Surname		Other Names	
Centre Number		Candidate Number	
Candidate Signature			

Leave blank

General Certificate of Secondary Education
June 2006

BIOLOGY (HUMAN) **3415/H**
Higher Tier

H

Wednesday 7 June 2006 1.30 pm to 3.45 pm

For this paper you must have:
- a ruler

You may use a calculator.

Time allowed: 2 hours 15 minutes

Instructions
- Use blue or black ink or ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- Answer the questions in the spaces provided.
- Do all rough work in this book. Cross through any work you do not want marked.

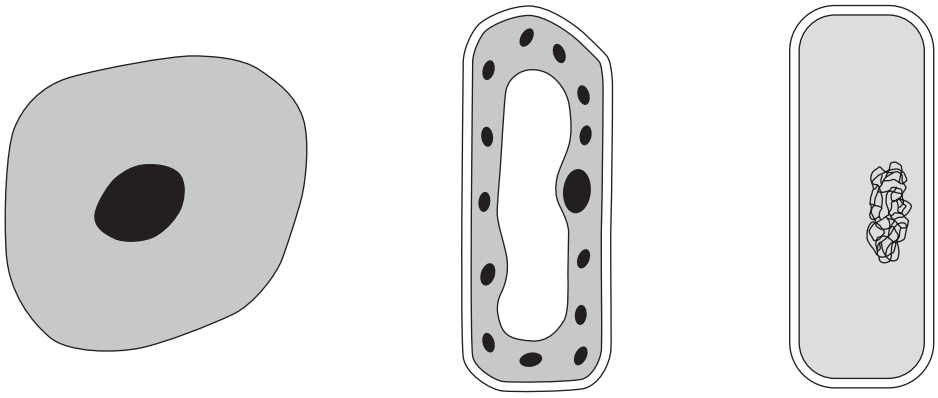
Information
- The maximum mark for this paper is 135.
- The marks for questions are shown in brackets.
- You are reminded of the need for good English and clear presentation in your answers.

For Examiner's Use			
Number	Mark	Number	Mark
1		11	
2		12	
3		13	
4		14	
5		15	
6		16	
7		17	
8		18	
9		19	
10		20	
		21	
		22	
		23	
Total (Column 1) →			
Total (Column 2) →			
TOTAL			
Examiner's Initials			

Answer **all** questions in the spaces provided.

1 Tuberculosis (TB) is a disease caused by a bacterium.

(a) The diagram shows three types of cell.



A **B** **C**

(not to scale)

(i) Which cell, **A**, **B** or **C**, is a bacterium? .....

(1 mark)

(ii) Describe **one** feature you can see in the diagram which helps you to identify this cell as a bacterium.

.....

(1 mark)

(b) TB is spread by coughs and sneezes. It is more common when people live together in crowded conditions. TB usually affects the lungs first, although other organs may later become infected.

(i) Why is TB more likely to spread when people live in crowded conditions?

.....

.....

(1 mark)

(ii) Why does TB affect the lungs first?

.....

.....

(1 mark)

(iii) How could TB later spread to other regions of the body?

.....

.....

(1 mark)

(c) The human body has several natural defences against bacteria. Some of these prevent bacteria from entering the body. Others act once the bacteria have entered.

Give **two** ways in which the body stops bacteria from entering.

1 .....

2 .....

(2 marks)

7

Turn over for the next question

2 A slice of bread contains 300 kilojoules of energy.
A typical teenage girl needs 10 200 kilojoules of energy each day.

(a) A girl eats only bread and drinks only water for one day.
How many slices of bread must she eat to supply her energy needs for the day?

Show clearly how you work out your final answer.

.....

.....

..... slices of bread
(2 marks)

(b) Most of the carbohydrate in bread is starch.

(i) Name **one** part of the digestive system where starch is digested.

.....
(1 mark)

(ii) Name the enzyme which digests starch.

.....
(1 mark)

(iii) Name **one** product of starch digestion.

.....
(1 mark)

(iv) Name **one** part of the digestive system where the products of starch digestion are absorbed into the blood.

.....
(1 mark)

6

LEAVE MARGIN BLANK

3 The following warning was printed on a packet of cigarettes.

Explain how cigarette smoking can cause fatal diseases.

To gain full marks in this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.

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(5 marks)

5

4 The table shows gas production by a plant at different light intensities and at two different concentrations of carbon dioxide.

Light intensity in arbitrary units	**Rate of gas production at 20 °C in cm^3 per hour**	
	at 0.03 % carbon dioxide	**at 1 % carbon dioxide**
0	0.00	0.00
10	0.27	0.30
20	0.44	0.60
30	0.54	0.80
40	0.60	0.89
50	0.60	0.95

(a) (i) Name the gas which was produced by the plant.

.....

(1 mark)

(ii) Name the process which produced this gas.

.....

(1 mark)

(b) The data obtained with 0.03 % carbon dioxide are plotted on the graph on the opposite page.
Draw a graph of the data obtained with 1 % carbon dioxide. Draw this on the same graph paper.

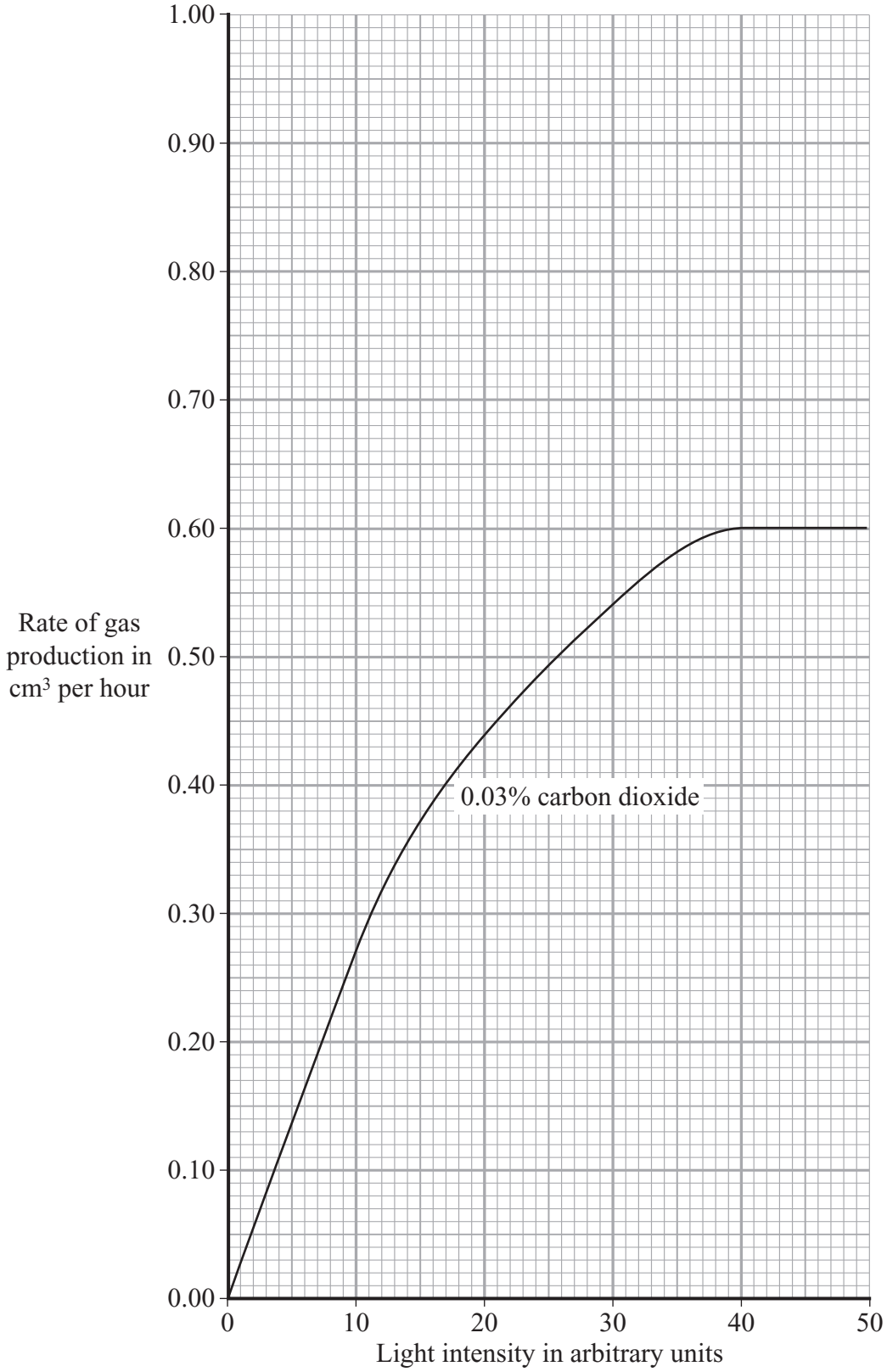
(3 marks)

(c) Give **two** environmental factors which might have limited the rate of gas production at 50 units of light intensity and 0.03 % carbon dioxide.

1 .....

2 .....

(2 marks)



7

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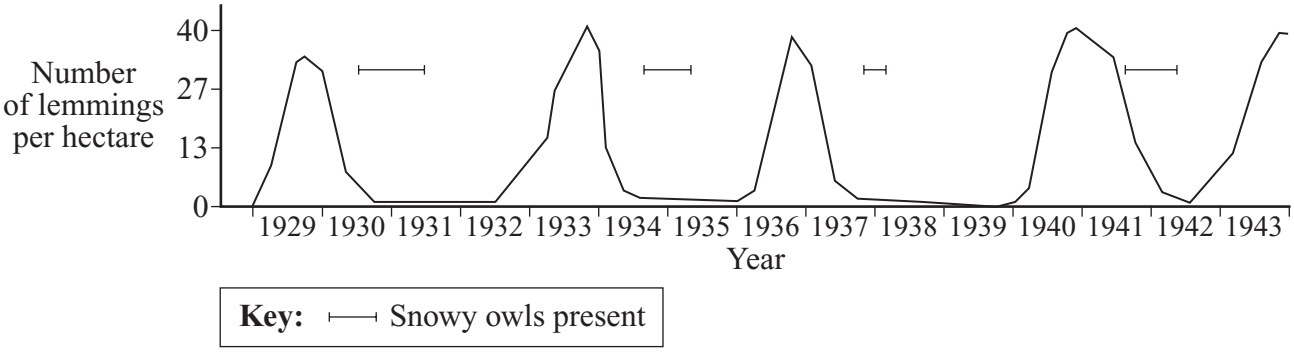
5 The lemming is a small mammal which eats plants. The snowy owl is a predator. The graph shows changes in the population of lemmings in one area of northern Canada.



(a) What is a *predator*?

.....

.....

(2 marks)

(b) It is unlikely that the snowy owls caused the decreases in the lemming population. What evidence from the graph supports this?

.....

.....

(1 mark)

(c) Suggest what environmental conditions might have caused the sudden decreases in the lemming population.

.....

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(3 marks)

6

LEAVE MARGIN BLANK

6 Explain how the burning of fossil fuels can harm the environment.

To gain full marks in this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.

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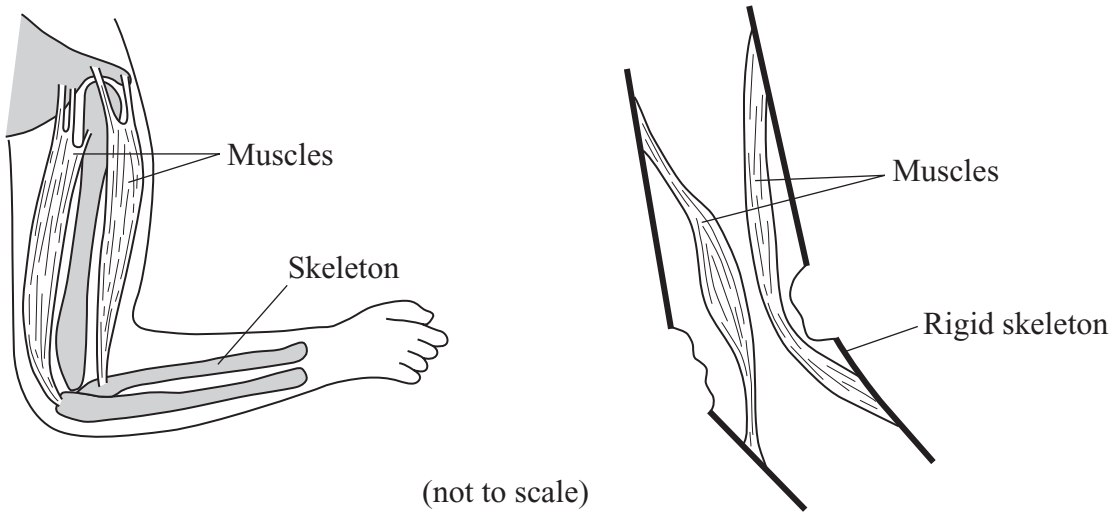
(5 marks)

5

Turn over for the next question

7 (a) The diagram shows the skeleton and muscles of a human arm and part of a crab leg.



(not to scale)

Human arm **Crab leg**

(i) The human arm and the crab leg both have joints.

Describe **one** other way in which the structure of the human arm and the crab leg is similar.

.....

.....

(1 mark)

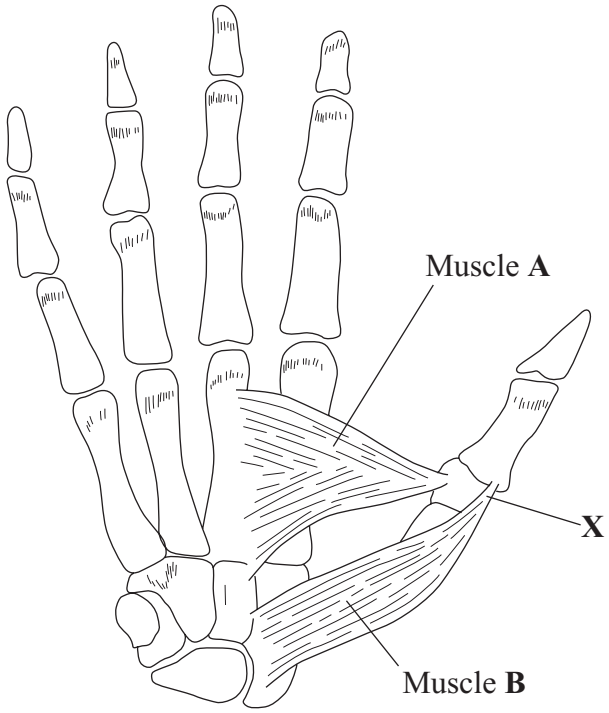
(ii) Describe **one** way in which the structure of the human arm is different from the crab leg.

.....

.....

(1 mark)

(b) The diagram shows the skeleton of a hand with two muscles which can move the thumb.



(i) The thumb can be moved either towards **or** away from the fingers.

Describe how these muscles can cause these **two** different actions.

.....

.....

.....

.....

(2 marks)

(ii) If the structure labelled **X** is accidentally torn, movement of the thumb is difficult.

Suggest the reason for this.

.....

.....

(1 mark)

5

8 (a) Scientists use fossilised bones and teeth when studying the origins of humans. Often only a few fossils are found.

Suggest **one** reason why there are only a few fossils.

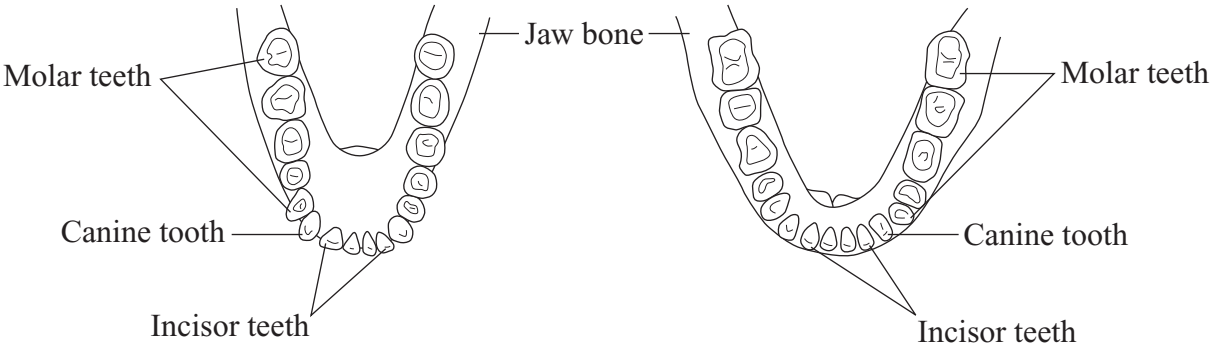
.....

.....

(1 mark)

(b) *Australopithecus* was a small bipedal animal with both ape and human characteristics. Some scientists thought that it was an ancestor of *Homo sapiens*. Others thought that it was not on the direct line of evolution of modern humans.

The diagram shows the lower jaw of *Australopithecus*. The lower jaw of *Homo sapiens* is also shown for comparison.



Australopithecus ***Homo sapiens*** **(Modern humans)**

(i) Describe **two** features shown in the diagram which suggest that *Australopithecus* was an ancestor of *Homo sapiens*.

.....

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(2 marks)

(ii) Describe **one** feature shown in the diagram which suggests that *Australopithecus* was **not** an ancestor of *Homo sapiens*.

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(1 mark)

4

9 Four students thought that smokers would have higher heart rates than non-smokers. They each measured the pulse rate of one adult. The table shows the results as recorded by the students.

Person	Pulse rate	Heart rate in beats per minute
A (non-smoker)	78 beats in one minute	78
B (non-smoker)	36 beats in 30 seconds	72
C (smoker)	160 beats in 120 seconds	
D (smoker)	12 beats in 10 seconds	

(a) Enter the heart rates for persons **C** and **D**. *(1 mark)*

(b) Suggest **one** reason why the students could not come to a firm conclusion about the effects of smoking on the rate of heartbeat.

.....

.....

(1 mark)

(c) Person **B** had a stroke volume of 70 cm^3. What was the cardiac output (cm^3 per minute) of this person? Show your working.

.....

.....

..... cm^3 per minute

(2 marks)

(d) During exercise the cardiac output increases. What is the advantage of this increase for the contracting muscles?

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.....

(1 mark)

(e) Regular athletic training can strengthen the heart muscles. This causes an increase in the stroke volume. Suggest **one** reason to explain why this change can help a person running a race.

.....

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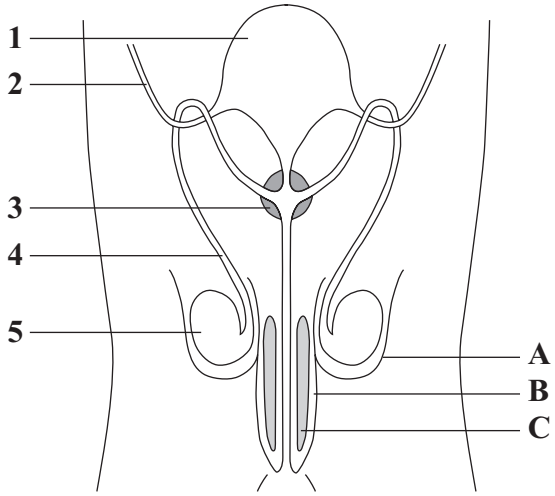
(1 mark)

6

Turn over ▶

10 The diagram shows the structure of the male reproductive system and part of the urinary system from the front.



(a) The table shows the functions of two of the parts numbered 1–5 in the diagram. Write the number of each of these parts in the second column.

Part	Number
Contains smooth muscle to move sperm	
Adds a liquid secretion to sperm before they are released	

(2 marks)

(b) During intercourse live sperm are released near the cervix.

Describe, in the correct order, the parts played by the structures labelled **A**, **B** and **C** to enable this to happen.

To gain full marks in this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.

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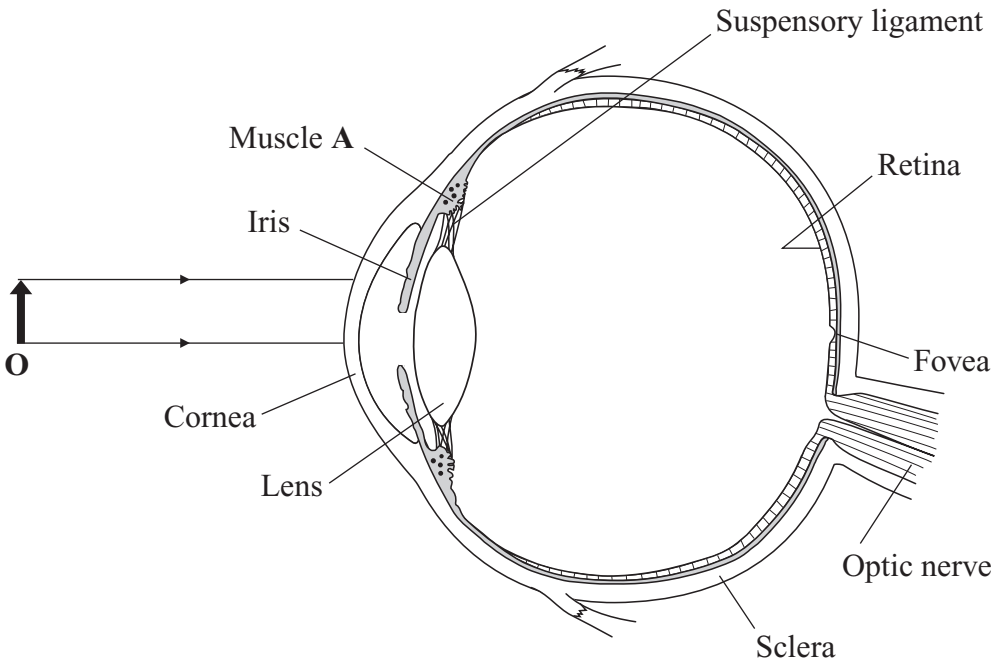
(4 marks)

6

Turn over for the next question

11 The diagram shows a section through the human eye.



(a) Which **two** parts of the eye help to bend the light rays to bring them to a focus?

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(1 mark)

(b) If object **O** were moved closer to the eye, what would muscle **A** do and how would this help to bring the light to a focus?

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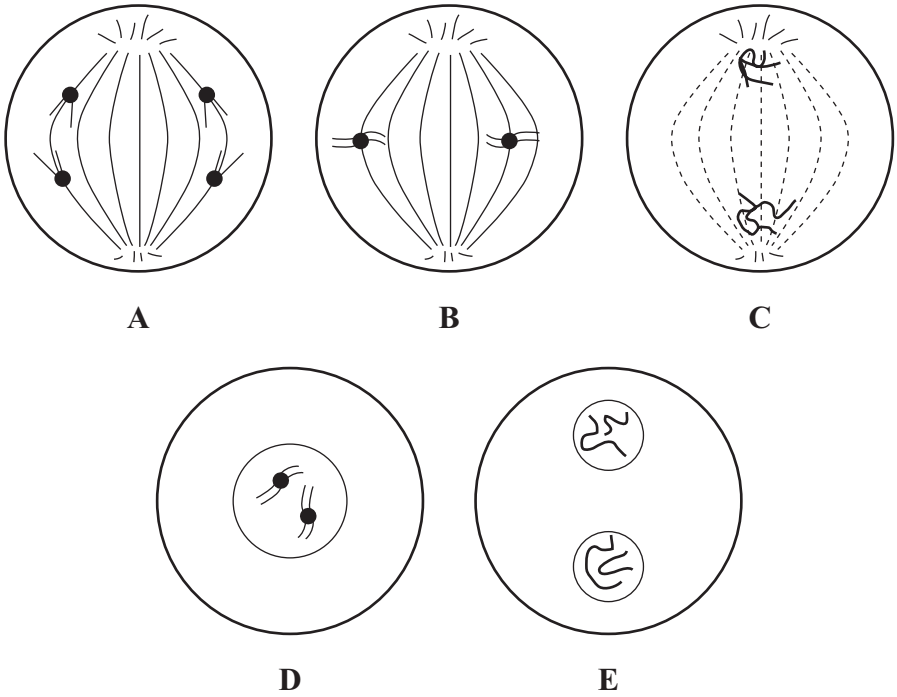
(2 marks)

3

12 The diagram shows five stages in one type of cell division. The stages are not in the correct order. Cells produced by this type of cell division are genetically identical.



A **B** **C**

D **E**

(a) (i) Name the type of cell division shown in the diagram. .....

(1 mark)

(ii) What is the correct order of stages **A**, **B**, **C**, **D** and **E**?

.....

(1 mark)

(b) Approximately one in every million cells produced by this type of cell division will be genetically different.

(i) What name do scientists use to describe a change in a gene?

.....

(1 mark)

(ii) The rate of genetic change can be increased by some environmental factors.

Give **one** environmental factor that would cause an increase in the rate of genetic change.

.....

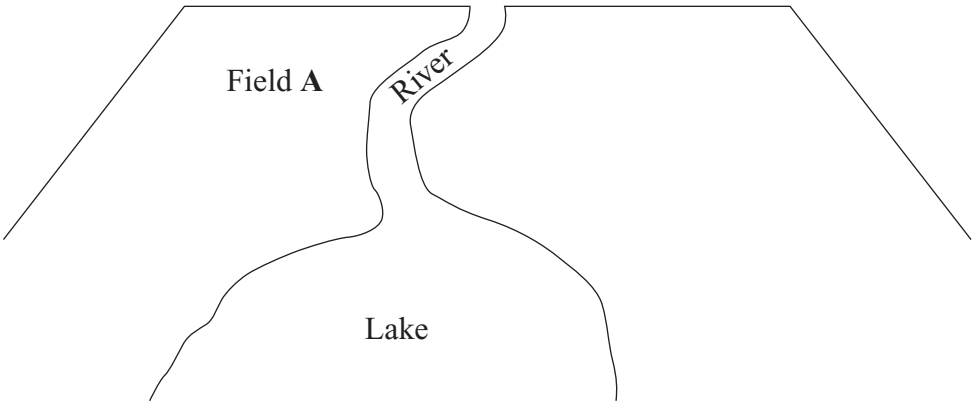
(1 mark)

4

13 **Figure 1** shows a section through part of a farm. **Figure 2** shows a map of the farm. A river flows through the farm and then enters a small lake.

Figure 1

Figure 2



The farmer added inorganic fertiliser to Field **A**. This was followed by heavy rainfall and then several weeks of hot, sunny weather. The water in the lake turned green and cloudy and many fish died.

Explain what caused these changes in the lake.

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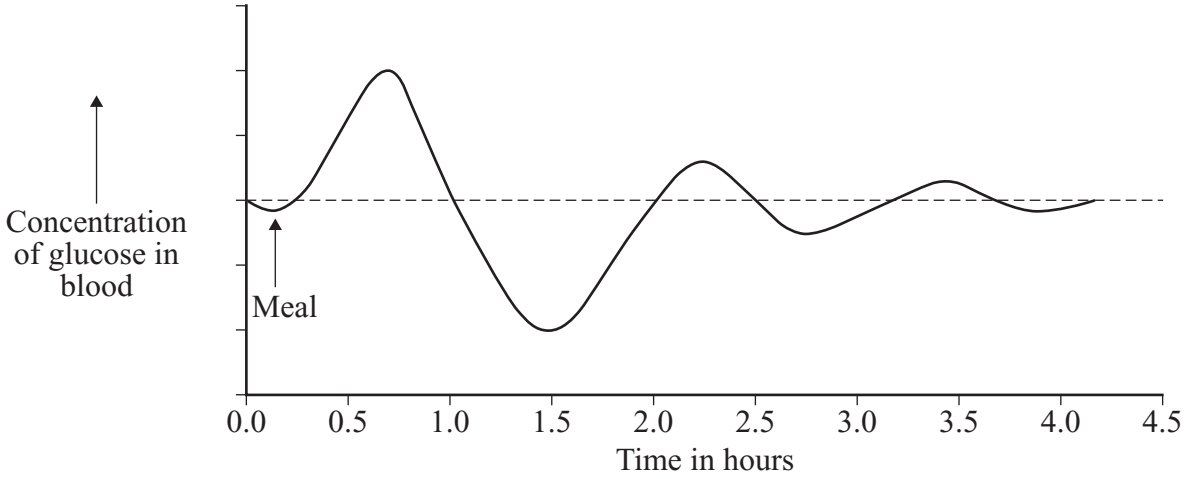
(4 marks)

4

14 (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 will be highest;

Y a time when insulin secretion will be highest.

(2 marks)

(b) Many diabetics require injections of insulin. The insulin is made by genetically-engineered bacteria which contain the gene for human insulin.

Suggest why treating diabetics with insulin made by genetically-engineered bacteria may be better than treating them with insulin made by pigs and cattle.

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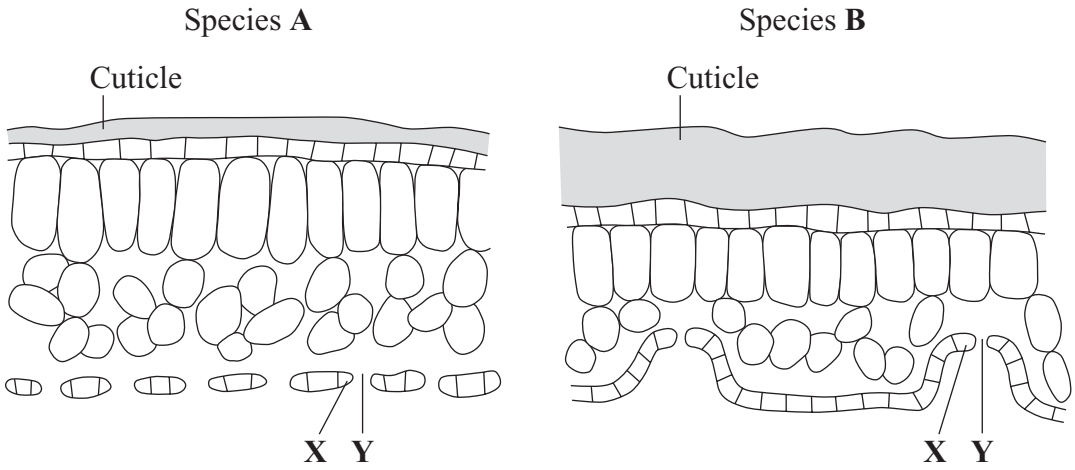
(2 marks)

4

15 The diagram shows sections through leaves from two different plant species.



(a) (i) Name cell **X** and space **Y**.

X: .....

Y: .....

(2 marks)

(ii) Which species, **A** or **B**, is better adapted to living in dry conditions?

Give **two** reasons for your answer.

Species .....

Reason 1 .....

Reason 2 .....

(2 marks)

(b) The leaves on both plants wilted in hot, dry, windy conditions.

Explain why.

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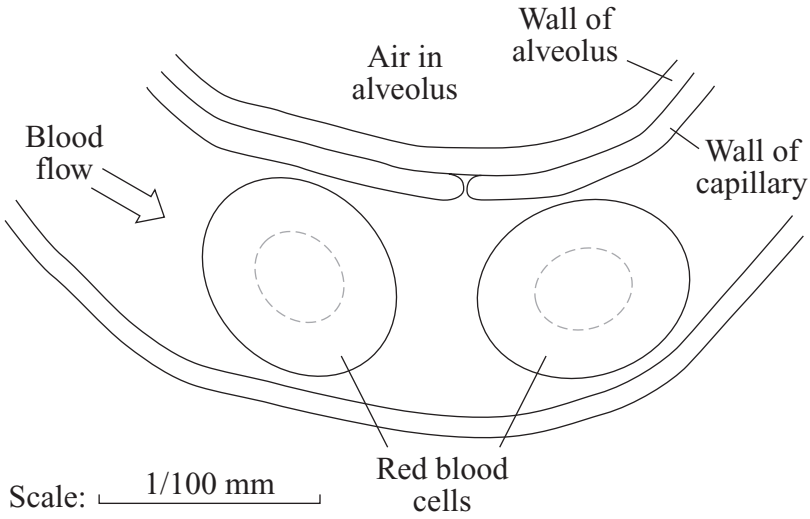
(3 marks)

7

16 There are about 400 million alveoli in the human lung.
The diagram shows some red blood cells in a capillary next to an alveolus.
Each red blood cell contains about 500 million molecules of haemoglobin.



Use this information and your own knowledge to explain how a large amount of oxygen enters the blood in the capillary.

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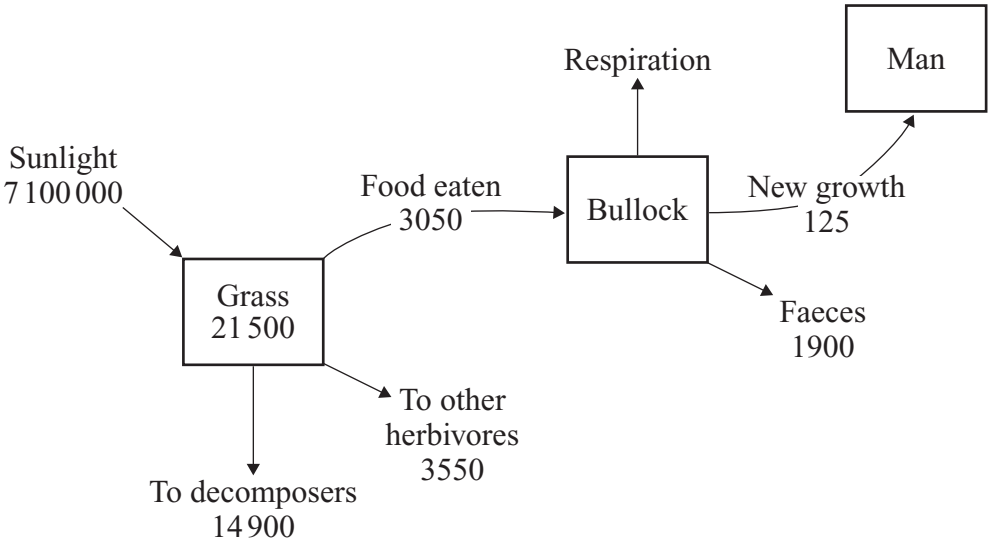
(5 marks)

5

17 The diagram shows the flow of energy through a food chain. The figures are in kilojoules of energy per square metre per year.



(a) How do decomposers break down carbon-containing compounds from the dead remains of grass plants?

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(3 marks)

(b) When the bullock eats the grass, much of the energy from the grass is released in respiration.

(i) How much energy is released by the bullock in respiration?

..... kJ per m^2 per year

(1 mark)

(ii) Give **one** use of the energy released in respiration.

.....

(1 mark)

(c) Intensive rearing of cattle indoors is an attempt to reduce energy losses. The table shows the energy balance for indoor and outdoor meat production from cattle.

	kJ per m^2 per year	
	Indoors	**Outdoors**
Energy input as food	10 000	5 950
Energy input as fossil fuel	6 000	50
Energy trapped in meat	40	1.8

(i) The percentage efficiency of rearing cattle indoors is 0.25 %.
Use the following formula to calculate the percentage efficiency of rearing cattle outdoors.

$$\text{Percentage efficiency} = \frac{\text{Energy trapped in meat}}{\text{Total energy input}} \times 100$$

Show clearly how you work out your answer.

.....

.....

..... Percentage efficiency
(2 marks)

(ii) Suggest **two** reasons why rearing cattle indoors is more efficient than rearing them outdoors.

1.....

.....

2.....

.....
(2 marks)

(iii) Suggest **two** possible disadvantages of rearing cattle indoors.

1.....

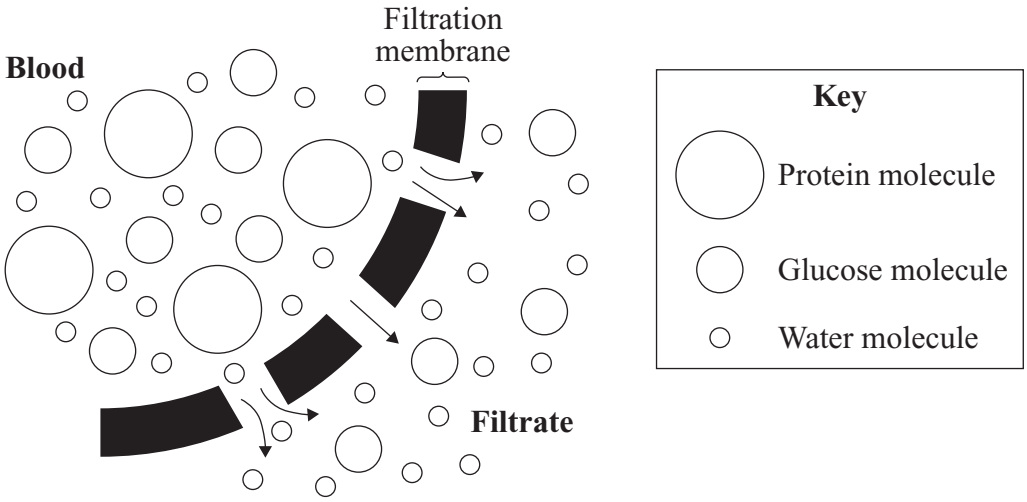
.....

2.....

.....
(2 marks)

11

18 The diagram shows the process of filtration in the kidney.



(a) Use information in the diagram and your own knowledge of how the kidney works to explain why:

(i) protein molecules are not normally present in urine;

.....

.....

.....

(1 mark)

(ii) glucose molecules are not normally present in urine.

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(3 marks)

(b) An athlete trained for two hours on a hot summer's day. At the end of the training session, the athlete had a higher concentration of antidiuretic hormone (ADH) in his blood than at the start of the training session.

Explain why.

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(4 marks)

8

Turn over for the next question

19 Cystic fibrosis is an inherited disorder caused by a recessive allele, **n**. People with cystic fibrosis produce thick, sticky mucus in their lungs which makes breathing difficult. Heterozygous individuals are unaffected because they have the dominant allele, **N**, in their genotype.

(a) What is the genotype of:

(i) a person with cystic fibrosis; .....

(ii) a person who is heterozygous for cystic fibrosis? .....

(2 marks)

(b) A man and his wife have a child with cystic fibrosis. Neither the man nor his wife has cystic fibrosis. What is the probability that their next child will have cystic fibrosis?

Use a genetic diagram to explain your answer.

Probability = ...

(4 marks)

(c) Gene therapy is being developed to treat cystic fibrosis. The patient breathes in tiny droplets from an inhaler which contain the functional gene wrapped up in fatty material. The fatty droplets are taken in through the surfaces of cells lining the lung, delivering the gene into these cells.

(i) Name the structure which controls the passage of substances into a cell.

.....

(1 mark)

(ii) Suggest why someone treated by gene therapy would not be able to pass on the functional gene to any offspring.

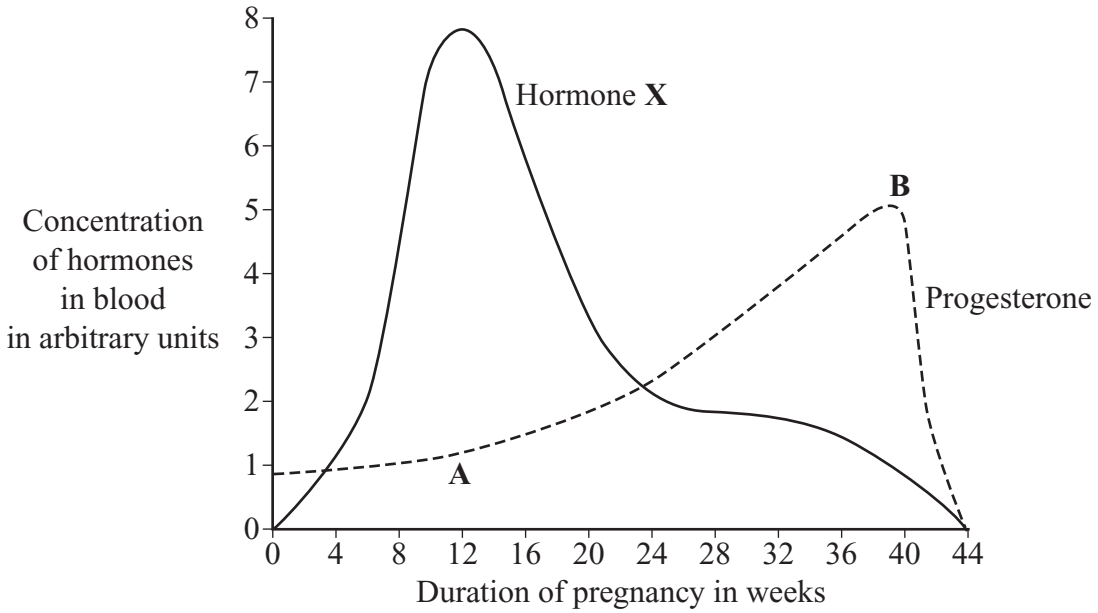
.....

.....

(1 mark)

8

20 The graph shows the relative concentrations of progesterone and hormone **X** in the blood of a person during a pregnancy. These two hormones help to ensure that the embryo is not aborted.



(a) (i) Name hormone **X**.

.....

(1 mark)

(ii) The increased secretion of hormone **X** causes the corpus luteum to remain and to continue releasing progesterone.

What is the cause of the change in the concentration of progesterone between points **A** and **B**?

.....

.....

(1 mark)

(b) Describe, in the correct order, how changes in the concentration of progesterone and oxytocin help to cause birth.

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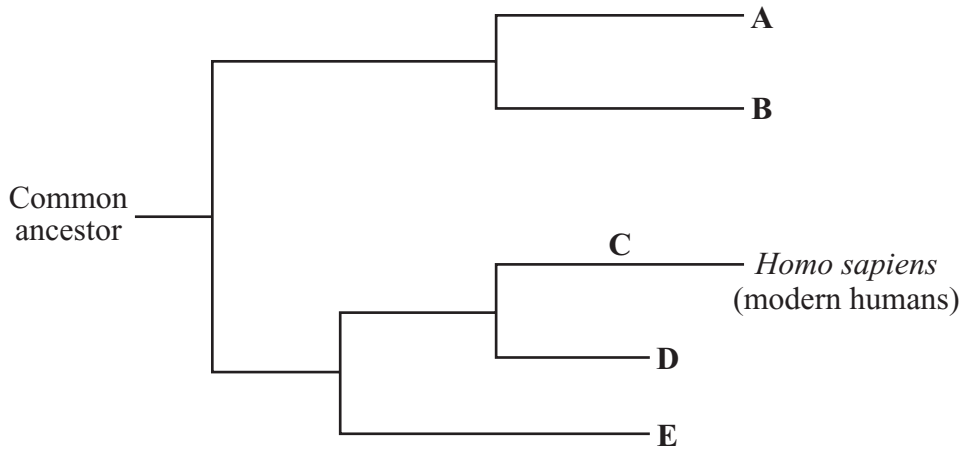
(3 marks)

5

21 The diagram shows some of the evolutionary relationships of *Homo sapiens* (modern humans) and some other primates.



(a) **A** and **B** are living primates. DNA can be used to find which of these two primates is most closely related to modern humans.

Explain how this can be done.

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(3 marks)

(b) Letter **C** shows the position on this evolutionary diagram of *Homo habilis*. Another early human was *Homo erectus* which had a larger brain than *Homo habilis*. *Homo erectus* also made sophisticated tools and used fire.

Place an **X** on the diagram to show the position of *Homo erectus*. *(1 mark)*

(c) **D** and **E** on the diagram are extinct primates. They are known only as fossils. *Radioisotopes* can be used to date such fossils.

(i) What is meant by the term *radioisotopes*?

.....

.....

(1 mark)

(ii) Describe how radioisotopes can be used to date a fossil.

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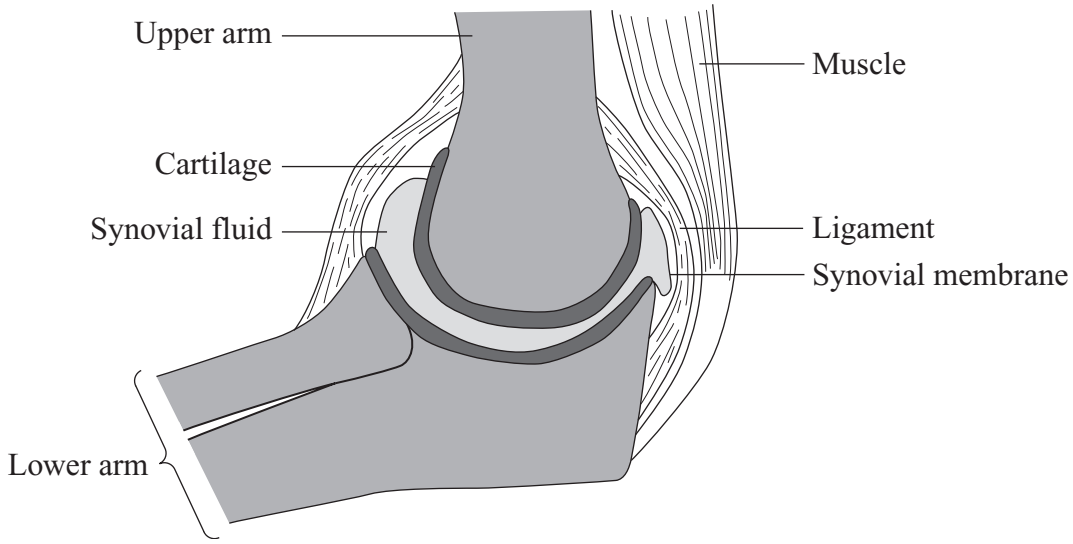
(1 mark)

6

Turn over for the next question

22 (a) Joints such as that shown in the diagram can be affected by different conditions such as dislocation, a sprain or osteoarthritis.



Describe how the diagram would appear if each of these conditions had been shown on it.

(i) dislocation .....
(1 mark)

(ii) sprain .....
(1 mark)

(iii) osteoarthritis .....
(1 mark)

(b) **Diagrams A** and **B** show the skeleton of a foot.

Diagram A

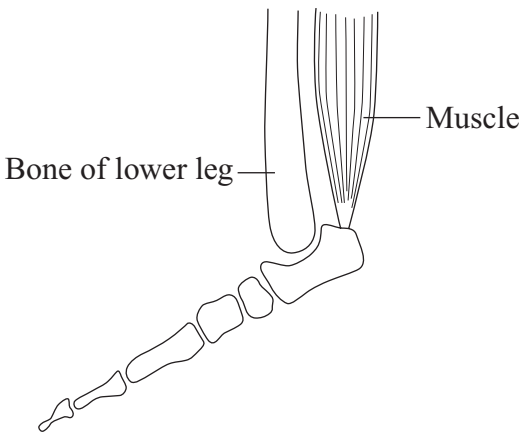


Diagram B

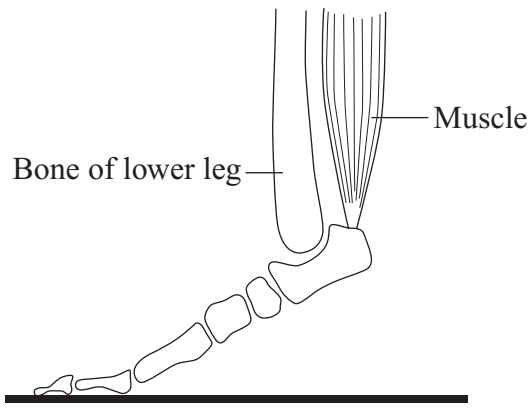


Diagram A shows the effect of the muscle contracting when the foot is not on the floor.

Diagram B shows the effect of this muscle contracting with the foot on the floor.

When the muscle contracts the effect is to produce a first order lever in **A** but a second order lever in **B**.

Explain the reason for this. Use the diagram of the orders of levers to help you. The muscle of the leg provides the effort.

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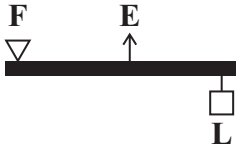
First order lever

Second order lever

Third order lever



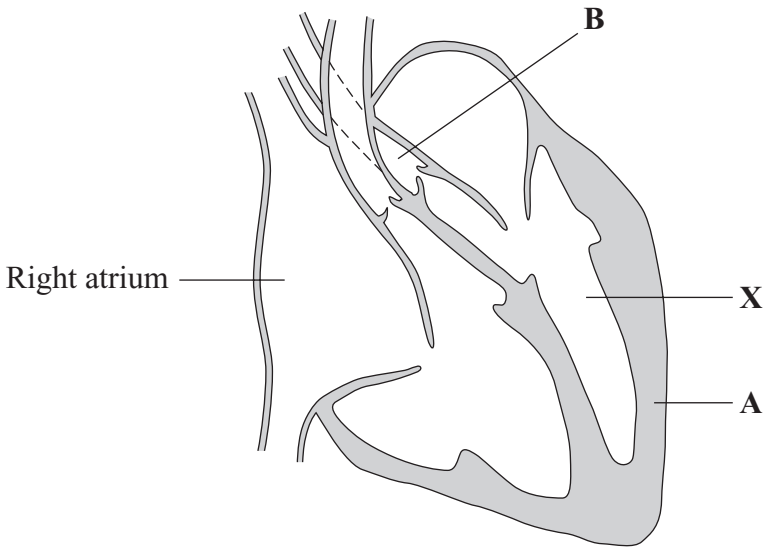
Key	
E	Effort
F	Fulcrum
L	Load

(4 marks)

7

Turn over for the next question

23 The diagram shows a section of the heart.



(a) Skeletal muscle and the type of muscle present in the part labelled **A** have some similarities in the way in which they function. They also have some differences.

(i) Describe **one** of the similarities in the way in which they function.

.....

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(1 mark)

(ii) Describe **two** ways in which the functioning of the muscle in part **A** is different from that of skeletal muscle.

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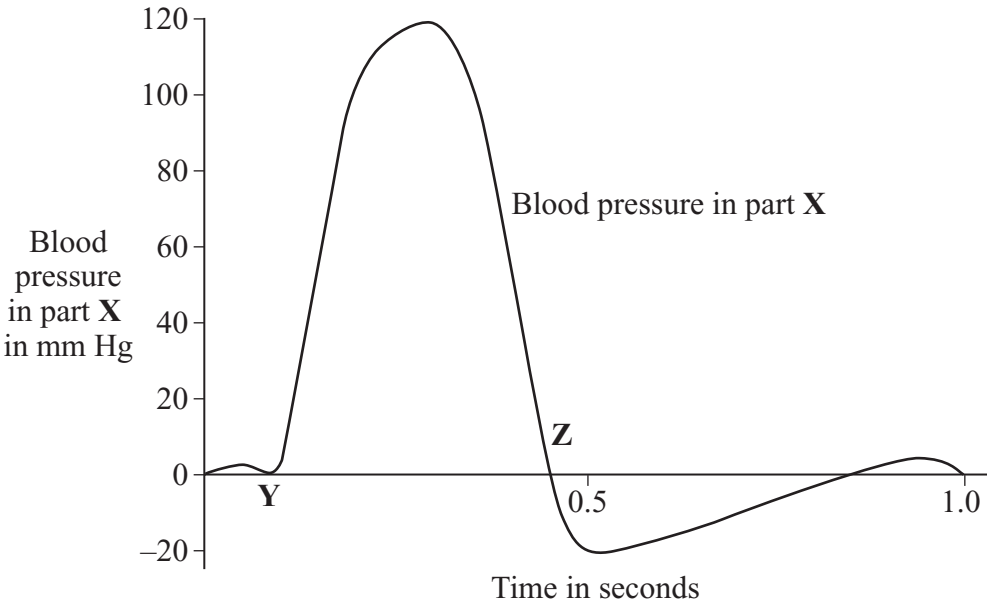
(2 marks)

(b) The graph shows the changes in the blood pressure in part **X** during a heartbeat.



Explain how the action of part **A** and the role of part **B** are related to the pressure changes between points **Y** and **Z** on the graph.

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(2 marks)

(c) An unsuitable diet may cause an extra layer to form on the inside of part **B**.

Describe and explain the effect this extra layer might have on the blood pressure in part **X**.

.....

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(1 mark)

6

END OF QUESTIONS

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Question 8 Source: adapted from TOMKINS, The Origins of Mankind, Cambridge University Press, 1984