

**Monday 12 June 2017 – Afternoon**

**A2 GCE HUMAN BIOLOGY**

**F224/01** Energy, Reproduction and Populations

Candidates answer on the Question Paper.

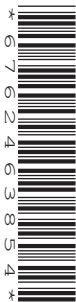
**OCR supplied materials:**

None

**Other materials required:**

- Electronic calculator
- Ruler (cm/mm)

**Duration:** 1 hour 15 minutes



Candidate forename		Candidate surname	
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Centre number						Candidate number				
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### INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Write your answer to each question in the space provided. If additional space is required, you should use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the barcodes.

### INFORMATION FOR CANDIDATES

- The number of marks is given in brackets [ ] at the end of each question or part question.
- The total number of marks for this paper is **60**.



Where you see this icon you will be awarded marks for the quality of written communication in your answer.

- You may use an electronic calculator.
- You are advised to show all the steps in any calculations.
- This document consists of **20** pages. Any blank pages are indicated.

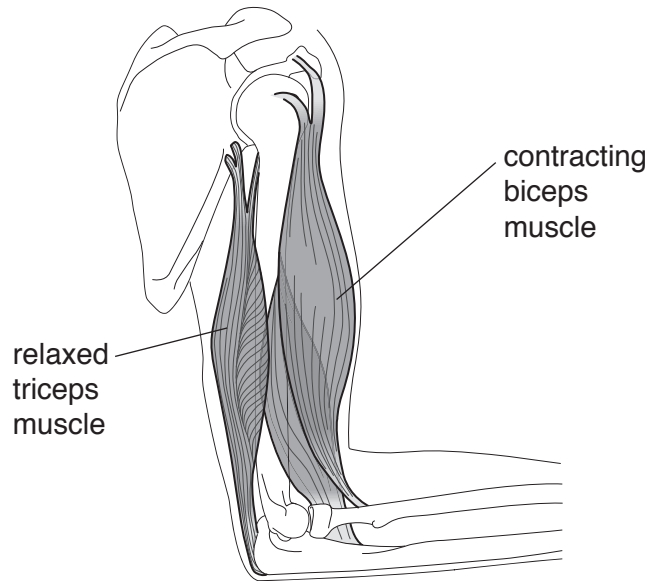
Answer **all** the questions.

- 1 The movement of joints in the skeletal system is brought about by the contraction and relaxation of pairs of antagonistic muscles.

Fig. 1.1 shows the two muscles responsible for the movement of the elbow joint.

When the arm bends at the elbow, the triceps muscle relaxes and the biceps muscle contracts.

Both the biceps and triceps muscles have the same histology and ultrastructure.



**Fig. 1.1**

- (a) Using the information shown in Fig. 1.1:

- (i) Name one band in the sarcomere that will be the same width in the biceps and triceps muscle.

..... [1]

- (ii) Complete the table by inserting a tick or a cross in the appropriate column.

Feature of muscle cell	Biceps muscle	Triceps muscle
H zone is visible in the sarcomere		
Myosin heads are cross-linking with actin molecules		
Calcium ions are inside the sarcoplasmic reticulum		

[3]

(b) One source of energy for muscle contraction is **creatine phosphate** (phosphocreatine).

Fig. 1.2 shows how the conversion of a molecule of creatine phosphate to creatine can be linked to the synthesis of molecule **Y**.

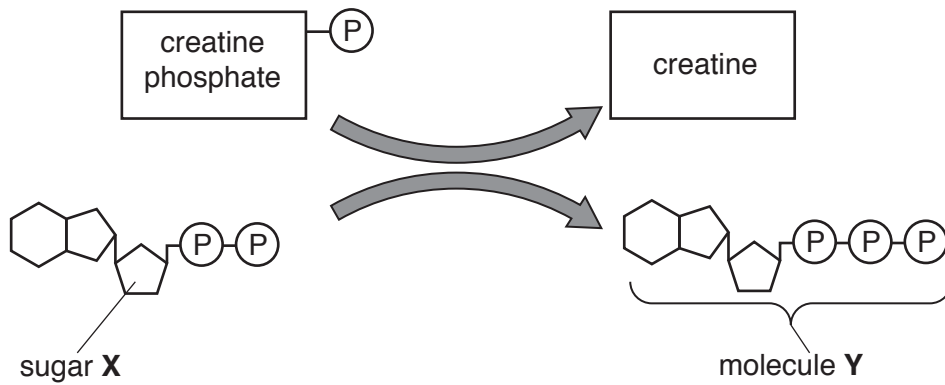


Fig. 1.2

(i) Identify molecule **Y**.

..... [1]

(ii) Name the **type** of reaction involved in the synthesis of molecule **Y**.

..... [1]

(iii) In addition to molecule **Y**, name one **polymer** within muscle cells that also contains sugar **X**.

..... [1]

(c) One of the long term consequences of certain types of exercise is to increase the creatine phosphate content of muscle cells.

Name one carbohydrate that can also increase in muscle cells as a result of training.

..... [1]

[Total: 8]

2 One of the major crops grown in the United Kingdom is oilseed rape.

Oilseed rape is grown for both human and animal consumption.

- Seeds are crushed to provide rapeseed oil for human consumption.
- The remaining seed material is processed for animal food.

(a) Table 2 compares the fatty acid composition of rapeseed oil to other oils commonly used for human consumption.

- Each type of fatty acid is identified by two numbers.
- The first number indicates the number of carbon atoms present in the hydrocarbon chain.
- The second number indicates the number of double bonds present in the hydrocarbon chain.

Oil type	Fatty acid composition (%)				
	18:0 and 16:0	18:1	18:2	18:3	20:1
Rapeseed	5.9	63.0	20.0	8.6	1.9
Olive	15.0	75.0	9.0	1.0	0.0
Sunflower	12.5	20.0	66.0	0.1	0.0

**Table 2**

(i) Rapeseed oil is promoted by growers and manufacturers as a 'heart healthy oil'.

Use the information in Table 2 to evaluate this claim.

.....

.....

.....

.....

.....

.....

..... [2]



- (b) Oilseed rape is susceptible to attack from a number of insect pests. Fig. 2 shows the changes in the total area of land used for oilseed rape production and the area of oilseed rape crops treated with insecticides.

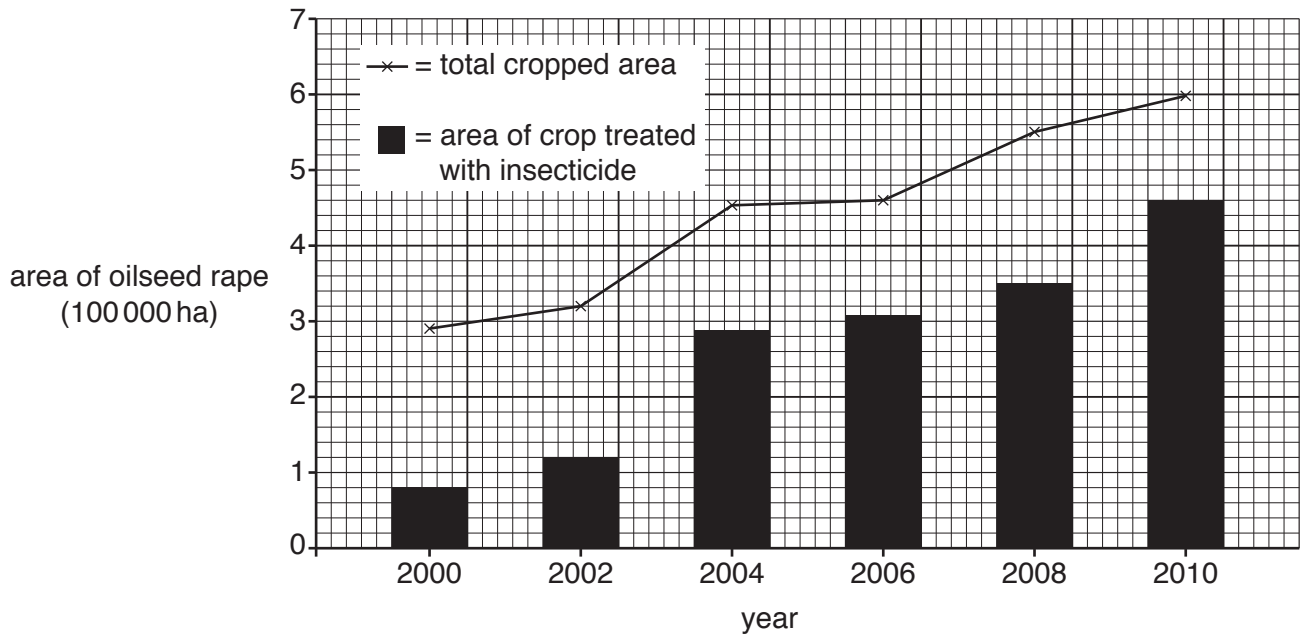


Fig. 2

- (i) Calculate the percentage increase in the area of oilseed rape crops treated with insecticide between 2000 and 2010.

Show your working. Give your answer to the nearest whole number.

..... % [2]

- (ii) What evidence in Fig. 2 suggests that oilseed rape was being farmed using more **intensive methods** in 2010 compared to 2000?

.....  
 ..... [1]

(c) One major insect pest of oilseed rape is the stem flea beetle *Psylliodes chrysocephala*.

- Before 2013, *P. chrysocephala* was effectively controlled using neonicotinoid insecticides.
  - Following the restrictions placed on the use of neonicotinoids in 2013, alternative insecticides known as pyrethroids were used.
  - Pyrethroids have been used as insecticides in the UK for many years.
  - In 2014, approximately 15% of crops suffered damage due to *P. chrysocephala*.
- (i) The high percentage of crop damage in 2014 suggests that populations of *P. chrysocephala* in the UK are showing some resistance to pyrethroid insecticides.

Outline how populations of *P. chrysocephala* resistant to pyrethroids might have developed in the UK.

.....

.....

.....

.....

..... [2]

(ii) One alternative method of reducing the population of *P. chrysocephala* in oilseed rape crops is to sow legume plants in between the oilseed rape plants. This is known as 'under sowing'.

Suggest one **additional** benefit gained by oilseed rape plants from under sowing with legumes.

.....

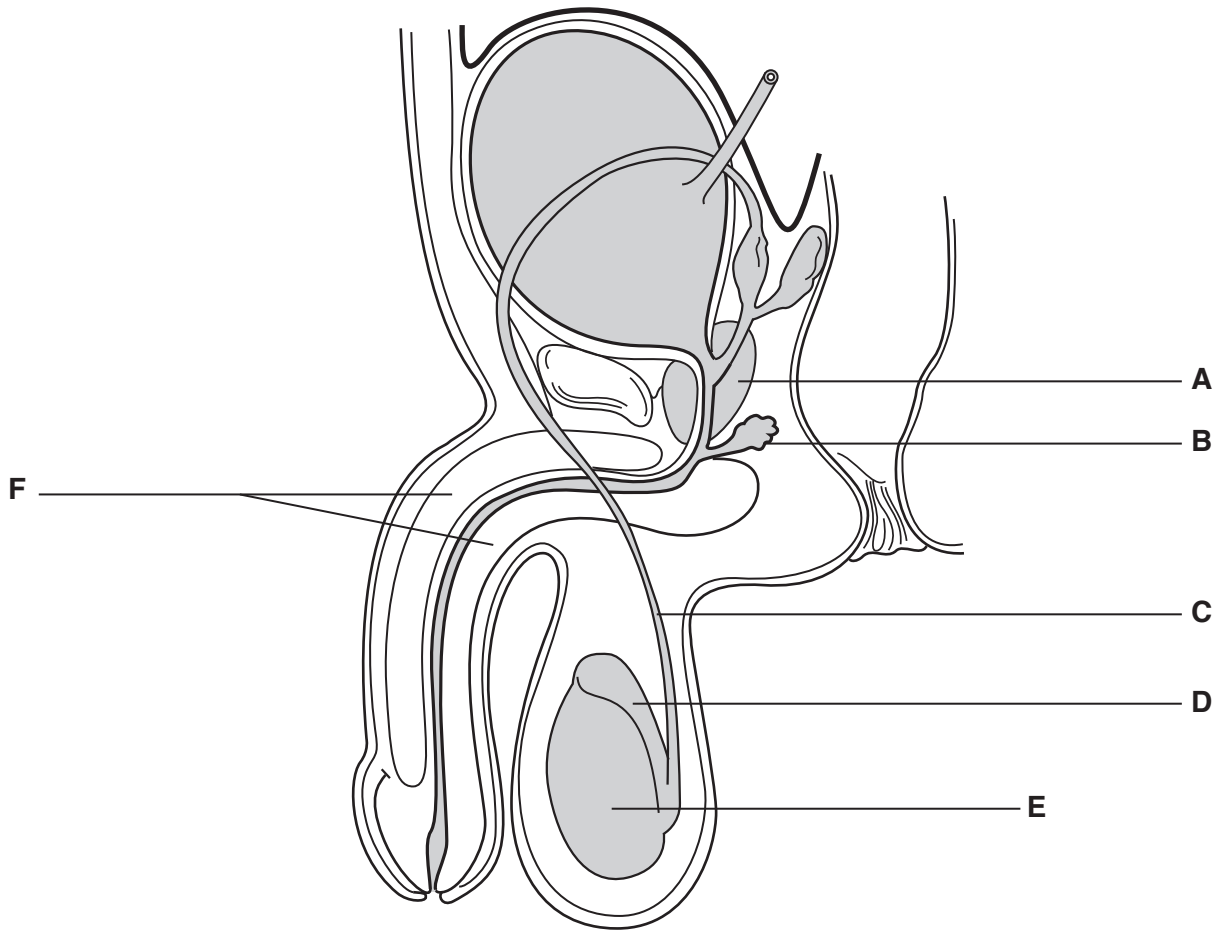
..... [1]

[Total: 13]

**PLEASE DO NOT WRITE ON THIS PAGE**



3 Fig. 3.1 is a diagram of the male reproductive system.



**Fig. 3.1**

(a) Complete the table below by inserting the letter(s) from Fig. 3.1 that corresponds to each of the following:

- (i) the prostate gland ..... [1]
- (ii) the location of spermatids ..... [1]
- (iii) the location of sperm cells ..... [1]

(b) Following a vasectomy, a number of changes occur in structure **D**. One of these changes is an increase in the number of macrophages.

Suggest why macrophage numbers increase.

.....

.....

.....

..... [2]

- (c) The vas deferens forms part of a structure called the spermatic cord. In addition to the vas deferens, the spermatic cord also contains blood vessels.

In a vasectomy, only the vas deferens is cut. The remaining structures such as the arteries and veins in the spermatic cord are left intact.

Which of the blood vessels in the spermatic cord will contain the highest concentration of testosterone?

Explain your answer.

.....

.....

..... [1]

- (d) In the **female** reproductive system, gametogenesis occurs in the ovaries. Fig. 3.2 is a photomicrograph of a developing gamete.

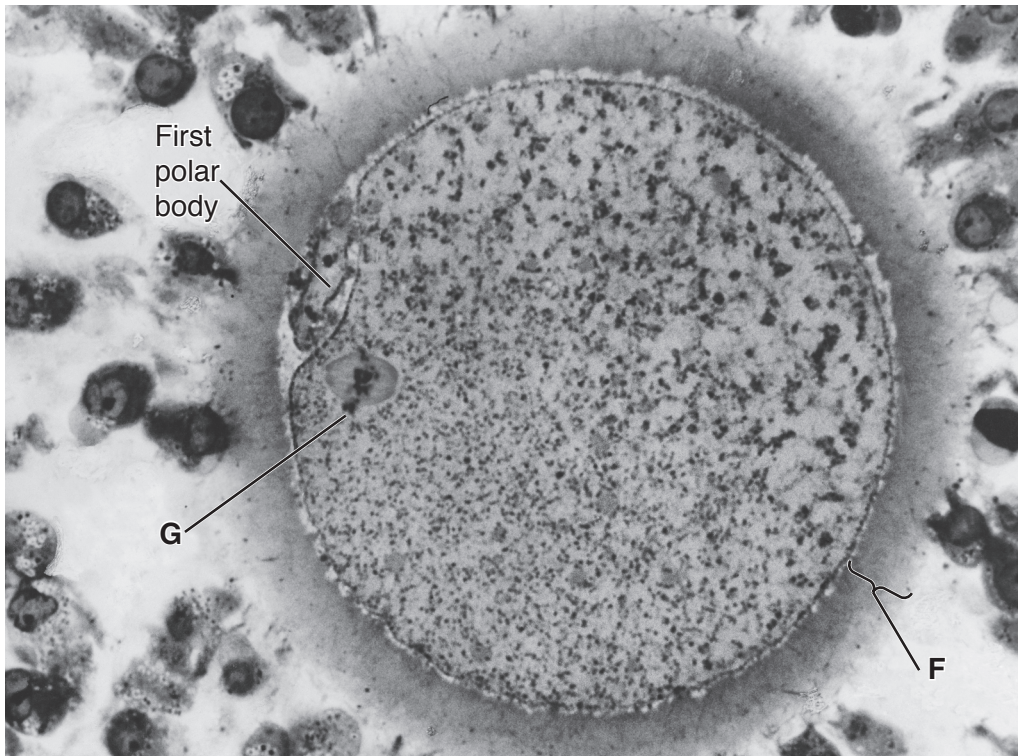


Fig. 3.2

- (i) Identify the **type** of cell shown in Fig. 3.2.

..... [1]

(ii) Identify region **F**.

..... [1]

(iii) The structures labelled **G** are chromosomes in metaphase.

Insert a tick(s) (✓) in the table next to the correct description of the chromosomes in Fig. 3.2.

Description	
There are 23 pairs of chromosomes each consisting of two chromatids.	
The chromosomes are in metaphase 2 of meiosis.	
The chromosomes are in metaphase 1 of meiosis.	
The chromosomes are in metaphase of mitosis.	
There are 23 chromosomes each consisting of two chromatids.	

[2]

(iv) In some cases of female infertility, hormone treatments are used to encourage ovulation.

State two **pituitary** hormones that can be used to encourage ovulation.

1 .....

2 .....

[2]

[Total: 12]

4 The development of erythrocytes (red blood cells) starts with stem cells in bone marrow. The cells that are produced go through a number of stages before finally becoming mature, functional cells.

(a) Fig. 4.1 shows some of the stages in the development of an erythrocyte from a stem cell.

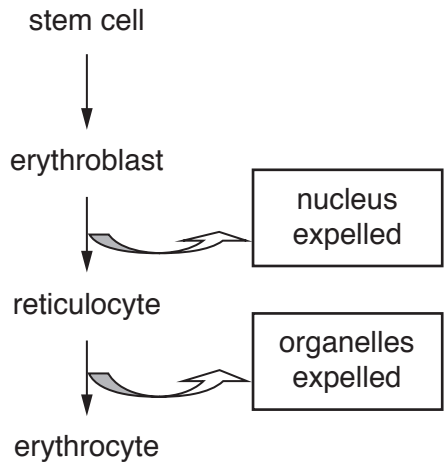


Fig. 4.1

Haemoglobin is synthesised in erythroblasts and reticulocytes.

(i) Complete the following table comparing the synthesis of haemoglobin in erythroblasts (**E**) and reticulocytes (**R**) by inserting the appropriate letter **or** letters alongside each statement.

The first row has been completed for you.

Statement	Letter(s)
peptide bonds are formed	<b>E and R</b>
transcription occurs	
complementary base pairing occurs between DNA and RNA triplets	
complementary base pairing occurs between RNA triplets	

[2]

(ii) Using the information in Fig. 4.1, state how mature erythrocytes synthesise ATP.

..... [1]

Fig. 4.2 shows the oxygen dissociation curve for normal adult haemoglobin.

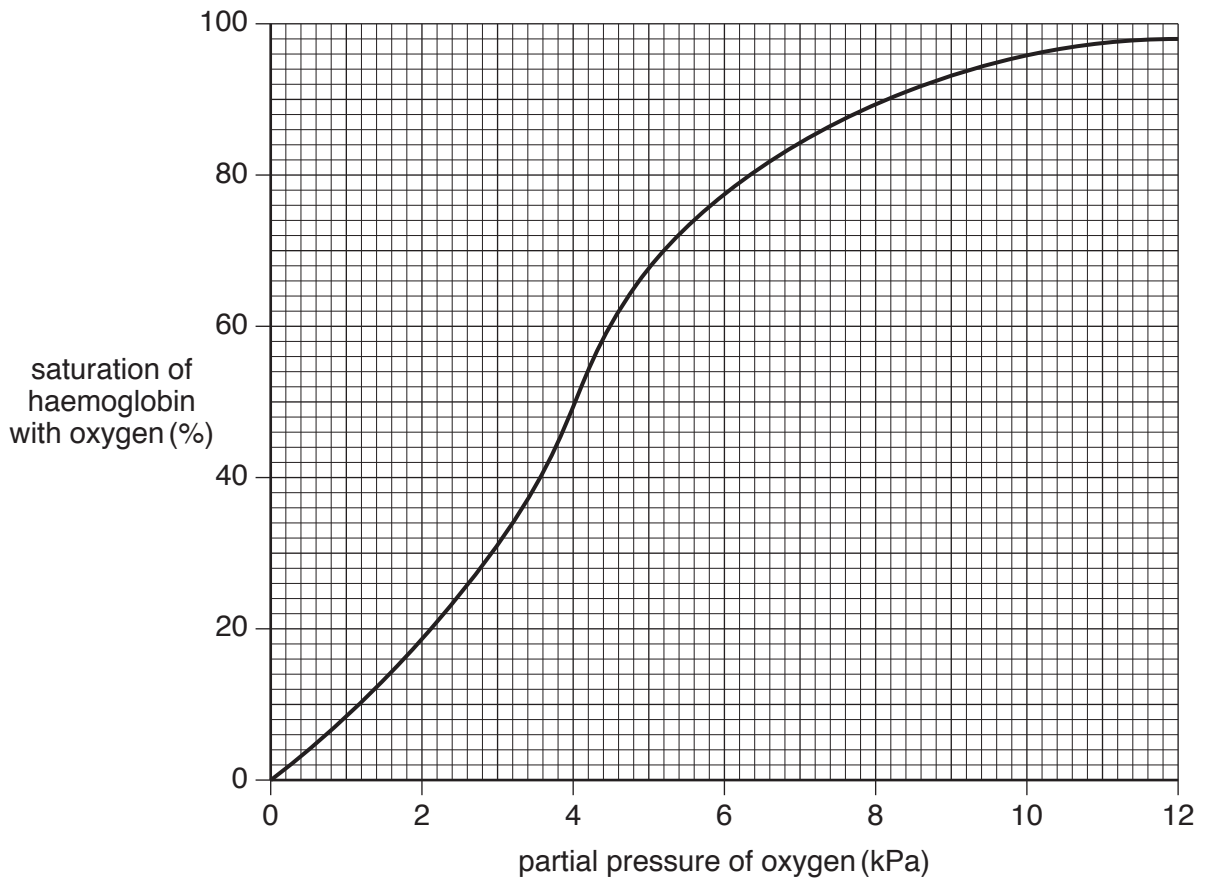


Fig. 4.2

When describing the oxygen dissociation curve, physiologists often refer to several significant points on the curve.

- (b) The arterial point in normal adult haemoglobin corresponds to an oxygen saturation of 97.5%.

Explain why the oxygen saturation of **arterial** blood remains high throughout the body.

.....

..... [1]

(c) In emergency medicine and in intensive care units (ICU), the **ICU point** corresponds to an oxygen saturation value of 91%.

(i) What is the partial pressure of oxygen that corresponds to a haemoglobin saturation value of 91%?

.....  
..... [1]

(ii) Using the information in **Fig. 4.2**, suggest why the **ICU point** is significant.

.....  
..... [1]

(d) The **P50 point** is the partial pressure of oxygen that corresponds to a haemoglobin saturation of 50%.

(i) Predict what will happen to the P50 value of normal adult haemoglobin in the presence of high concentrations of carbon dioxide.

.....  
..... [1]

(ii) Increased concentrations of carbon dioxide in red blood cells change the affinity of haemoglobin for oxygen.

Describe the reactions in the erythrocyte that bring about this change.



*In your answer, you should use appropriate technical terms, spelled correctly.*

.....  
.....  
.....  
.....  
.....  
.....  
.....  
..... [3]

**[Total: 10]**

5 Human population growth rates are affected by both mortality rates and birth rates.

(a) Both mortality rates and birth rates are affected by our interaction with the ecosystem.

(i) Define the term 'ecosystem'.

.....  
.....  
.....  
..... [2]

(ii) Infant mortality rates have declined globally since the start of this millennium.

Suggest one factor **other than** improved medical access and medical treatments that has led to a global decline in **infant** mortality rates.

.....  
..... [1]

(iii) The replacement fertility rate is the number of children that need to be born for a population to replace itself.

Suggest why the theoretical replacement fertility rate to maintain the size of a population is 2.

.....  
..... [1]

(iv) The calculated replacement fertility rate for the UK is 2.075. In less economically developed countries (LEDCs), calculated replacement fertility rates are higher.

Suggest why.

.....  
..... [1]

- (b) Scientists have shown that a strong positive correlation exists between the global population and concentrations of atmospheric carbon dioxide.

The world population is currently increasing at an annual rate of 1.18%.

- (i) Suggest a reason why the annual rate of increase in atmospheric carbon dioxide may be **less** than 1.18%.

.....  
..... [1]

- (ii) Outline **one** piece of evidence that rising levels of carbon dioxide are associated with a change in the global climate.

.....  
.....  
.....  
..... [1]

[Total: 7]



6 Respiration is a characteristic of all living organisms.

(a) Carbon dioxide is produced during the process of aerobic respiration by the action of decarboxylase enzymes.

(i) Describe the reaction in mitochondria that produces carbon dioxide from pyruvate.

.....  
 .....  
 ..... [2]

(ii) Name a substrate in the mitochondrion, other than pyruvate, from which carbon dioxide is also produced.

..... [1]

(b) Respiratory quotients can be calculated experimentally using the formula below:

$$RQ = \frac{\text{volume of CO}_2 \text{ produced}}{\text{volume of O}_2 \text{ consumed}}$$

The volume of oxygen consumed and the volume of carbon dioxide produced by respiring organisms such as germinating seeds can be measured using a respirometer.

Fig. 6 is a diagram of a simple respirometer set up to measure oxygen consumption.

- The narrow tube contains coloured water.
- The position of the meniscus is noted at the beginning of the experiment.
- The tube is left for 20 minutes.
- The new position of the meniscus is then noted.
- The distance moved to the right by the meniscus is measured.
- The experiment is repeated.

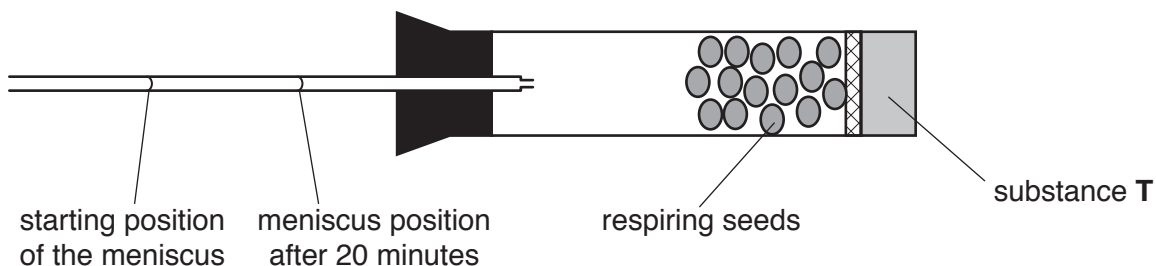


Fig. 6

(i) Identify substance T in Fig. 6.

..... [1]

(ii) State one variable that needs to be controlled in this experiment.

..... [1]

(c) Substance **T** is removed and the experiment is repeated again.

If the seeds are respiring only carbohydrates, the meniscus will **not** move.

The RQ value obtained for fats is 0.7.

What will happen to the meniscus if fats are the **only** respiratory substrate for the seeds?  
Explain your answer.

.....  
.....  
.....  
..... [2]

(d) Seeds store carbohydrates, fats and proteins for use as respiratory substrates.

- The energy content of proteins and carbohydrates is approximately  $17 \text{ kJ g}^{-1}$ .
- The energy content of fat is approximately  $37 \text{ kJ g}^{-1}$ .

(i) Explain why fats have a higher energy content than proteins or carbohydrates.

.....  
.....  
.....  
..... [2]

(ii) Name the immediate source of energy in the cells of germinating seeds.

..... [1]

[Total: 10]

END OF QUESTION PAPER

**ADDITIONAL ANSWER SPACE**

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).

A large area of lined paper for writing, consisting of 25 horizontal dotted lines. A solid vertical line runs down the left side of the page, creating a margin. The rest of the page is open for writing.

A large area of the page is reserved for writing, featuring a vertical solid line on the left side and horizontal dotted lines extending across the page.



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