Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel Level 3 GCE

Wednesday 5 June 2024

Afternoon (Time: 1 hour 45 minutes)

Paper reference **9BI0/01**

Biology B

Advanced

PAPER 1: Advanced Biochemistry, Microbiology and Genetics

You must have:
Scientific calculator, HB pencil, ruler

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided – *there may be more space than you need.*

Information

- The total mark for this paper is 90.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*
- In question(s) marked with an **asterisk** (*), marks will be awarded for your ability to structure your answer logically showing how the points that you make are related or follow on from each other where appropriate.

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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Answer ALL questions.

Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 Blood is pumped around the body in blood vessels to supply cells with nutrients and oxygen.

(a) Which box in each row of the table shows where endothelial cells and valves are found?

(2)

Features of blood vessels	Type of blood vessel			
	both capillaries and veins	capillaries only	veins only	neither capillaries nor veins
Endothelial cells	☒	☒	☒	☒
Valves	☒	☒	☒	☒

(b) Nutrients and oxygen pass into cells from tissue fluid.

Explain how tissue fluid is formed.

(2)

(Total for Question 1 = 4 marks)

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2 Glucose is a monosaccharide that is found in sucrose, amylose and amylopectin.

(a) Sucrose is made from glucose and one other molecule.

Which row of the table gives the name of this molecule and the type of reaction that joins the two molecules together?

(1)

	Name of molecules	Type of reaction
☒ **A**	fructose	condensation
☒ **B**	fructose	hydrolysis
☒ **C**	galactose	condensation
☒ **D**	galactose	hydrolysis

(b) Compare and contrast the structure of amylose and amylopectin.

(3)

(Total for Question 2 = 4 marks)

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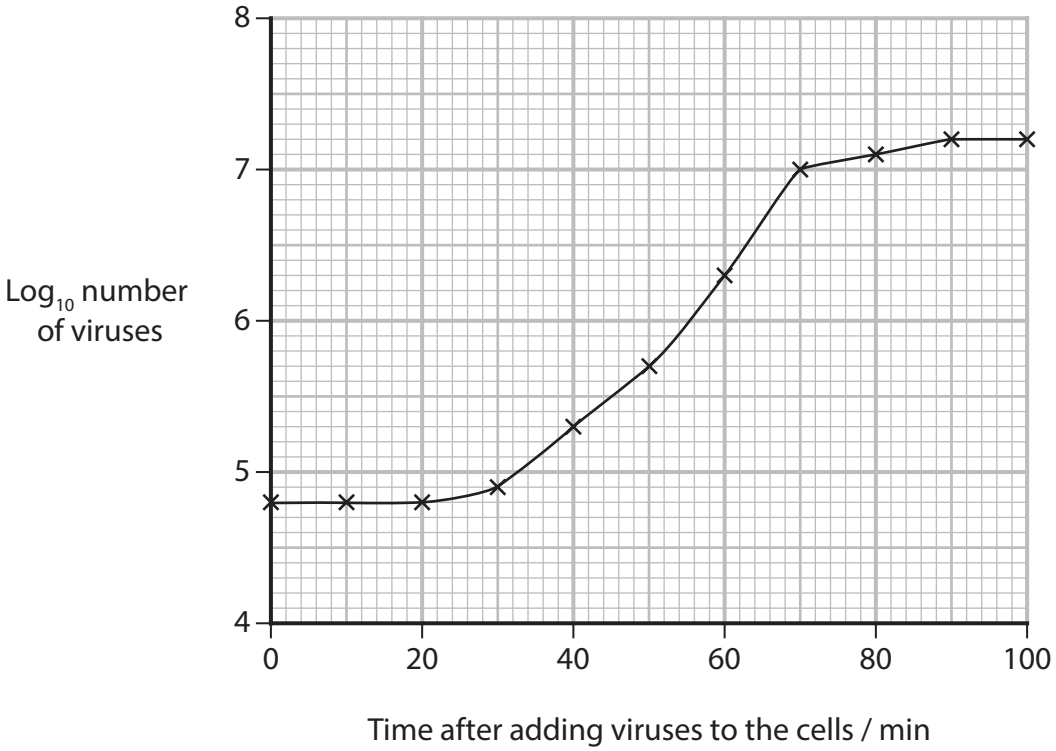
3 Viruses can replicate using the lytic cycle.

Viruses can be grown in a laboratory by culturing them with appropriate cells.

(a) Explain why viruses have to be cultured with 'appropriate cells'.

(2)

(b) The graph shows the changes in the number of viruses after they had been added to the cells.



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(i) Explain why the number of viruses did not start to increase until after 20 minutes.

(3)

(ii) Calculate how many more viruses are present at 70 minutes than at 50 minutes.

Give your answer to **three significant figures**.

(2)

Answer .....

(Total for Question 3 = 7 marks)

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4 Photosynthesis results in the production of GALP. This molecule is used by plants to produce glucose and other organic molecules.

(a) Glucose consists of the elements of carbon, hydrogen and oxygen.

Name the inorganic molecules that supply these elements for photosynthesis.

(2)

Carbon .....

Hydrogen .....

Oxygen .....

(b) Light is essential for photosynthesis. It is needed for photolysis and for the excitation of electrons in the photosystems.

Which row in the table shows where photolysis and the excitation of electrons occurs?

(1)

		Photolysis	Excitation of electrons
☒	**A**	stroma	stroma
☒	**B**	stroma	thylakoid membrane
☒	**C**	thylakoid membrane	stroma
☒	**D**	thylakoid membrane	thylakoid membrane

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(c) Scientists have developed an experimental technique that uses artificial photosynthesis.

Electricity generated from solar panels was used to convert carbon dioxide and water into the organic compound acetate.

Plants were then able to grow in the dark using the acetate.

(i) Explain why these plants were able to grow in the dark.

(3)

(ii) The scientists hope that this technique will be able to produce plant-based food.

State **one** advantage of using this method.

Give a reason for your answer.

(1)

(Total for Question 4 = 7 marks)

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5 Septicaemia is a life-threatening condition that can arise from bacterial infection.

(a) In one year, 245 000 people were diagnosed with septicaemia and 49 735 of these people died as a result.

Which percentage of people **survived** septicaemia in this year?

(1)

- ☒ **A** 20.3%
- ☒ **B** 25.5%
- ☒ **C** 39.3%
- ☒ **D** 79.7%

(b) Two types of bacteria that cause septicaemia are *Escherichia coli* (*E. coli*) and *Staphylococcus aureus* (*S. aureus*).

E. coli is Gram negative and *S. aureus* is Gram positive.

(i) Which of the following statements about the cell walls of these bacteria are correct?

(1)

1. Both bacteria have peptidoglycan (murein) in their cell walls.
2. *S. aureus* has an outer membrane (lipopolysaccharide layer).
3. The cell wall of *E. coli* is thinner than that of *S. aureus*.

- ☒ **A** 2 only
- ☒ **B** 3 only
- ☒ **C** 1 and 2 only
- ☒ **D** 1 and 3 only

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(ii) Both *E. coli* and *S. aureus* produce toxins.

E. coli produces the same type of toxin as *Salmonella* bacteria.

Which of the following statements about the toxins produced by these bacteria are correct?

(1)

1. *E. coli* produces endotoxins.
2. The toxins produced by *S. aureus* are released only once the bacteria die.
3. The toxins produced by *S. aureus* are components of their cell wall.

☒ **A** 1 only

☒ **B** 2 only

☒ **C** 1 and 2 only

☒ **D** 1, 2 and 3

(c) Vaccines against bacteria are not always effective. The antigens they contain stimulate only a weak immune response.

Which of the following types of immune response is stimulated by a vaccine?

(1)

☒ **A** artificial active

☒ **B** artificial passive

☒ **C** natural active

☒ **D** natural passive

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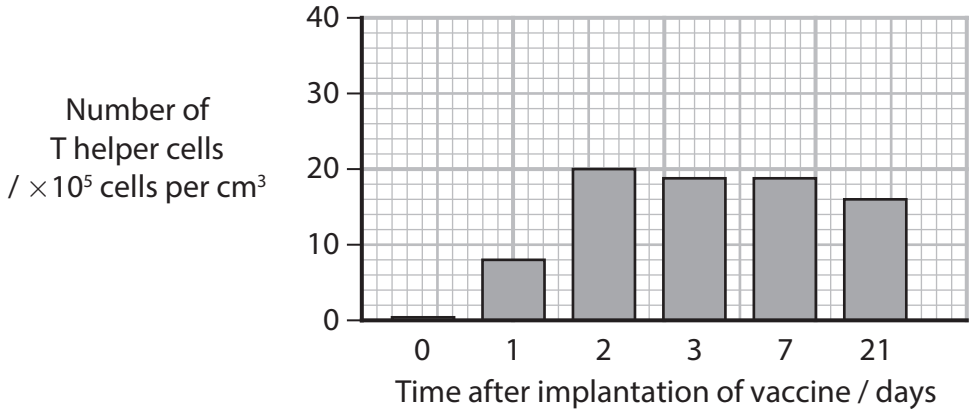
(d) There are currently no vaccines for either *E. coli* or *S. aureus*.

Scientists are developing vaccines against *E. coli* and *S. aureus* which can be implanted under the skin.

The bacterial antigens are held in a mesh that contains chemicals to attract tissue macrophages.

The effect of implantation of these vaccines on the immune response in mice was investigated.

(i) The graph shows the number of T helper cells in the lymph nodes that drain the part of the body where the vaccine was implanted.



Explain the results shown in the graph.

(3)

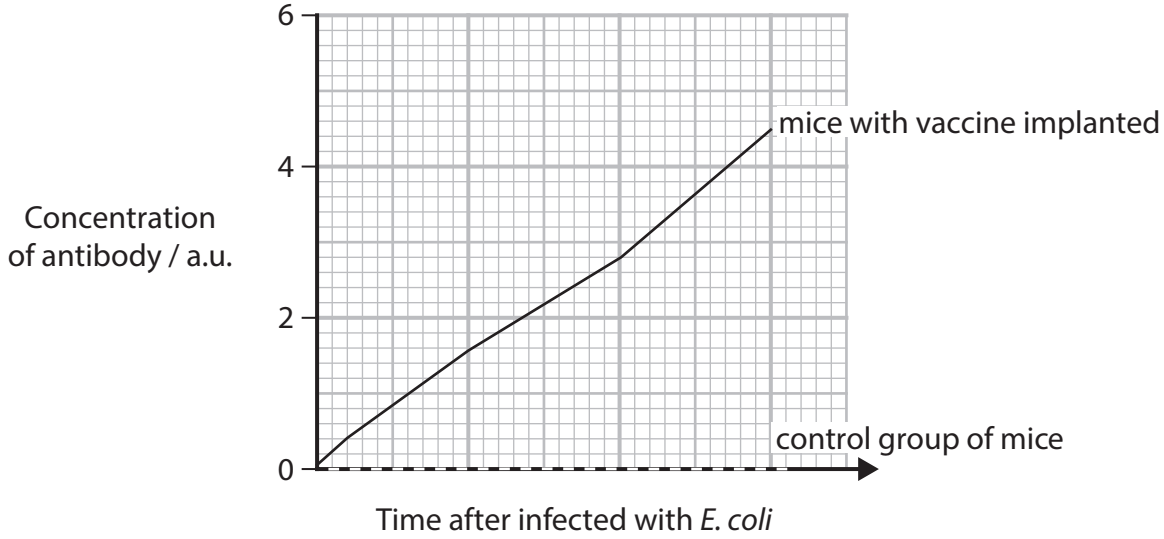
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(ii) In part of this investigation, mice had the vaccine implanted 35 days before being infected with *E. coli*.

A control group that had not received the vaccine was also infected with *E. coli*.

The levels of antibody in the blood of both groups of mice were determined.

The graph shows these results.



Explain the results shown in the graph.

(3)

(Total for Question 5 = 10 marks)

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6 In a cell, DNA is found in both the nucleus and the mitochondria.

(a) Where is DNA found in mitochondria?

(1)

- ☒ **A** cytoplasm
- ☒ **B** intermembrane space
- ☒ **C** matrix
- ☒ **D** nucleus

(b) Which row of the table describes DNA found in the mitochondria?

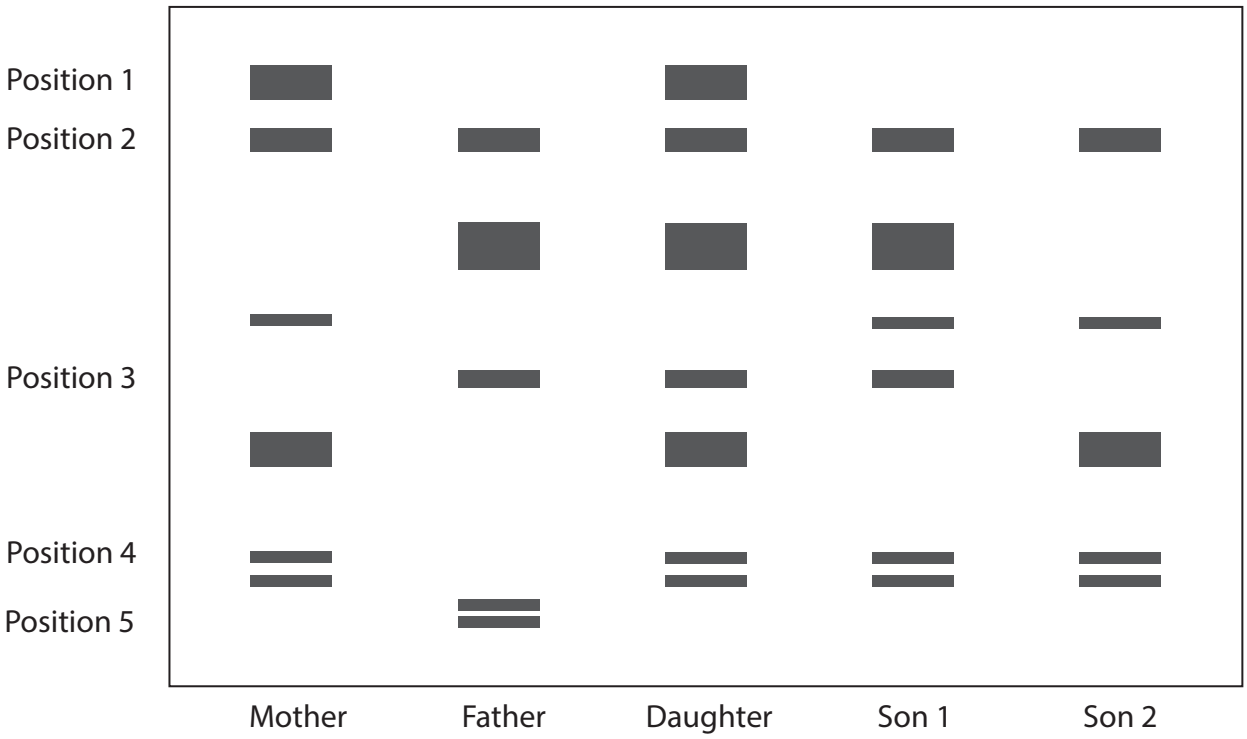
(1)

	Shape	Ratio of phosphodiester bonds : pentose sugars
☒ **A**	circular	higher than nuclear DNA
☒ **B**	circular	lower than nuclear DNA
☒ **C**	linear	higher than nuclear DNA
☒ **D**	linear	lower than nuclear DNA

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(c) Gel electrophoresis can be used to analyse the DNA of a person.

The diagram shows some of the bands produced when the DNA of a family was analysed using gel electrophoresis.



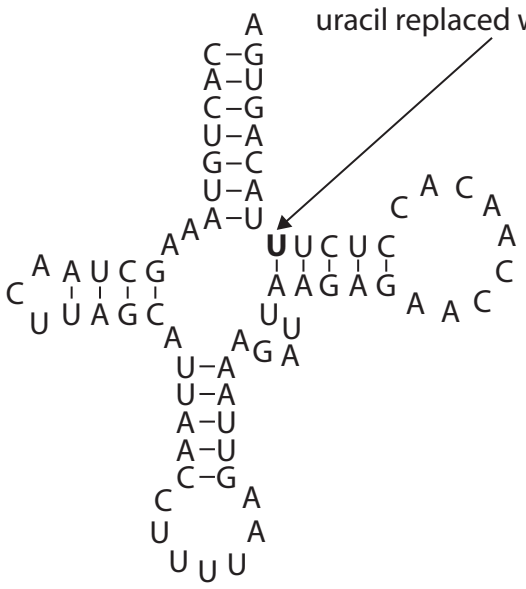
Analyse the information to explain the bands found at positions 1 to 5 in this family.

(4)

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(d) A mutation in the $tRNA^{Lys}$ gene in the mitochondria replaces one uracil with a cytosine in the resulting tRNA molecule.

The diagram shows the position of the uracil that is replaced with cytosine in a $tRNA^{Lys}$ molecule.



(i) Name this type of mutation.

(1)

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(ii) Explain how this mutation could affect the structure of the $tRNA^{Lys}$ molecule shown in the diagram.

(2)

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(iii) Explain how this mutation could affect the role of the $tRNA^{Lys}$ molecule.

(2)

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(Total for Question 6 = 11 marks)

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7 Coal tits, blue tits and great tits are three species of bird found in the UK all year round.

The photograph shows a blue tit.



(Source: © Andrew_Howe/Getty Images)

These birds all have mitochondria in their red blood cells.

(a) More than 90% of ATP is produced by mitochondrial respiration.

(i) Describe how the remaining ATP is produced.

(2)

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(ii) In the mitochondria, ATP is synthesised on the inner mitochondrial membrane.

Leakage of protons (H^+) across the inner mitochondrial membrane reduces ATP synthesis and generates more heat. This is called leaked respiration.

Explain why leakage of protons reduces ATP synthesis.

(3)

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(b) The table shows some information about adult coal tits, blue tits and great tits.

Species of bird	Length from head to tail / cm	Wing span / cm	Mass / g
Coal tit	11	19	11
Blue tit	12	18	11
Great tit	14	24	18

(i) Calculate the magnification of the photograph of the blue tit.

Measure from the top of the head to the tip of the tail.

(1)

Answer .....

(ii) Calculate the length from head to tail : mass ratio for the **great tit**.

Give your answer to **one decimal place**.

(1)

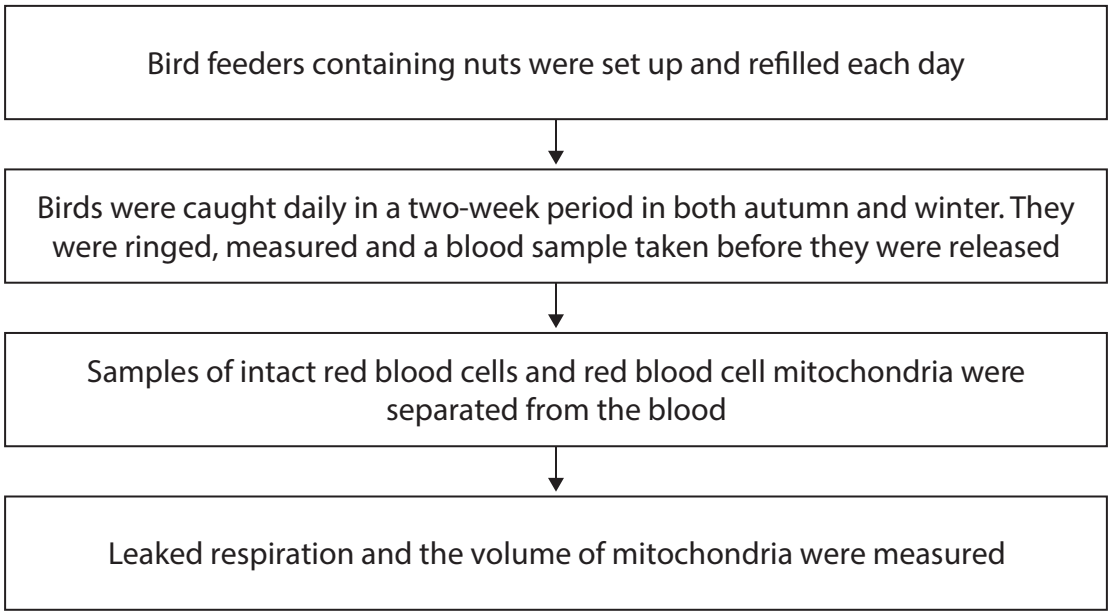
Answer .....

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(c) The generation of heat by red blood cell mitochondria in these birds in autumn and winter was investigated.

The mean air temperature in autumn was 10.7 °C and in winter 7.2 °C.

The flowchart shows some of the stages in this investigation.



(i) Explain why well-stocked bird feeders containing nuts were available throughout this investigation.

(2)

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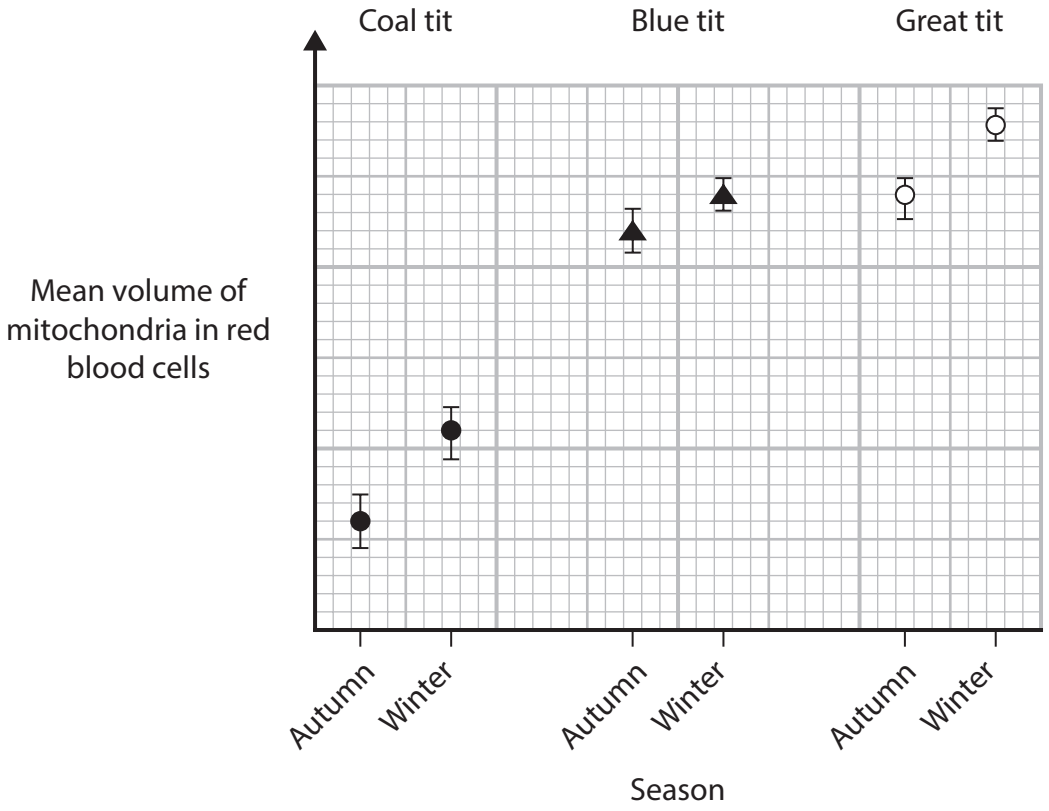
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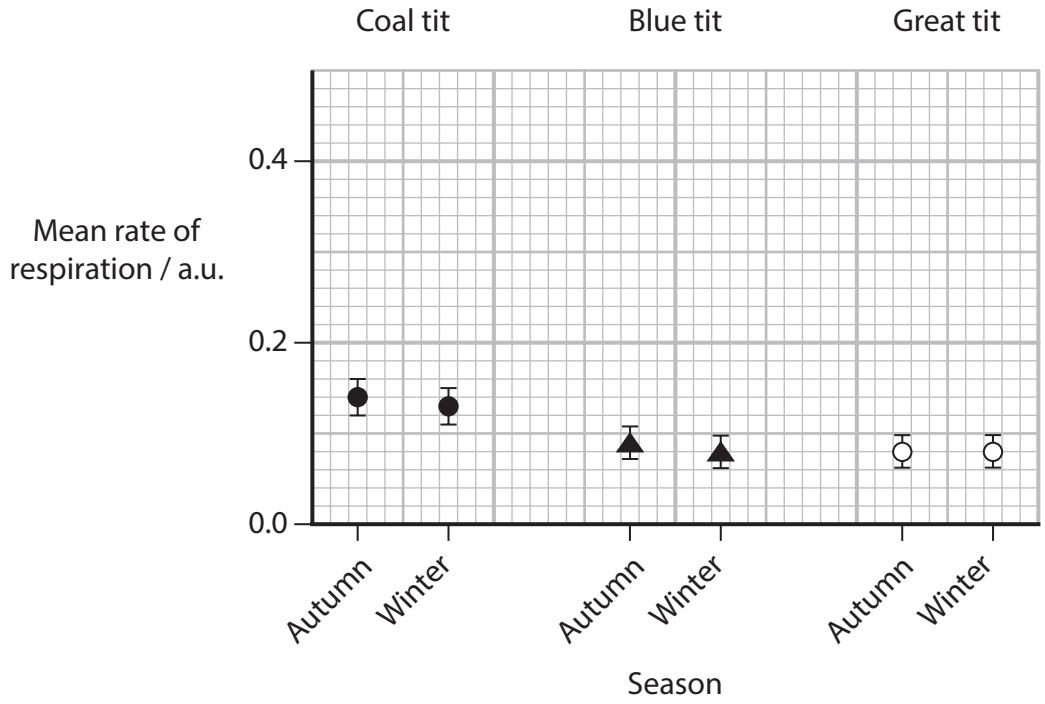
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*(ii) The graphs show the results of this investigation.

Graph 1: volume of mitochondria

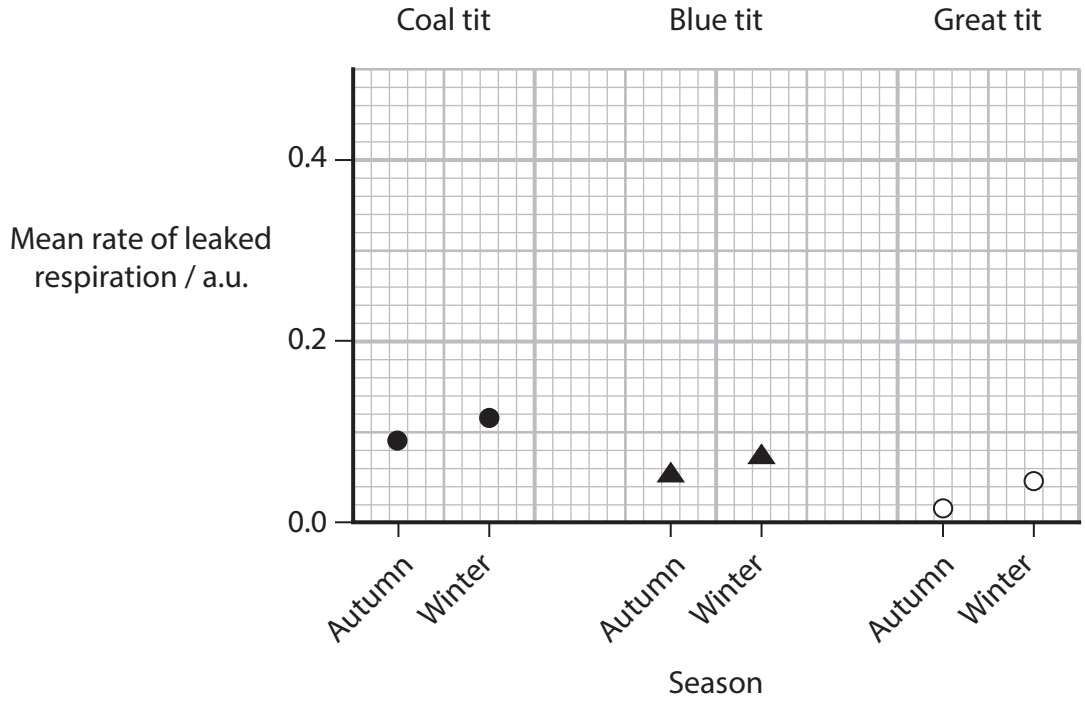


Graph 2: respiration producing ATP



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Graph 3: leaked respiration



Explain the results of this investigation.

Use all the information in the question to support your answer.

(6)

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(Total for Question 7 = 15 marks)

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8 Changes must occur to mammalian sperm cells as they pass through the female reproductive tract, if successful fertilisation is to take place.

Capacitation results in changes to the sperm cell membrane and increased motility.

The acrosome reaction (AR) must follow capacitation but not too soon nor too late.

(a) Explain why the timing of the AR is important for successful fertilisation.

(3)

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(b) A protein is involved in the timings of capacitation and the AR.

This protein exists in two forms: protein G and protein G-P.

Protein G-P results in the stimulation of capacitation and protein G results in the inhibition of the AR.

Protein G-P is located in the midpiece (neck) and flagellum of the sperm.

Protein G is located in the head region of the sperm.

The levels of these two forms of protein change just before capacitation, during capacitation and just before the AR.

Complete the table to show which form of protein is present and which is absent.

If the protein is present put a tick (✓) in the box and if the protein is absent put a cross (✗) in the box.

(4)

Event	Presence of protein G		Presence of protein G-P	
	Head region	Midpiece and flagellum	Head region	Midpiece and flagellum
Just before capacitation				
During capacitation				
Just before the AR				

(c) In some infertile males, the gene coding for protein G is methylated.

Explain why DNA-methylation of this gene could result in infertility.

(3)

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(d) Scientists have used 'knockout' mice to investigate the effect of protein G on fertility.

(i) State the meaning of the term 'knockout' mice, as used in this context.

(2)

(ii) In an investigation, female mice and 'knockout' mice were housed together.

Describe how this investigation should be designed to confirm that protein G affects fertility.

(3)

(Total for Question 8 = 15 marks)

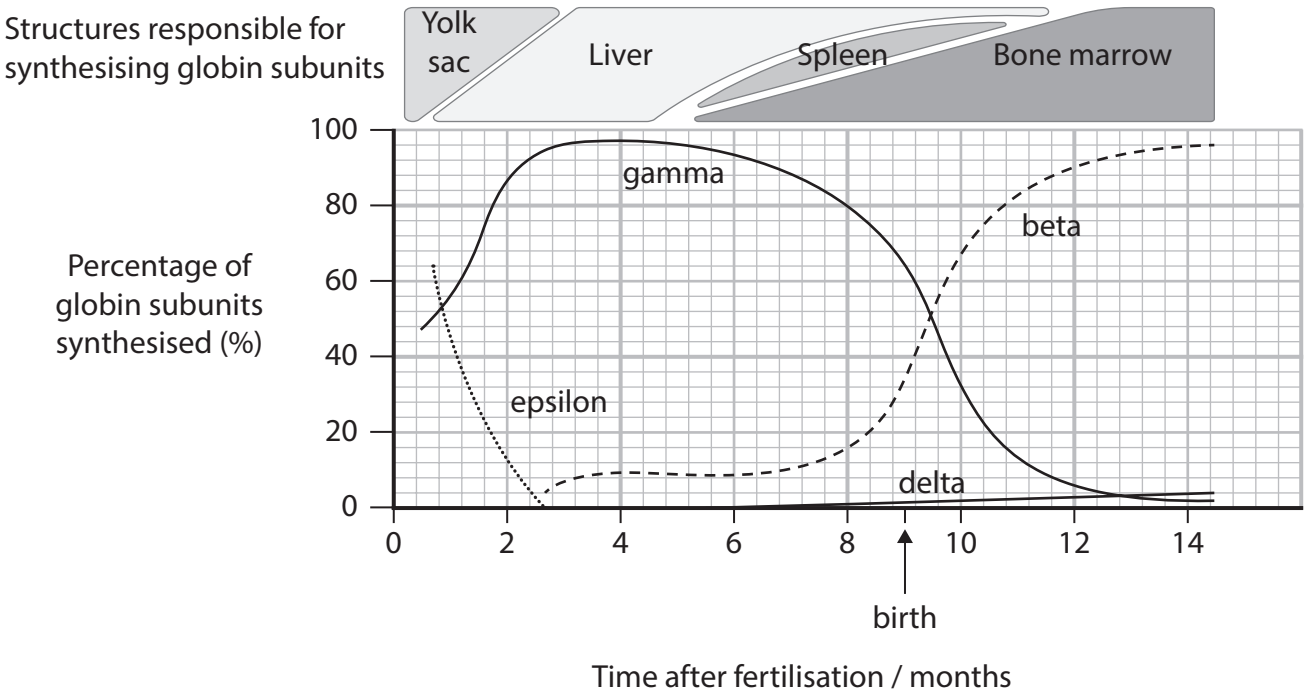
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9 The structure of haemoglobin changes as the embryo develops into a fetus and after the child is born.

(a) The graph shows the changes in the synthesis of four globin subunits (beta, gamma, delta, epsilon) during these stages of development.



(i) Explain why there is no synthesis of globin subunits in the first few days after fertilisation.

(3)

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(ii) Analyse the data to describe conclusions that can be made about globin subunit synthesis during the 14 months following fertilisation.

(4)

(iii) Calculate the rate of decrease in percentage of gamma globin subunit synthesis from 7.6 to 10 months after fertilisation.

Give your answer to **two decimal places** with appropriate units.

(2)

Answer .....

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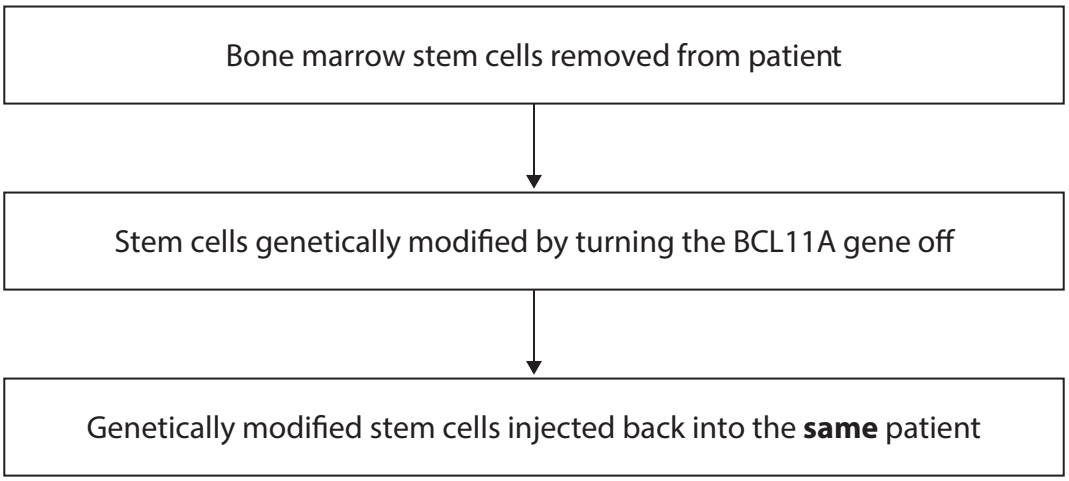
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(b) Sickle cell disease (SCD) is an inherited disorder.

A new treatment for SCD is being developed that involves genetic modification.

The flowchart shows some of the stages in this process.



(i) There are approximately 67 million people in the UK, 15 000 of these people are affected by SCD.

Calculate the ratio of the number of people **without** SCD to the number of people **with** SCD in the UK.

Express your answer in **whole numbers**.

(2)

Answer .....

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*(ii) The product of the BCL11A gene regulates the switch from the synthesis of fetal to adult globin subunits.

Analyse all the information in this question to discuss how this approach could provide a cure for SCD and the ethical issues surrounding this treatment.

Use your own knowledge to support your answer.

(6)

(Total for Question 9 = 17 marks)

TOTAL FOR PAPER = 90 MARKS

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