

Please check the examination details below before entering your candidate information

Candidate surname

Other names

Centre Number

Candidate Number

**Pearson Edexcel Level 3 GCE**

**Friday 16 June 2023**

Morning (Time: 1 hour 45 minutes)

Paper  
reference

**9BI0/02**

**Biology B**

**Advanced**

**PAPER 2: Advanced Physiology, Evolution and Ecology**

**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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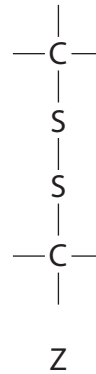
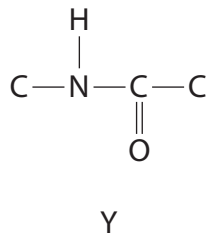
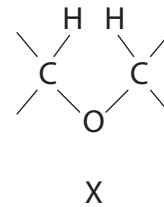
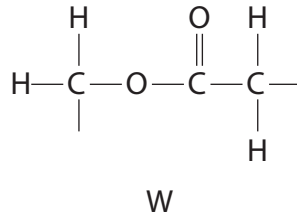
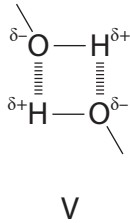
  
Pearson

Answer ALL questions. Write your answers in the spaces provided.

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 Carbohydrates and proteins are important biological molecules.

(a) The diagrams show some of the bonds found in biological molecules.



(i) Which one of the letters shows a bond that joins glucose molecules together in a disaccharide?

(1)

- A W
- B X
- C Y
- D Z



(ii) Which letters show bonds that hold together the tertiary structure of a protein?

(1)

- A V and X
- B V and Z
- C W and Y
- D W and Z

(iii) Which letter shows a bond that holds together cellulose molecules within a cellulose microfibril?

(1)

- A V
- B W
- C X
- D Y

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2 Bromelain is a protease enzyme in pineapple juice.

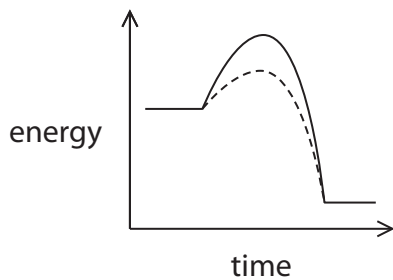
(a) Which graph shows the energy changes that occur in a typical enzyme catalysed reaction?

(1)

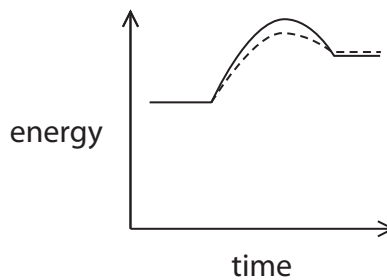
**Key:**

— without enzyme

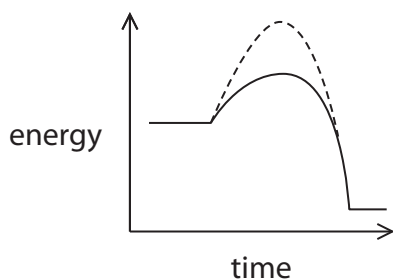
- - - with enzyme



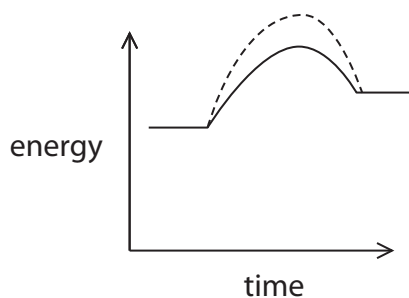
W



X



Y



Z

- A W
- B X
- C Y
- D Z



(b) A student investigated the digestion of gelatine protein by pineapple juice.

This is the method used.

**Step 1:** Make a solid disc of gelatine protein, with a depth of 1 cm, in a Petri dish.

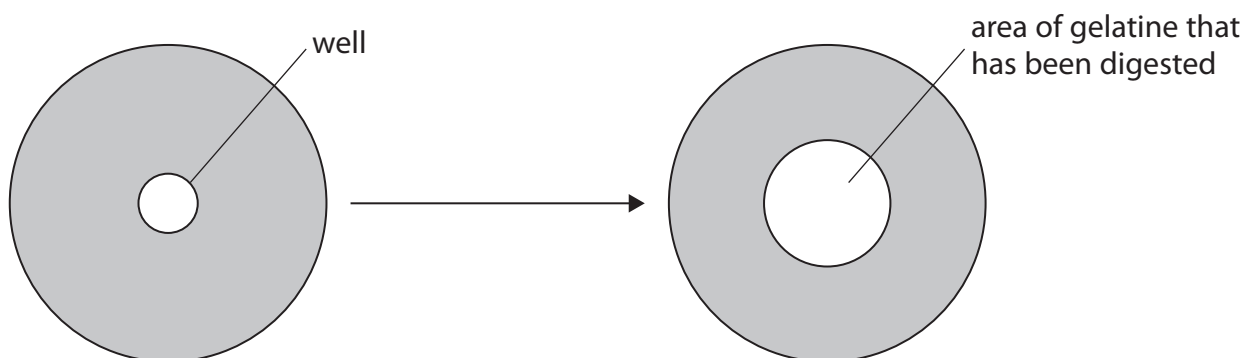
**Step 2:** Cut out a circular well with a diameter of 2 cm in the centre of the disc.

**Step 3:** Fill the well with pineapple juice.

**Step 4:** Incubate the dish for one hour at 37°C.

**Step 5:** Measure the diameter of the area that has been digested by the bromelain enzyme.

The diagram shows a gelatine disc before and after incubation with the pineapple juice.



The diameter of the circular area that had been digested after one hour was 6 cm.

Calculate the volume of gelatine that had been digested.

Give your answer, in  $\text{mm}^3$ , to two significant figures.

Volume of a cylinder =  $\pi r^2 l$

$\pi = 3.14$

(3)

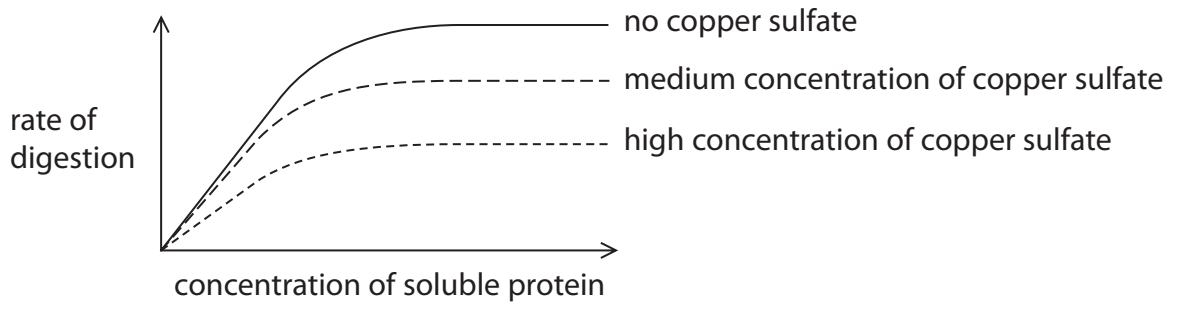
Answer .....  $\text{mm}^3$



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(c) Bromelain also digests other proteins.  
The student also investigated the effects of changing the concentration of a soluble protein, and the addition of copper sulfate on the rate of digestion of this soluble protein by bromelain.

The results are shown in the graph.



(i) Explain the effect of increasing substrate concentration on the rate of digestion of the soluble protein. (2)

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(ii) Explain the effect of copper sulfate on the rate of digestion of the soluble protein. (2)

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**(Total for Question 2 = 8 marks)**

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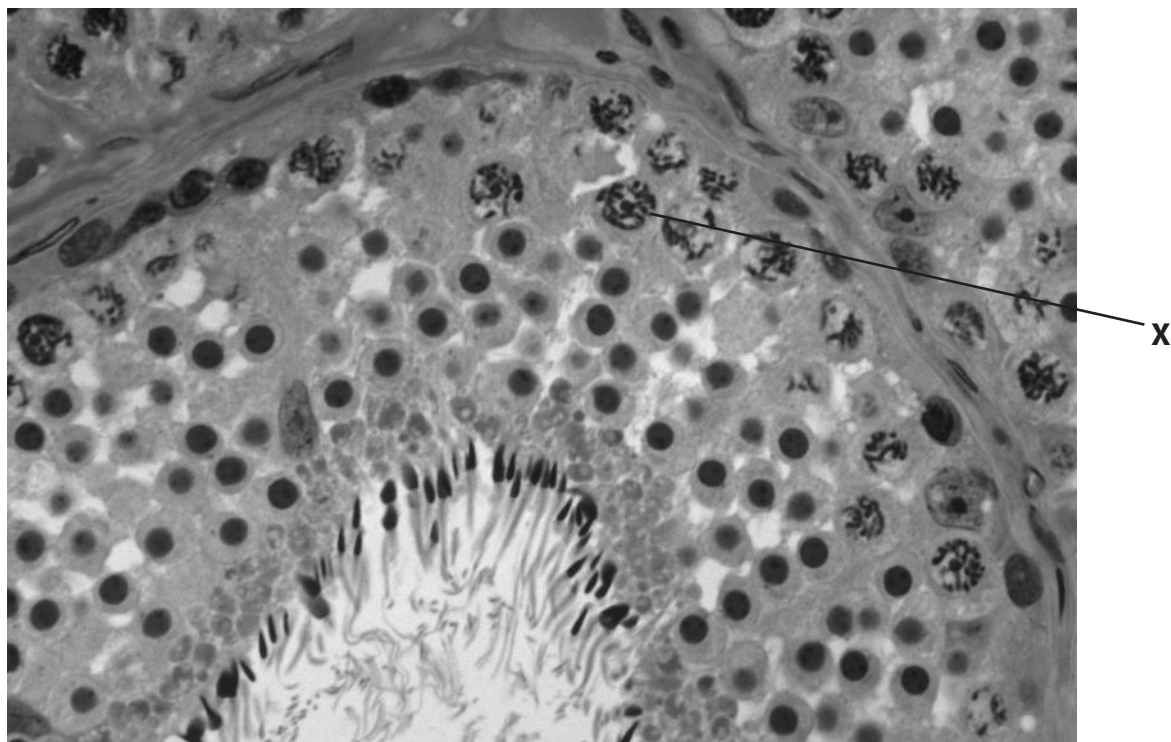


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3 The photograph shows part of a testis, as seen using a light microscope.



(Source: © M. I. WALKER / SCIENCE PHOTO LIBRARY)

(a) The cell labelled X is a primary spermatocyte.

(i) At which stage of cell division is cell X?

(1)

- A prophase I of meiosis
- B prophase II of meiosis
- C prophase I of mitosis
- D prophase II of mitosis

(ii) In the photograph, cell X has a width of 0.8 cm.

The magnification of the photograph is  $\times 1500$ .

Calculate the actual width, in micrometres ( $\mu\text{m}$ ), of cell X.

Give your answer to one decimal place.

(2)

Answer .....  $\mu\text{m}$



(b) Some pregnancies do not develop to full term, so no baby is born.

Damage to the DNA of sperm is thought to be one cause of pregnancies not developing to full term.

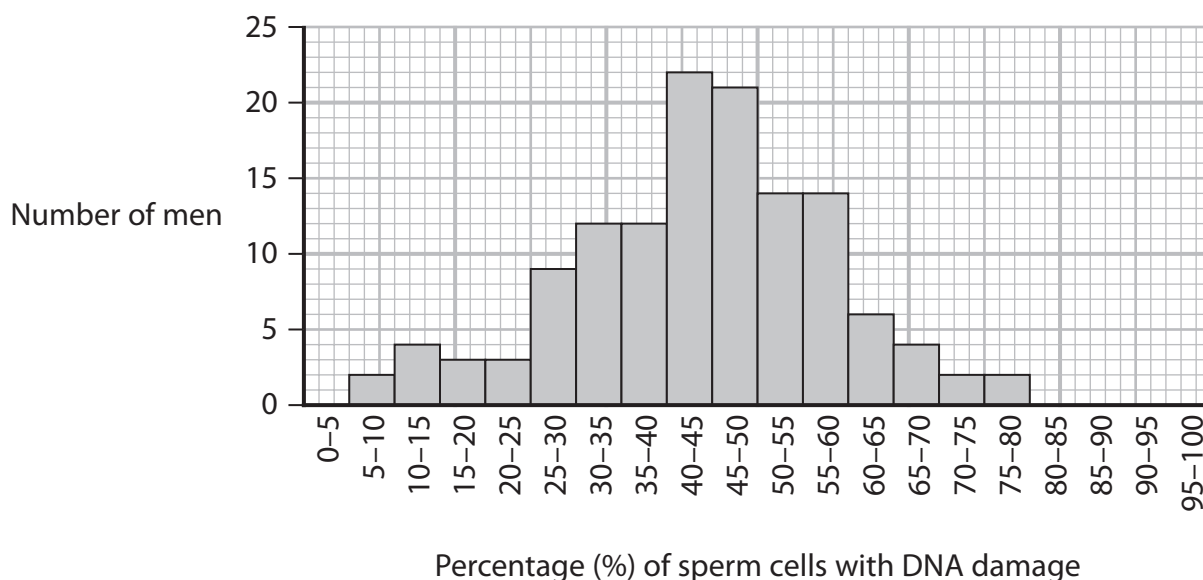
Scientists investigated if there is an association between the production of sperm with damaged DNA and the risk of pregnancies not developing to full term.

The percentage of sperm cells with DNA damage was determined for 130 men where there was a history of pregnancies not developing to full term.

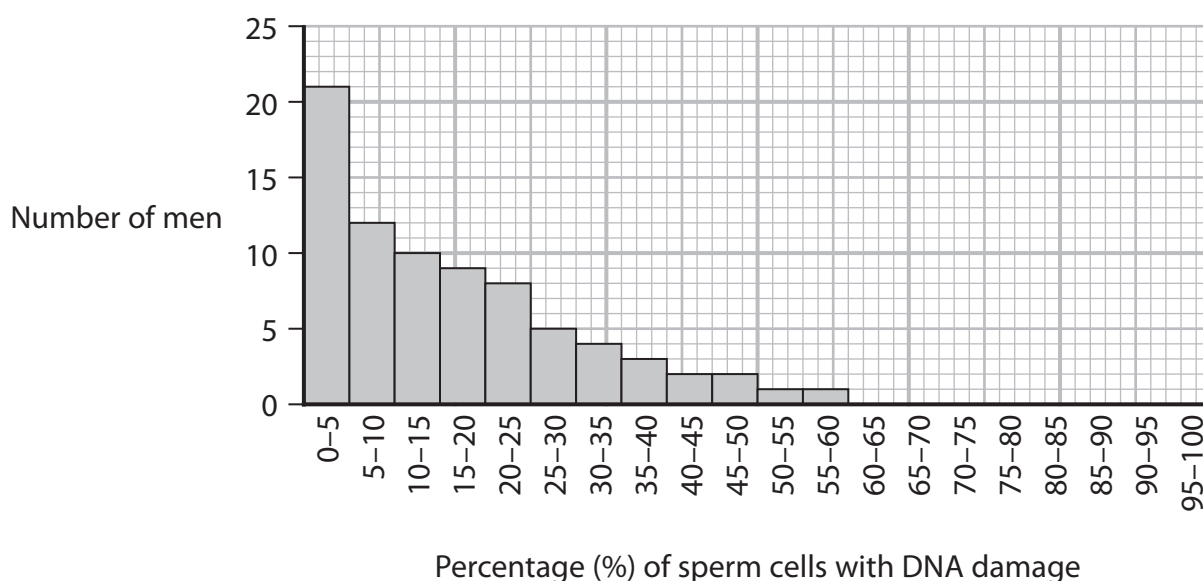
The percentage of sperm cells with DNA damage was measured for 78 men where pregnancies developed to full term.

The graphs show the results of this investigation.

Men with partners with history of pregnancies not developing to full term



Men with partners where pregnancies developed to full term





- 4 Saltmarshes are coastal habitats where silt (mud) is deposited. Saltmarshes are colonised by different species of plants and are regularly flooded with seawater.

The photograph shows an area of salt marsh.



(Source ©BOB GIBBONS / SCIENCE PHOTO LIBRARY)

- (a) Conditions close to the sea are very windy.

- (i) Which row in the table causes the highest rate of transpiration from a plant?

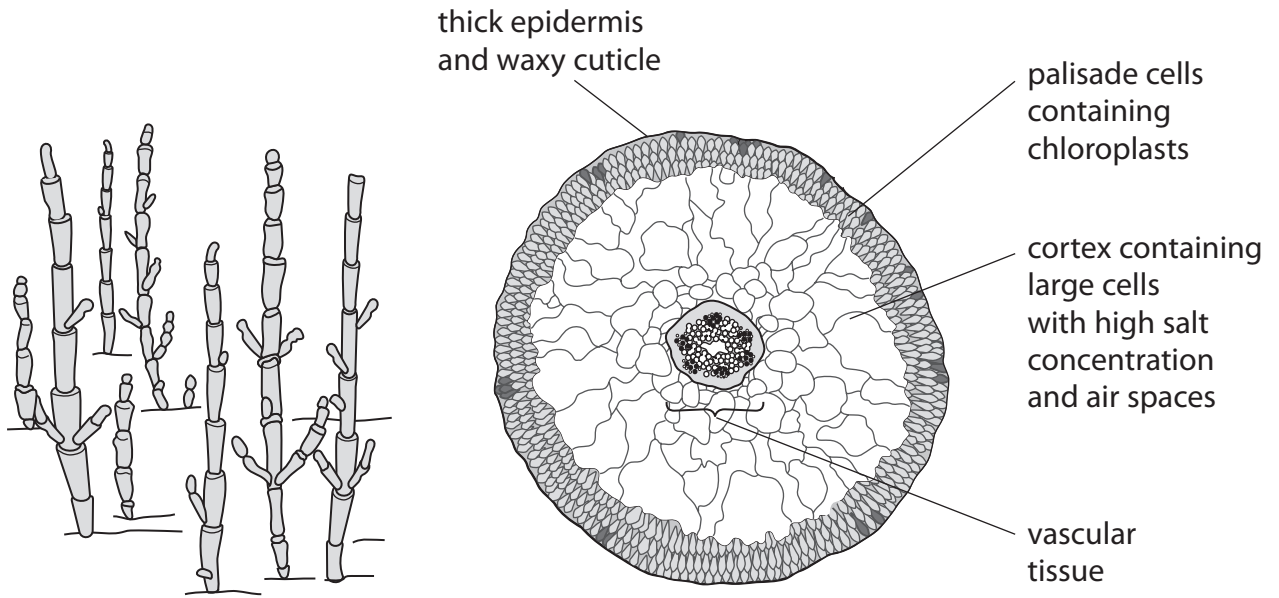
(1)

	Temperature	Wind speed	Air humidity
<input type="checkbox"/> <b>A</b>	high	high	high
<input type="checkbox"/> <b>B</b>	high	high	low
<input type="checkbox"/> <b>C</b>	high	low	high
<input type="checkbox"/> <b>D</b>	low	high	low



(ii) Samphire is one of the few plants that can grow in the areas close to the sea. Samphire plants have very small leaves and swollen stems.

The diagrams show a samphire plant and a cross section through the stem of a samphire plant.



Explain how samphire is adapted to grow in areas of saltmarshes closest to the sea.

(4)

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(b) A group of students investigated succession in a saltmarsh.

The students measured several factors at 5 m intervals along a transect, starting at the edge of the sea.

The factors measured were:

- ACFOR scales for samphire, sea lavender, and scurvy grass
- index of diversity of all plant species
- percentage of silt (mud) made up of organic material.

The results are shown in the table.

Factor		Distance from sea / m				
		0	5	10	15	20
ACFOR scales	Samphire	Abundant	Common	Rare	Absent	Absent
	Sea lavender	Absent	Rare	Common	Common	Rare
	Scurvy grass	Absent	Absent	Rare	Occasional	Abundant
Index of diversity for all plant species		0.20	0.54	0.85	2.54	2.85
Percentage of silt made up of organic material (%)		15	10	25	35	55

(i) Give **two** limitations of using ACFOR scales to compare the distribution of different plant species.

(2)

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5 The human retina contains photoreceptors called rod cells and cone cells.

(a) (i) Which of the following occur in the rod cell when it is stimulated by light? (1)

- 1 rhodopsin breaks down into retinal and opsin
- 2 there is a decrease in the release of neurotransmitter molecules
- 3 there is more diffusion of sodium ions into the rod cell

- A** 1 and 2
- B** 1 and 3
- C** 1, 2 and 3
- D** 2 and 3

(ii) Explain why the centre of the retina is less sensitive to low intensity light than the outer areas. (2)

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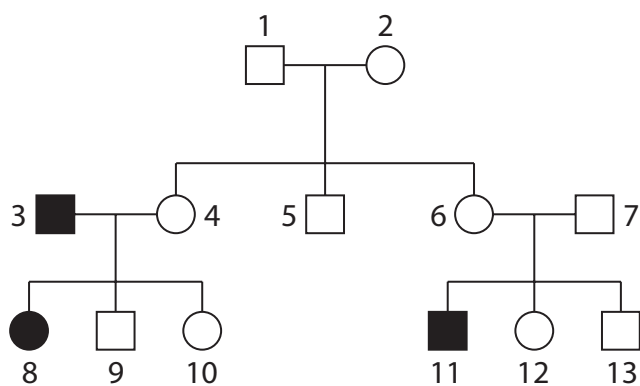




- (b) Red-green colour blindness is a sex-linked genetic condition. People with this condition are unable to detect differences between red and green colours.

The pedigree diagram shows the inheritance of red-green colour blindness in a family.

The allele for red-green colour blindness,  $X^r$ , is recessive to the allele for colour vision,  $X^R$ .



**Key:**

- male without colour blindness
- male with colour blindness
- female without colour blindness
- female with colour blindness

- (i) How many of the individuals in the family must have a genotype of  $X^R X^r$ ?

(1)

- A 2
- B 3
- C 4
- D 5

- (ii) Explain how this pedigree diagram demonstrates that red-green colour blindness is caused by a recessive allele.

(2)

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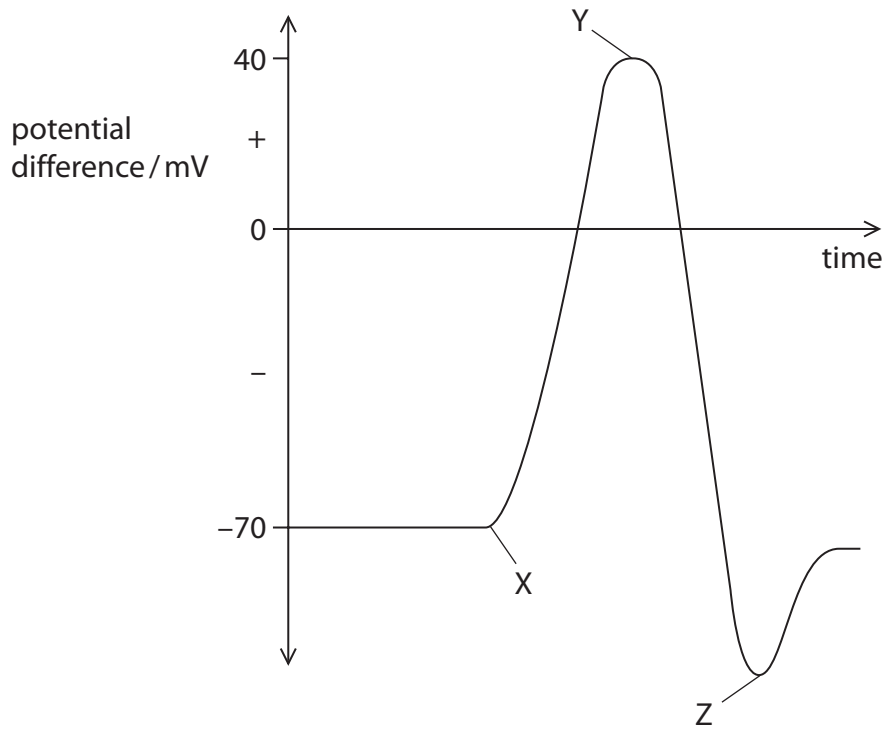
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6 The diagram shows an action potential in a neurone.



(a) (i) Which of the following causes the change in potential between X and Y? (1)

- A movement of calcium ions out of the neurone
- B movement of potassium ions out of the neurone
- C movement of sodium ions into the neurone
- D movement of sodium ions out of the neurone

(ii) Explain how membrane proteins cause the change in potential between Y and Z. (2)

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(b) The photograph shows an African crested rat.



(Source: © [https://commons.wikimedia.org/wiki/File:Lophiomys\\_imhausi.jpg](https://commons.wikimedia.org/wiki/File:Lophiomys_imhausi.jpg))

This rat has several adaptations to prevent it being eaten by predators.

These adaptations include:

- The rat chews the bark of a tree called the arrow tree. The bark of this tree contains a poison called ouabain.
- The rat rubs the poison onto its fur, which is hollow to absorb the poison.
- The rat produces proteins in its saliva that prevent the ouabain harming it.

(i) Which types of adaptation has the rat evolved?

- 1 anatomical
- 2 behavioural
- 3 physiological

- A 1 and 2
- B 1, 2 and 3
- C 1 and 3
- D 2 and 3

(1)





- 7 Scientists investigated the role of ex-situ conservation of plant species on genetic biodiversity.

The scientists investigated the variability of DNA sequences of 30 different genes for a number of species of plants in seed banks and in the wild.

- (a) (i) Which row gives correct statements about the genetic code in eukaryotes? (1)

	Overlapping	Degenerate	Contains introns in genes
<input type="checkbox"/> A	yes	yes	yes
<input type="checkbox"/> B	yes	no	yes
<input type="checkbox"/> C	no	yes	no
<input type="checkbox"/> D	no	yes	yes

- (ii) Explain why the DNA sequences of genes are more variable than the sequences of amino acids in the proteins coded for by these genes. (2)

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- (iii) Describe how the scientists could use technology to find out whether gene sequences of two species are similar. (2)

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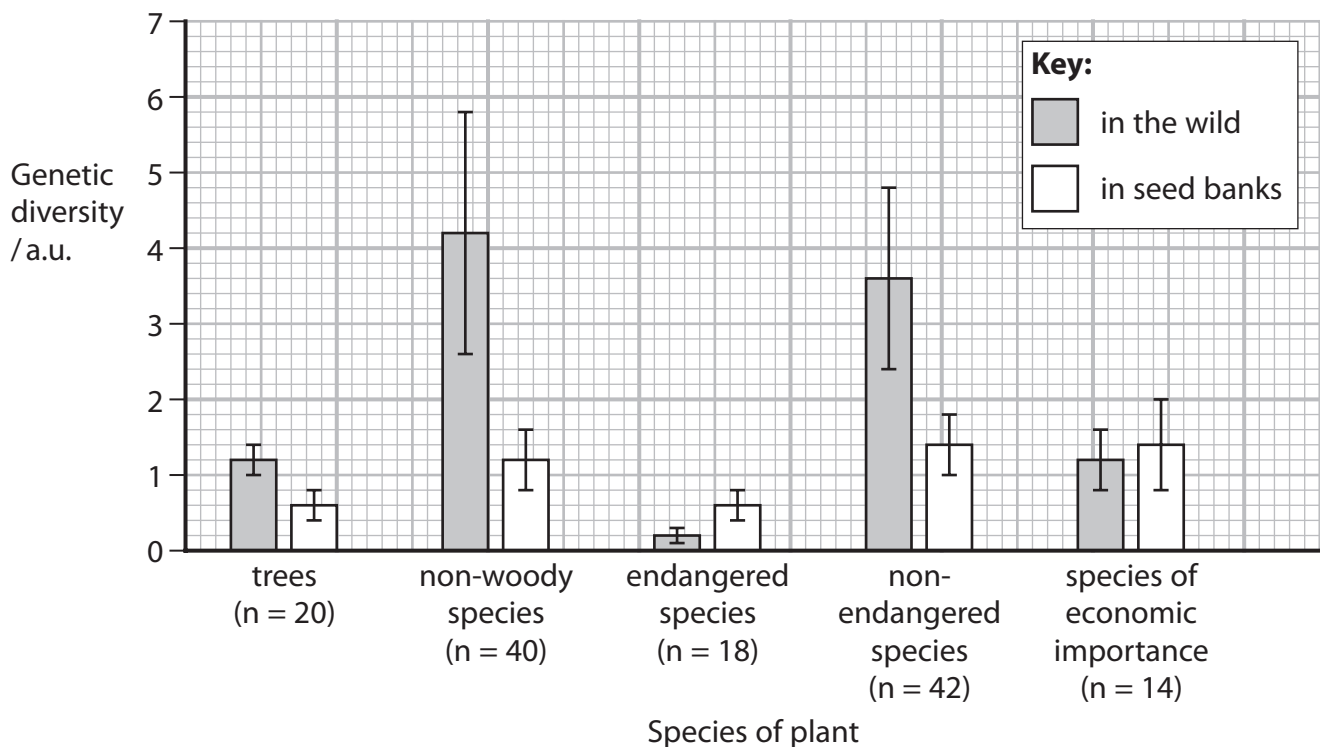
\*(b) The scientists measured the mean genetic diversity of species in the wild and the mean genetic diversity of the same species in seed banks.

The species examined included:

- trees
- non-woody species of plant
- plant species classed as endangered
- plant species classed as not endangered
- plants of economic importance that are harvested by people.

The scientists also measured the mean number of differences in the DNA sequences of the seeds that had been stored for different lengths of time compared with plants in the wild.

The graphs show the results.



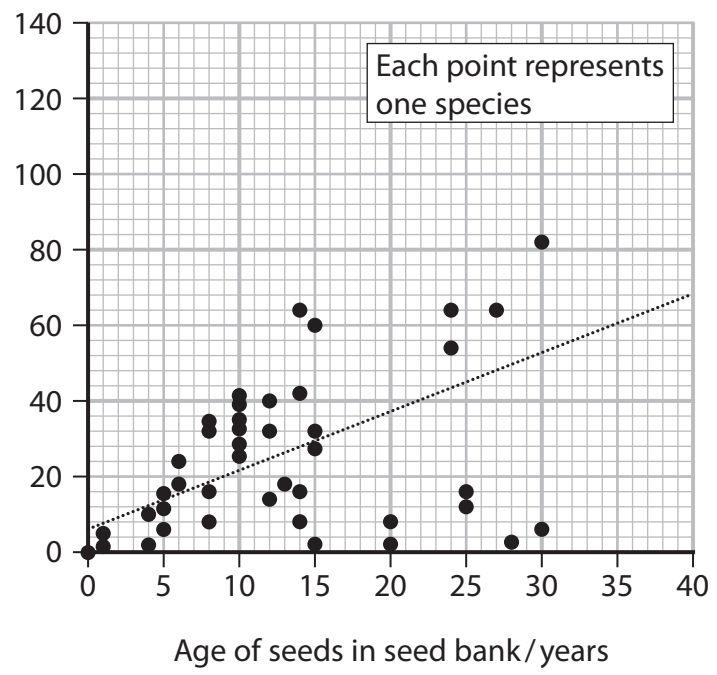
Error bars represent  $\pm 1$  standard deviation  
 n = number of different species





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Mean number of differences in DNA sequences from seed bank compared with wild plant



Analyse the data to discuss the results of this investigation.

(6)

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Handwriting practice lines consisting of multiple horizontal dotted lines.

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8 (a) Explain why a double circulatory system enables mammals to have a high metabolic rate.

(2)

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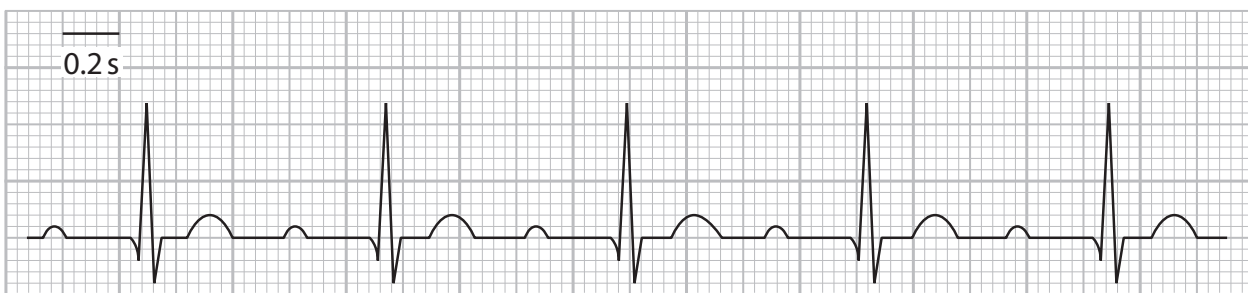
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(b) Abnormal heart rhythms can be identified in ECG traces.

The diagram shows ECG traces of a person with a regular, healthy heart rhythm and a person with an abnormal heart rhythm.



Person with regular heart rhythm



Person with abnormal heart rhythm



- (i) Calculate the heart rate, in beats per minute, of the person with an abnormal heart rate.

Give your answer to the nearest whole number.

(2)

Answer ..... beats per minute

- (ii) Explain how the ECG traces show this abnormal heart rhythm is due to damage to the septum in the centre of the heart between the left and right sides.

(2)

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(iii) Bradycardia is a heart condition that results in a heart rate that is slower than normal.

Atropine is a drug that can be used to treat some forms of bradycardia.

Atropine is a competitive inhibitor of acetylcholine.

Explain why atropine will lead to an increase in heart rate.

(3)

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(iv) Describe how exercise leads to the stimulation of the cardiac centre in the medulla oblongata.

(4)

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**(Total for Question 8 = 13 marks)**

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9 Phytoplankton are producer organisms in marine ecosystems.

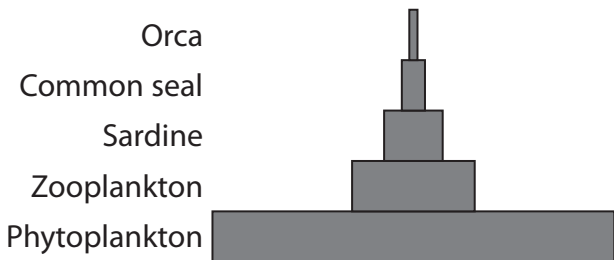
Zooplankton are small animals that live in the surface waters of the oceans.

The diagram shows a food chain for the South Atlantic Ocean.

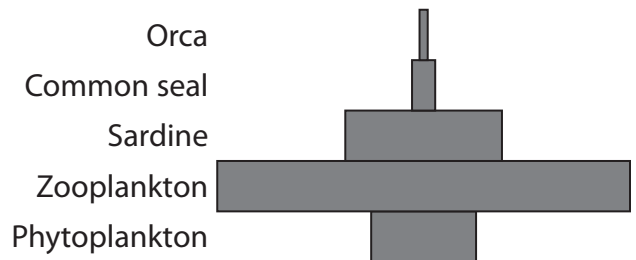
phytoplankton → zooplankton → sardine → common seal → orca

The diagrams below show ecological pyramids for this food chain.

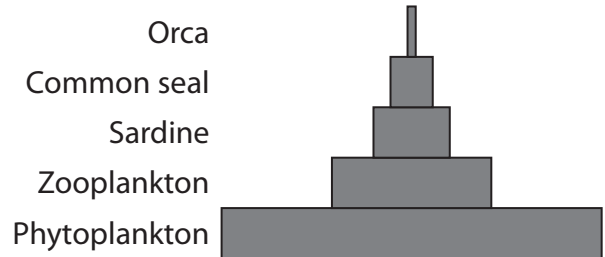
Pyramid of biomass for November



Pyramid of biomass for December



Pyramid of energy for one whole year



The units for biomass are  $\text{kg m}^{-3}$   
The units for energy are  $\text{kJ m}^{-3} \text{yr}^{-1}$

(a) Comment on the shapes of these three ecological pyramids.

(3)

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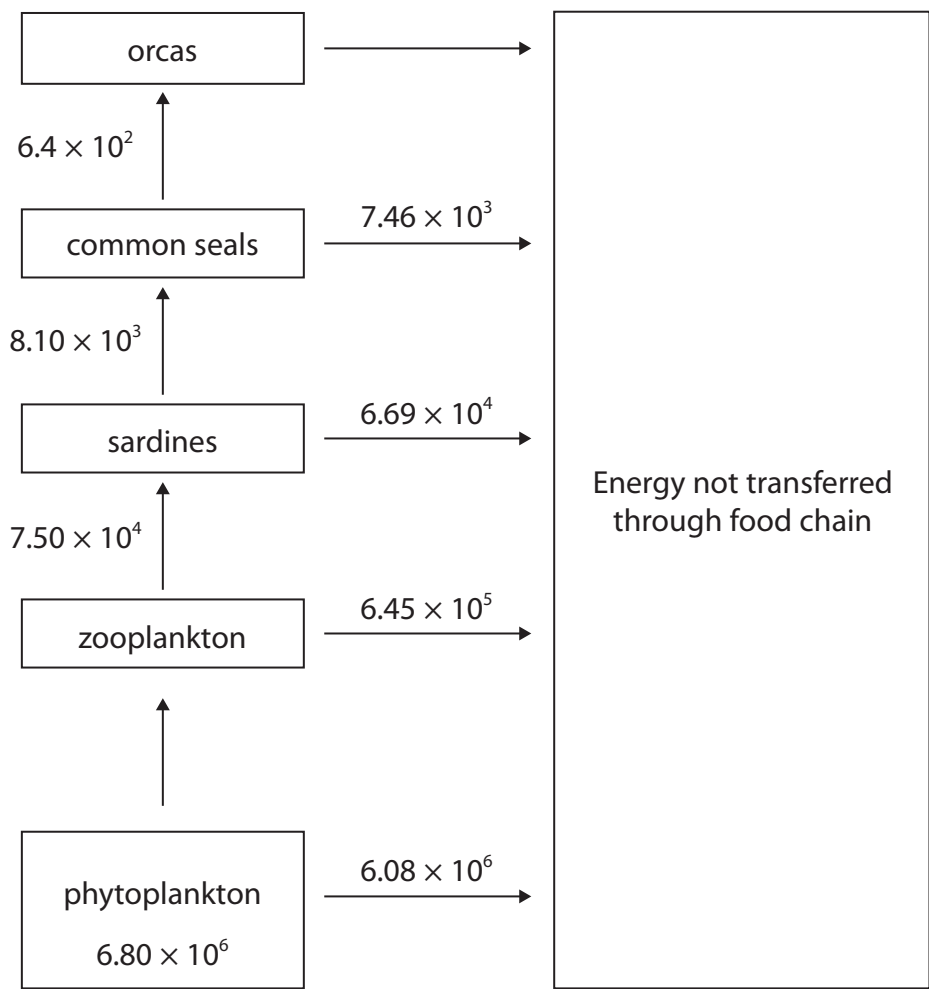
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(b) The diagram shows the flow of energy through this food chain.



All values are measured in  $\text{kJ m}^{-3} \text{yr}^{-1}$

(i) Calculate the percentage efficiency of energy transfer between the phytoplankton and the zooplankton.

Give your answer to the nearest whole number.

(2)

Answer .....%







(c) Scientists investigated the impact of global warming on marine productivity.

They determined the effect of temperature and light intensity on the net primary productivity (NPP) of phytoplankton.

Phytoplankton were exposed to different light intensities at three different temperatures for one month. After one month, the scientists measured the increase in dry biomass of phytoplankton.

The results are shown in the table.

Light intensity /arbitrary units	Mean increase in dry biomass of phytoplankton / g		
	10°C	20°C	30°C
5	4	6	2
10	8	10	4
15	10	20	15
20	12	24	28
25	12	28	35

(i) State what is meant by the term net primary productivity (NPP).

(1)





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