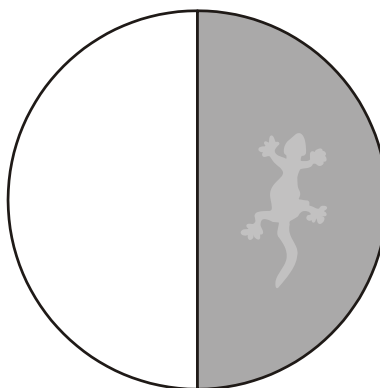
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(Total 9 marks)

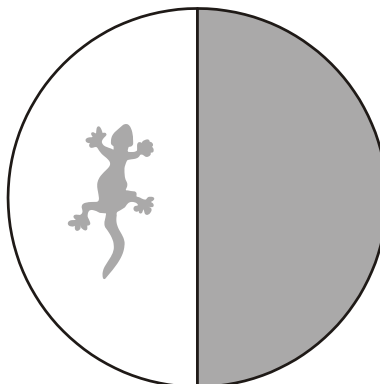
40. The body temperature of desert-living lizards is greatly affected by the temperature of their environment. A lizard was placed in a chamber where one half was maintained at 20 °C and the other at 40 °C. The lizard was free to move from one half to the other. The lizard's behaviour was observed using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

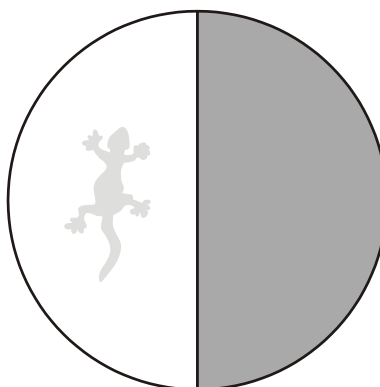
Photograph 1
The lizard had been in the
20°C side for several minutes



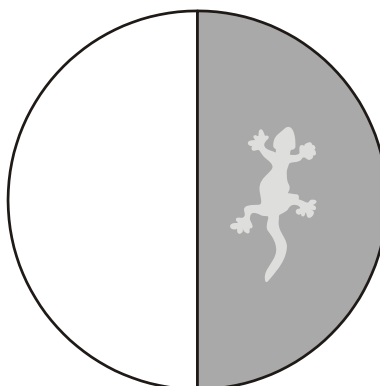
Photograph 2
The lizard then moved
to the 40°C side



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.

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(3)

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

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(2)

- S** (c) The lizard responds to the stimulus of a change in its body temperature. Describe how the nervous system brings about this response.

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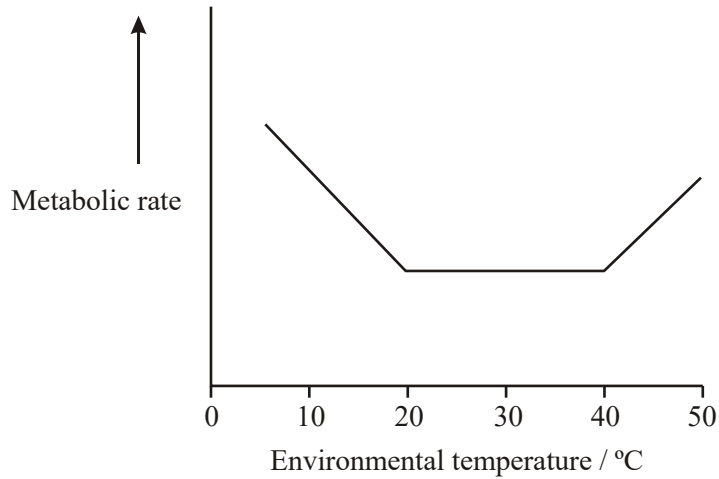
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(3)
(Total 8 marks)

41. The graph shows the effect of increasing the environmental temperature on the metabolic rate of a small mammal.



- (a) Suggest **one** way of measuring the metabolic rate.

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(1)

- (b) The small mammal has ears which are usually pink, but they appear pale when the environmental temperature is low. Explain the pale appearance of the mammal's ears when the environmental temperature is low.

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(3)

(c) Use your knowledge of thermoregulation to explain

(i) the change in metabolic rate of the mammal when the environmental temperature increases from 5°C to 40°C;

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(3)

(ii) the increase in metabolic rate after 40°C.

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(2)

(Total 9 marks)

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

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(1)

- (ii) A person swimming in cold water may not be able to maintain their core body temperature and begins to suffer from hypothermia. Explain why a tall, thin swimmer is more likely to suffer from hypothermia than a short, stout swimmer of the same body mass.

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(2)

- (c) 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.

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(3)

(Total 15 marks)

43. A student ate a meal containing carbohydrates at 07:00. He ate nothing else for the next five hours. The table shows the concentration of glucose in his blood at hourly intervals after the meal.

Time of day	Concentration of glucose in blood/mg per 100 cm ³ of blood
07:00	90
08:00	120
09:00	70
10:00	85
11:00	110
12:00	80

(a) Explain the rise in the concentration of glucose between 07:00 and 08:00.

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(1)

(b) The concentration of glucose in his blood fell between 08:00 and 09:00. Explain why.

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(2)

(c) Describe the role of hormones in the fluctuation of glucose concentration between 09:00 and 12:00.

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(4)

(Total 7 marks)

44. MDMA is a compound that is often used as a recreational drug. It is commonly known as ecstasy. Unfortunately, a number of people have died soon after taking ecstasy.

A research team investigated the effects of MDMA. They chose to work with groups of mice. The mice in one group were injected with MDMA whilst a second group acted as a control.

(a) Suggest **two** reasons why the research team chose to use mice in this investigation.

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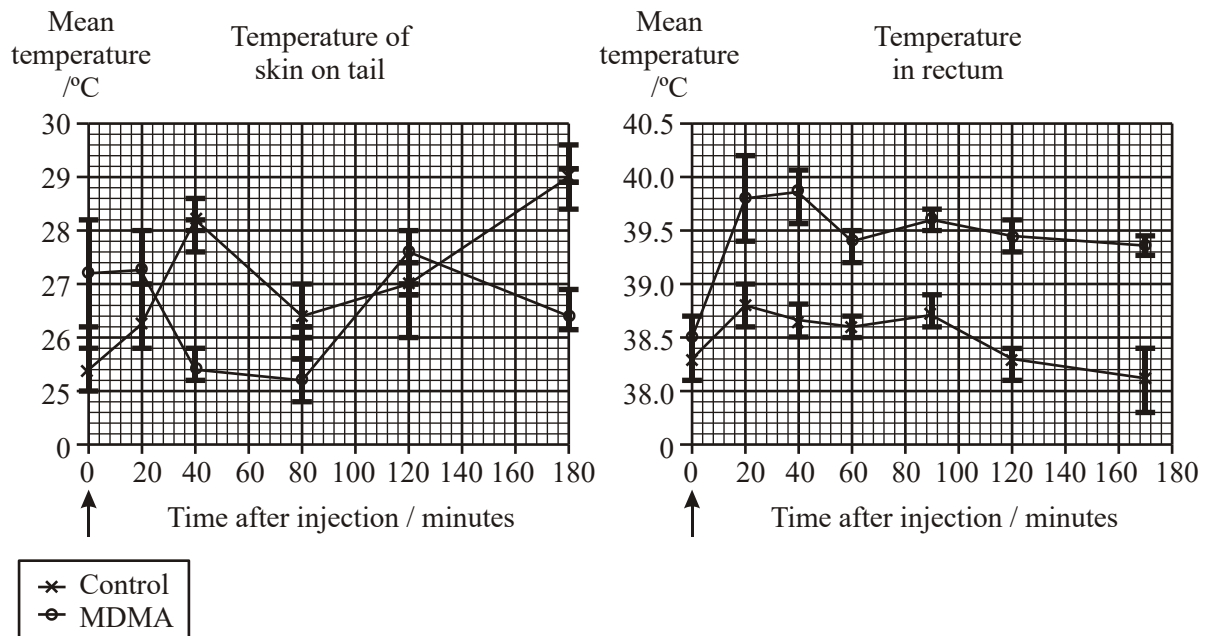
(2)

(b) How should the control group be treated?

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(1)

(c) For each mouse, the scientists monitored the temperature of the skin on its tail and the temperature in its rectum (lower part of the gut).
The graphs show the mean temperatures, and standard deviations of these means, after the injections were administered.



(i) Explain why the tail temperatures were always lower than the temperature in the rectum.

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(2)

(ii) The scientists concluded that MDMA causes death by stimulating heat generation. Use the data to evaluate their conclusion.

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(3)

(Total 8 marks)