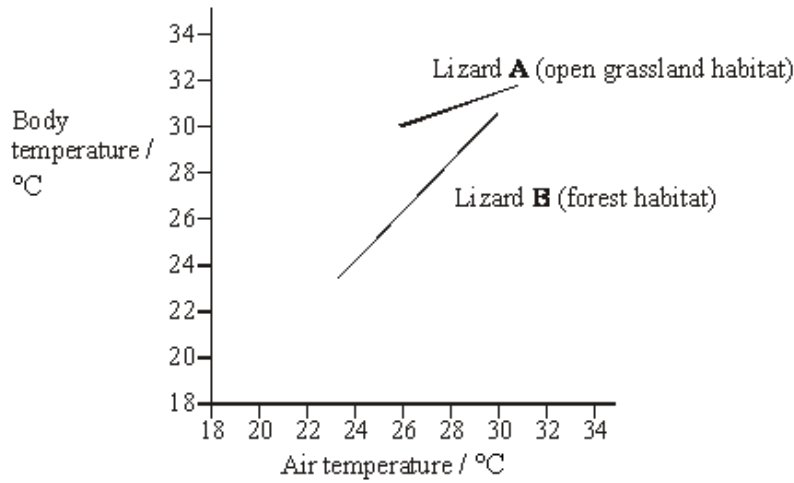


Q1. Lizards are reptiles. The graph shows the results of an investigation into the relationship between air temperature and body temperature for two lizards living in different habitats. The investigation took place on a hot sunny day over a period of four hours.



(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)

Q2. (a) Adrenaline binds to receptors in the plasma membranes of liver cells. Explain how this causes the blood glucose concentration to increase.

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(Extra space)
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(2)

(b) Scientists made an artificial gene which codes for insulin. They put the gene into a virus which was then injected into rats with type I diabetes. The virus was harmless to the rats but carried the gene into the cells of the rats.

The treated rats produced insulin for up to 8 months and showed no side-effects. The scientists measured the blood glucose concentrations of the rats at regular intervals. While the rats were producing the insulin, their blood glucose concentrations were normal.

(i) The rats were not fed for at least 6 hours before their blood glucose concentration was measured. Explain why.

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(1)

(ii) The rats used in the investigation had type I diabetes. This form of gene therapy may be less effective in treating rats that have type II diabetes. Explain why.

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(1)

(iii) Research workers have suggested that treating diabetes in humans by this method of gene therapy would be better than injecting insulin. Evaluate this suggestion.

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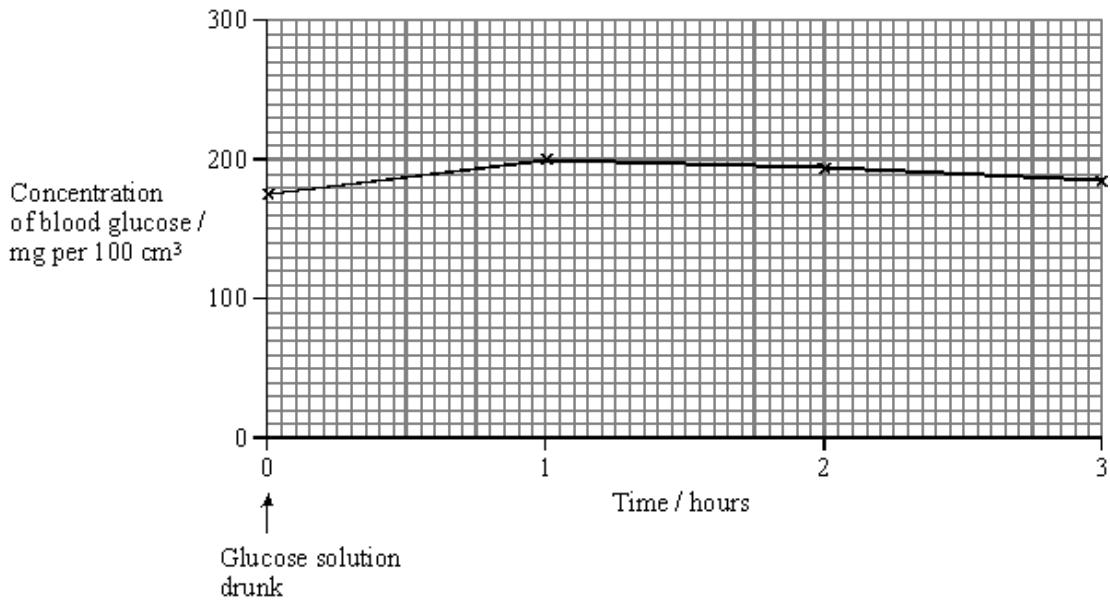
(Total 8 marks)

Q3. (a) Describe how insulin reduces the concentration of glucose in the blood.

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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)

Q4. Cows suffer from heat stress when the environmental temperature is too high. Heat stress occurs when their core body temperature rises above 39.4 °C. The table shows how environmental temperature affects the food intake, water intake and milk production of cows in a fixed period of time.

Environmental temperature / °C	Food intake / kg	Water intake / dm ³	Milk production / dm ³
20	18.2	81.8	27.0
25	17.7	88.6	25.0
30	17.0	95.0	22.9
35	16.7	144.1	18.0

- (a) Calculate the percentage decrease in milk production between the temperatures of 30 °C and 35 °C. Show your working.

Answer %

(2)

- (b) Suggest how each of the following responses helps to maintain core body temperature.

- (i) The change in water intake as environmental temperature increases.

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(1)

(ii) The change in food intake as environmental temperature decreases.

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(2)

(c) Explain the change in milk production as environmental temperature increases.

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(1)

(d) The rectal temperatures of cows are recorded to monitor heat stress. This is a better measurement of core body temperature than measuring the temperature of the skin. Explain why.

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(2)

(e) Selective breeding can be used to produce cows with desirable features. This involves mating cows with bulls. Suggest how a bull is selected to increase the probability of producing cows with a high milk yield.

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(1)

Milk contains lactose. Human babies produce the enzyme lactase, which digests lactose. Many human adults do not produce lactase and are lactose intolerant.

People who are lactose intolerant can become very ill if they drink milk or eat dairy products, such as butter and cheese.

- (f) Scientists have recorded the percentage of adults who are lactose intolerant in different countries. Explain the advantage of using percentages in this type of study.

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(2)

- (g) The scientists found that the percentage of people who can tolerate lactose is much higher in populations that drink a lot of milk and eat a lot of dairy products.

Use your knowledge of natural selection to explain this finding.

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(Extra space)

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(4)

(Total 15 marks)

Q5. 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
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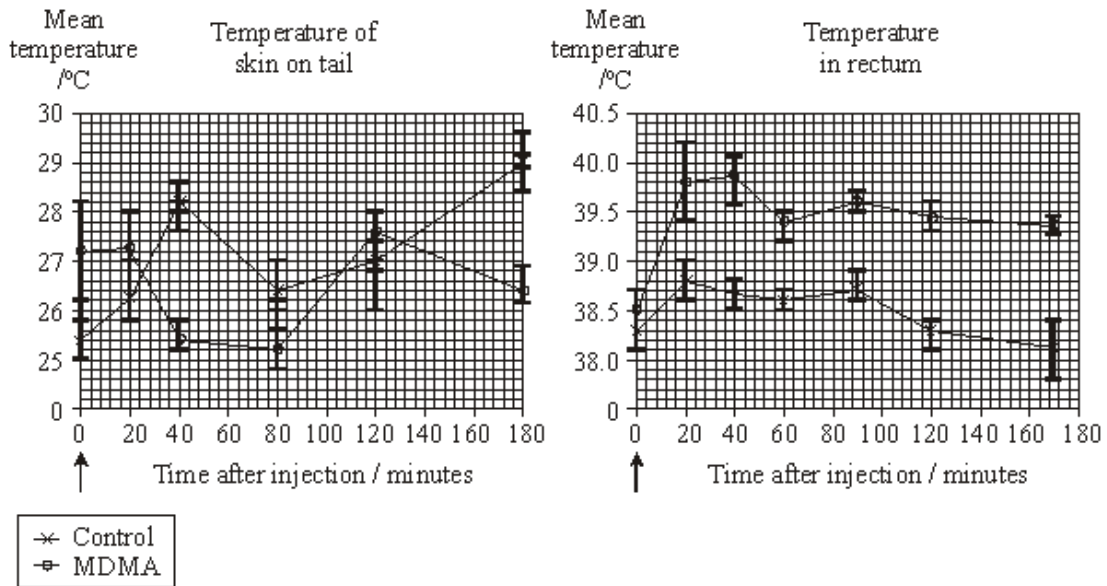
(2)

(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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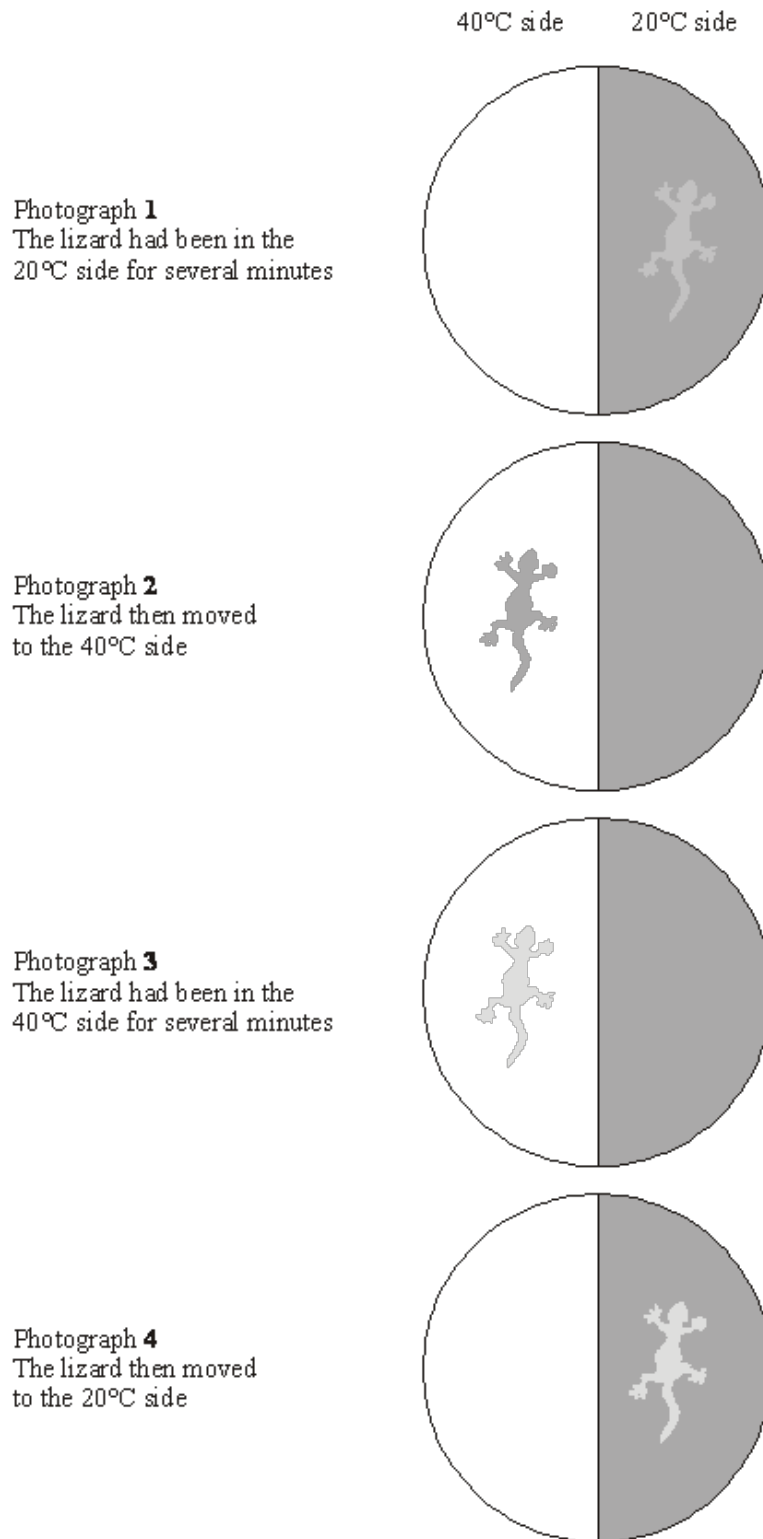
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(3)
(Total 8 marks)

Q6. 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.



(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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(3)

(Total 8 marks)

Q7. 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)

Q8. (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)

Q9. 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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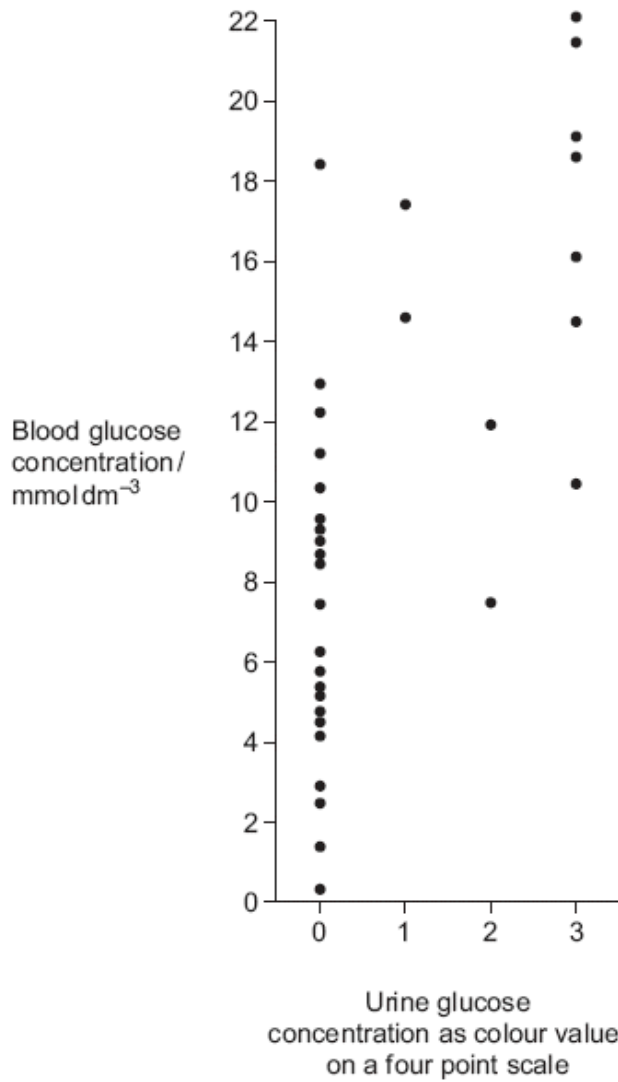
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(4)
(Total 6 marks)

- Q10.** (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.

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(2)

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

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(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.

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(2)

(Total 7 marks)

Q11. Different substances are involved in coordinating responses in animals.

- (a) Hormones are different from local chemical mediators such as histamine in the cells they affect.

- (i) Describe how hormones are different in the cells they affect.

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(1)

- (ii) Describe how hormones and local chemical mediators reach the cells they affect.

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(2)

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

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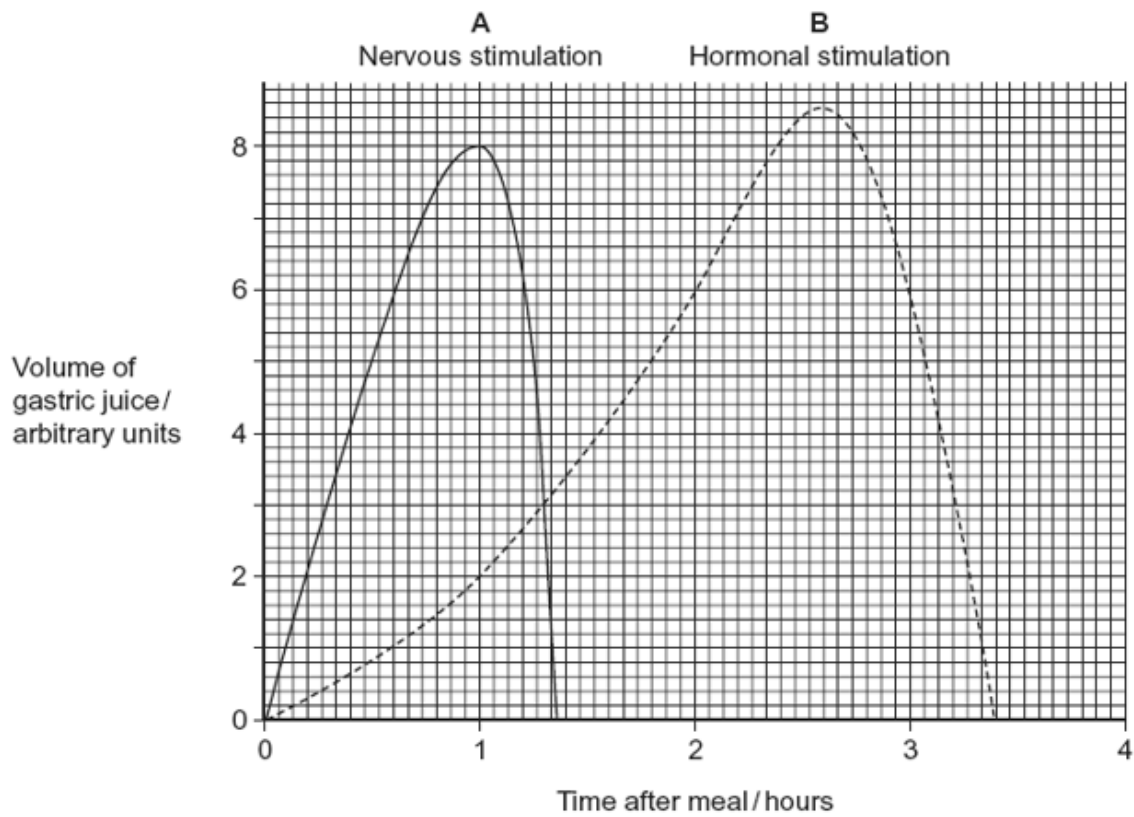
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(2)

- (c) 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.

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(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 8 marks)

Q12. 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

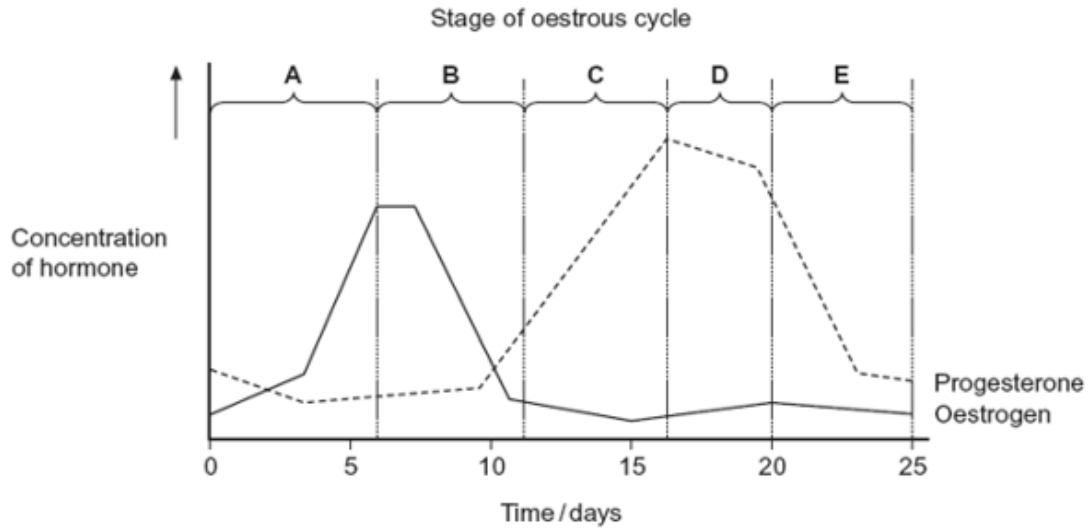
Scientific	16
Breadth of knowledge	3
Relevance	3
Quality of written communication	3

Write an essay on the following topic:

Negative feedback and its importance in biology.

(Total 25 marks)

Q13. The graph shows the concentrations of two hormones in the blood of an adult female pig over 25 days.



(a) (i) Use the graph to give the letter of the stage where ovulation occurred.

(1)

(ii) Give one piece of evidence from the graph that this pig was **not** pregnant at 25 days.

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(1)

(b) The relationship between oestrogen and LH is an example of positive feedback.

Explain how.

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(2)

- (c) Farmers sometimes give progesterone to sheep to prevent ovulation. Explain how progesterone prevents ovulation.

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(2)
(Total 6 marks)

Q14. 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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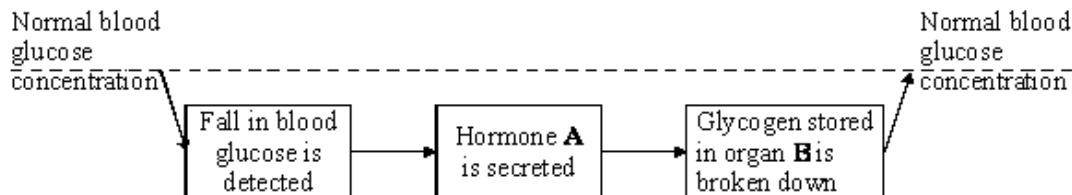
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(2)

(Total 9 marks)

Q15. The diagram shows some of the events which maintain blood glucose concentration in a mammal.



(a) Name

- (i) hormone **A**;
- (ii) organ **B**.

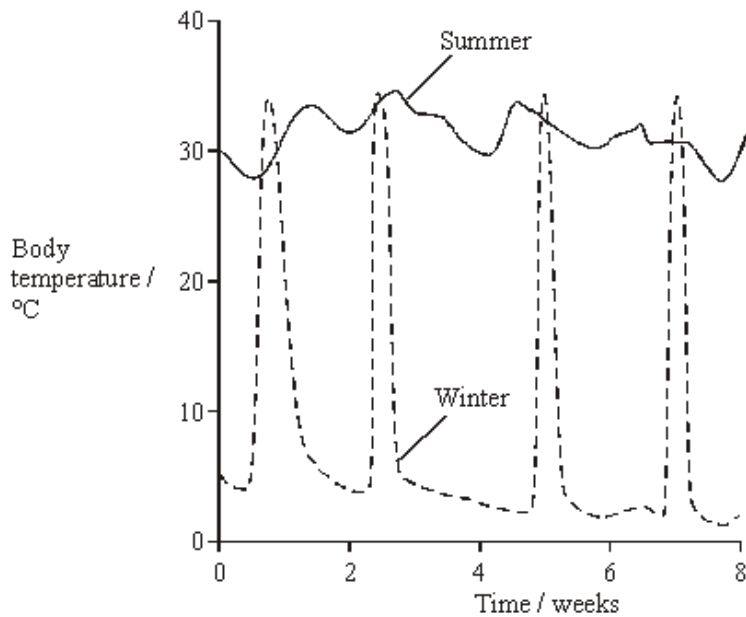
(2)

- (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)

Q16. 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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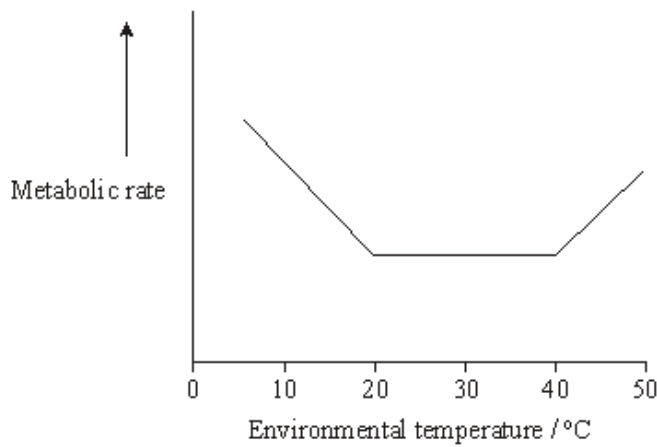
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(b) Explain how a higher body temperature is of benefit to an active echidna.

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(2)
(Total 4 marks)

Q17. 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)

Q18. (a) (i) What is meant by homeostasis?

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(1)

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

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(2)

- (b) (i) Cross-channel swimmers experience a large decrease in external temperature when they enter the water. Describe the processes involved in thermoregulation in response to this large decrease in external temperature.

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(7)

- (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)

- Q19.** 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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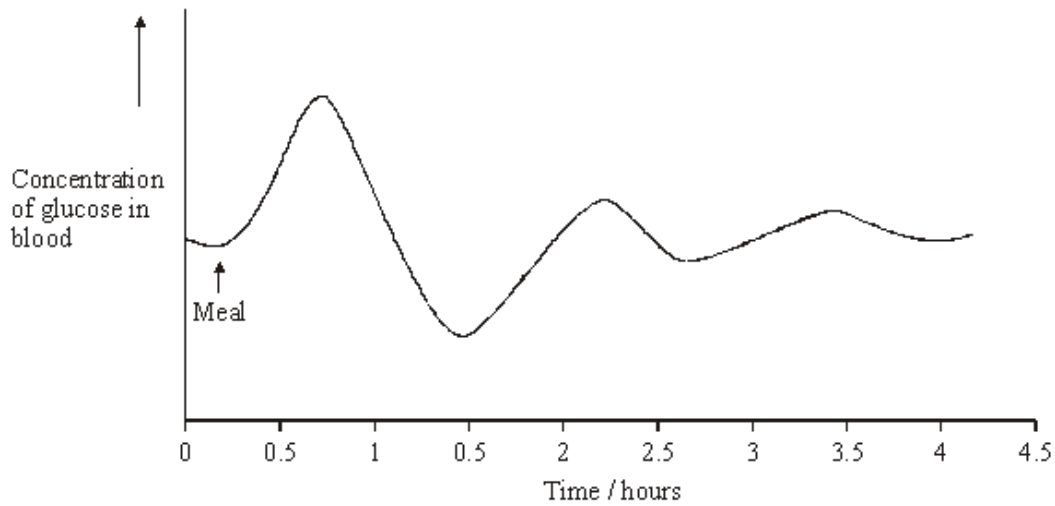
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(4)
(Total 7 marks)

- Q20.** (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)

Q21. 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

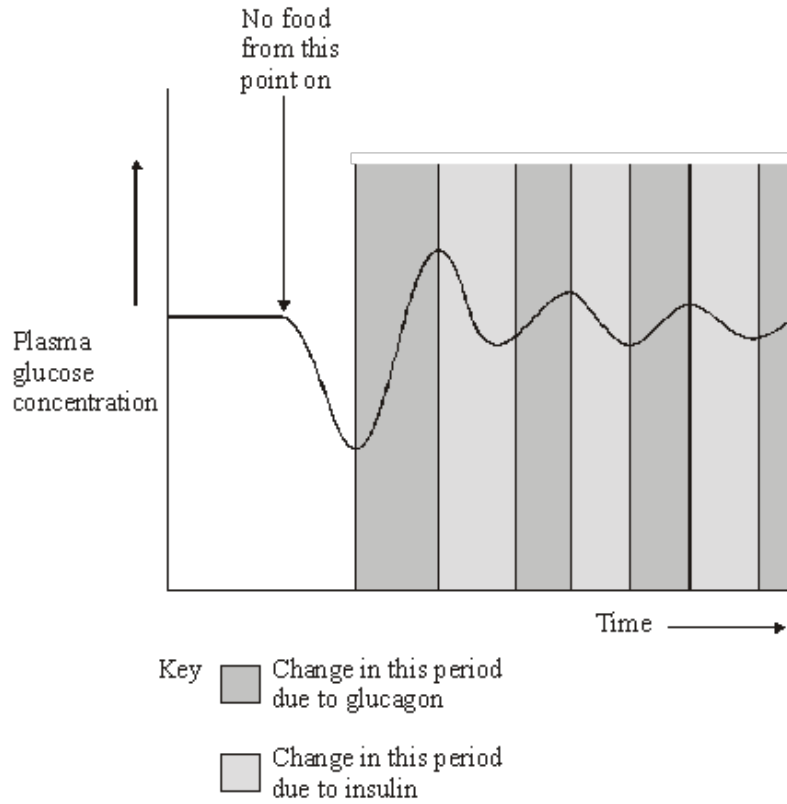
Write an essay on the following topic:

Negative feedback in living organisms.

(Total 25 marks)

Q22. 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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(5)

(Total 15 marks)

Q23. **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.

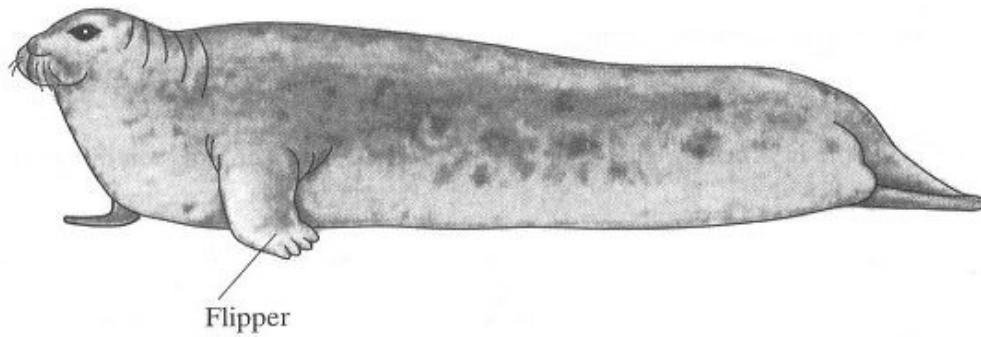


Figure 1

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

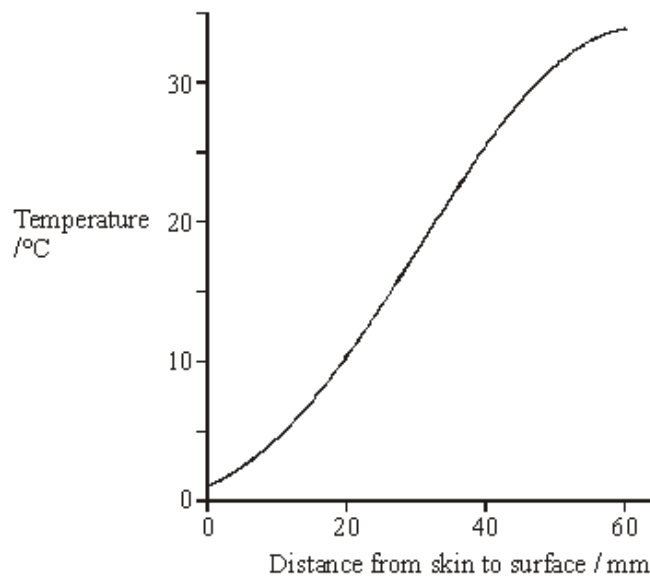


Figure 2

(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.

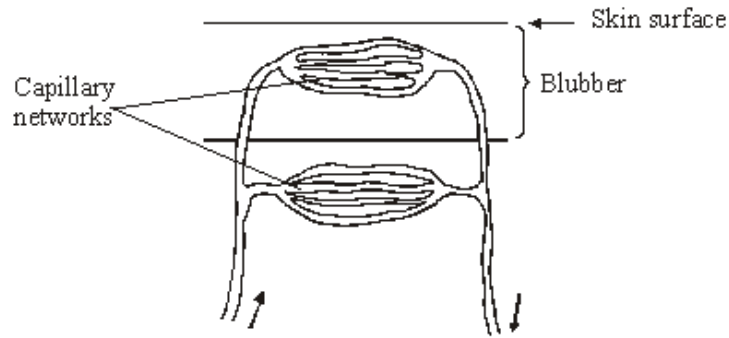


Figure 3

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**.

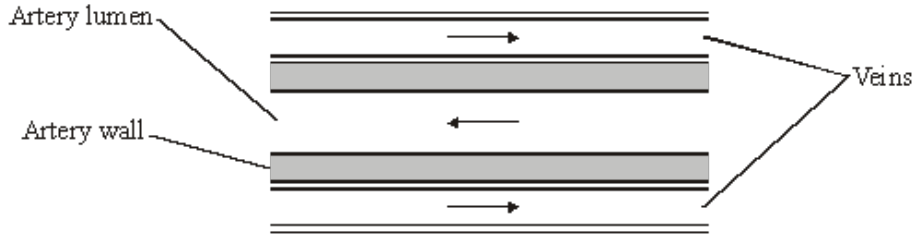


Figure 4

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)

- Q24.** (a) Desert iguanas are lizards that live in hot, dry conditions. Scientists measured the rate of oxygen consumption of desert iguanas at different body temperatures. Some of their results are shown in the table.

Body temperature / °C	Mean rate of oxygen consumption at rest / $\text{cm}^3 \text{g}^{-1} \text{h}^{-1}$
25	0.4
30	0.7
35	1.2
40	1.5

- (i) Explain how an increase in the iguana's body temperature affects its oxygen consumption when it is at rest.

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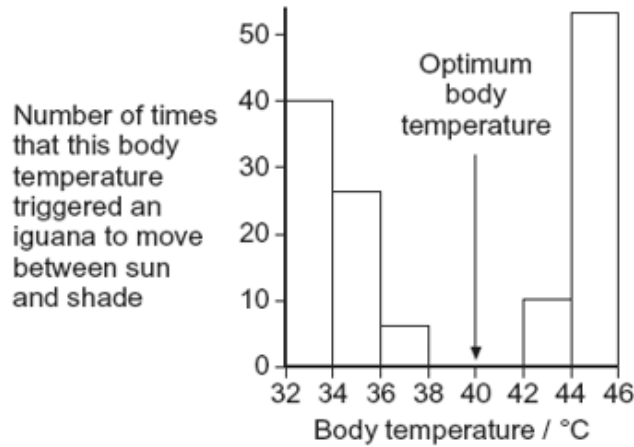
(3)

- (ii) The units in the table allowed the scientists to compare the oxygen consumptions of different iguanas. Explain how.

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(1)

- (b) The scientists then investigated how body temperature affected the behaviour of desert iguanas. They kept the iguanas in cages. Half of each cage was in the sun and half was covered to provide shade. The scientists continuously measured the body temperature of each iguana. They also recorded the body temperature when the iguana moved between sun and shade. Their results are shown in the graph.



- (i) Describe how the movements of the iguanas between sun and shade are related to body temperature.

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(1)

- (ii) The behaviour of the desert iguanas keeps their body temperatures within a narrow range. Explain how.

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(2)

- (c) At high temperatures, a desert iguana keeps its mouth wide open and breathes in and out rapidly. This is called panting. Explain how panting helps to reduce the body temperature of an iguana.

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(2)

(Total 9 marks)

