

Please write clearly in block capitals.

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INTERNATIONAL AS BIOLOGY (9610)

Unit 1 The Diversity of Living Organisms

Monday 13 May 2024

07:00 GMT

Time allowed: 1 hour 30 minutes

Materials

For this paper you must have:

- a ruler with millimetre measurements
- a scientific calculator, which you are expected to use where appropriate.

Instructions

- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- All working must be shown.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information

- The marks for questions are shown in brackets.
- The maximum mark for this paper is 75.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
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6	
7	
TOTAL	



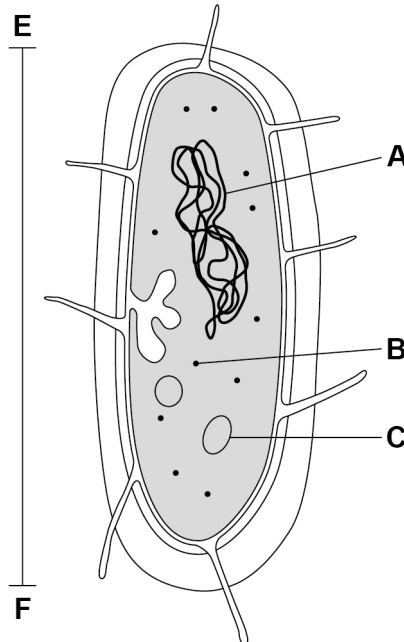
J U N 2 4 B L 0 1 0 1

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

0 1

Figure 1 shows the structure of a prokaryotic cell.

Figure 1



Magnification $\times 75\,000$

0 1 . 1

Name the structures labelled **A**, **B** and **C**.

[3 marks]

A *(Circular) DNA (nucleoid)*

B *Ribosome*

C *Plasmid*

0 1 . 2

Calculate the actual length of the cell between **E** and **F**.

Give your answer in μm to 2 significant figures.

[2 marks]

Length of E to F on the image = 71 mm = 71 000 μm

Actual length = image size $\div$ magnification

= 71 000 $\div$ 75 000 = 0.9467 μm

0.95 μm



0 1 . 3

The antibiotic penicillin causes some prokaryotic cells to die. Penicillin prevents cell wall formation when the cell divides.

Explain why the lack of a cell wall causes cell death.

[3 marks]

Water enters the cell by osmosis.

Water moves down a water potential gradient, from a higher water potential outside the cell to a lower water potential inside the cell.

Without a cell wall the cell expands and the cell surface membrane breaks, so the cell bursts (lysis).

0 1 . 4

Why does penicillin **not** cause the death of human cells?

[1 mark]

Human cells do not have cell walls (so there is no cell wall for penicillin to affect).

Question 1 continues on the next page

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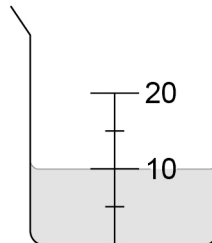


Scientists can culture prokaryotic cells in a Petri dish containing nutrient agar.

A scientist uses a beaker to put 10 cm³ of nutrient agar into a Petri dish.

Figure 2 shows the beaker containing nutrient agar.

Figure 2



0 1 . 5

Suggest how the scientist can make the measurement of the volume of nutrient agar more accurate.

[1 mark]

*Use a graduated pipette (or a syringe, or a small measuring cylinder)
with smaller intervals on the scale.*

0 1 . 6

The scientist then:

- spreads prokaryotic cells evenly over the surface of the nutrient agar in the Petri dish
- adds two antibiotic discs to the surface of the nutrient agar
- incubates the Petri dish at 37 °C for 48 hours to allow the prokaryotic cells to grow.

Explain why the scientist incubates the Petri dish at 37 °C.

[2 marks]

37 °C is the optimum temperature for the enzymes in the prokaryotic cells, so enzyme activity is highest.

So the prokaryotic cells grow quickly, with more cell division and faster synthesis of molecules for new cells.



Question 1 continues on the next page

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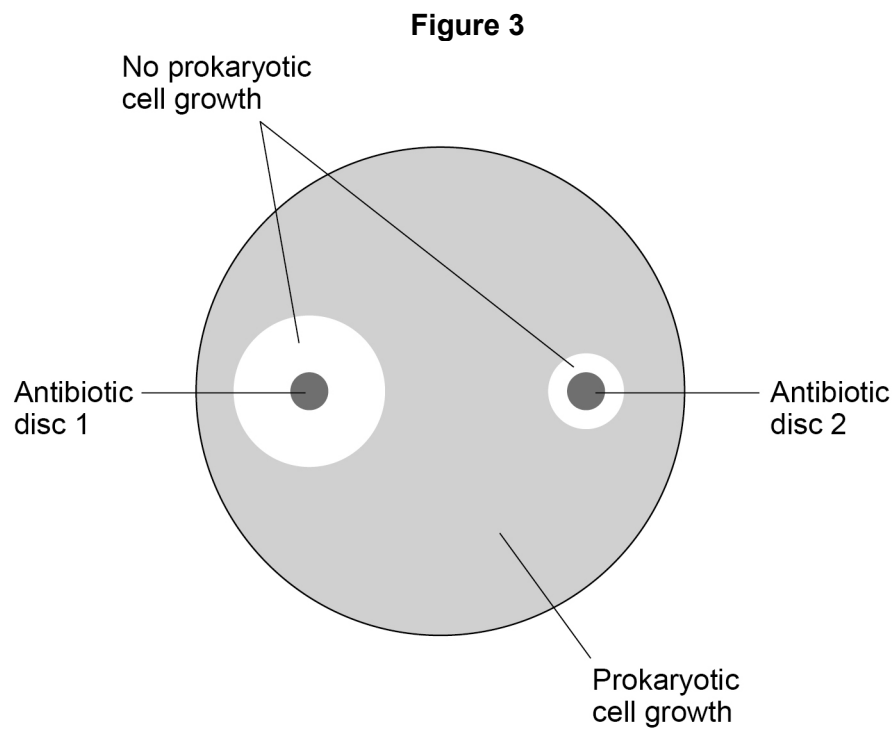
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0 5

After 48 hours the scientist looks at the Petri dish.

Figure 3 shows the areas where the prokaryotic cells cannot grow on the nutrient agar.



0 1 . 7

A student looks at the scientist's results and concludes:

'**Antibiotic 1** is twice as effective as **Antibiotic 2** at preventing the growth of these prokaryotic cells.'

Evaluate the student's conclusion about the effectiveness of the antibiotics.

Include a calculation in your answer.

The area of a circle = πr^2

$\pi = 3.14$

[3 marks]

The diameter (radius) of the clear zone around disc 1 is twice that of disc 2, so Antibiotic 1 appears to be twice as effective.

Area 1: radius = 10 mm, area = $3.14 \times 10^2 = 314 \text{ mm}^2$. Area 2: radius = 5 mm, area = $3.14 \times 5^2 = 78.5 \text{ mm}^2$.

$314 \div 78.5 = 4$, so Antibiotic 1 is 4 times more effective (the area is 4 times larger), not twice, and the conclusion is wrong.

Also there was only one investigation with no repeats, so the conclusion is not reliable.

15

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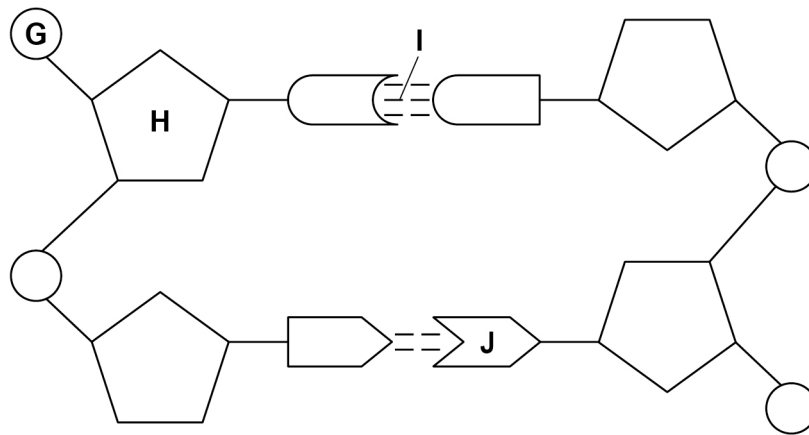
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0 2

Figure 4 shows part of a DNA molecule.

Figure 4



0 2 . 1

Name the structures **G**, **H**, **I** and **J**.

[4 marks]

G *Phosphate (group)***H** *Deoxyribose (pentose sugar)***I** *Hydrogen bonds***J** *(Nitrogenous) organic base*

0 2 . 2

A section of DNA contains 248 000 000 nucleotides.

Calculate how many nucleotides are in the template strand.

Give your answer in standard form.

[2 marks]

The template strand is one of the two strands of DNA:

$$248\,000\,000 \div 2 = 124\,000\,000$$

$$1.24 \times 10^8$$



0 2 . 3 Figure 5 shows part of an mRNA sequence.

Figure 5

DNA sequence	<u>T</u>	<u>T</u>	<u>G</u>	<u>C</u>	<u>A</u>	<u>T</u>	<u>G</u>	<u>G</u>	<u>A</u>
mRNA sequence	A	A	C	G	U	A	C	C	U
tRNA anti-codons	<u>U</u>	<u>U</u>	<u>G</u>	<u>C</u>	<u>A</u>	<u>U</u>	<u>G</u>	<u>G</u>	<u>A</u>

Complete **Figure 5** to show the DNA sequence and the corresponding tRNA anti-codons.

[2 marks]

0 2 . 4 State how mRNA initially transcribed from eukaryotic DNA differs from mRNA transcribed from prokaryotic DNA.

[1 mark]

Eukaryotic mRNA (pre-mRNA) contains introns (non-coding regions), so it needs to be spliced.

0 2 . 5 The code in mRNA is translated by a ribosome into a polypeptide.

Name a biochemical reagent that can be used to test for polypeptides and give the colour seen if polypeptides are present.

[2 marks]

Biochemical reagent *Biuret reagent*

Colour seen *Purple (lilac)*



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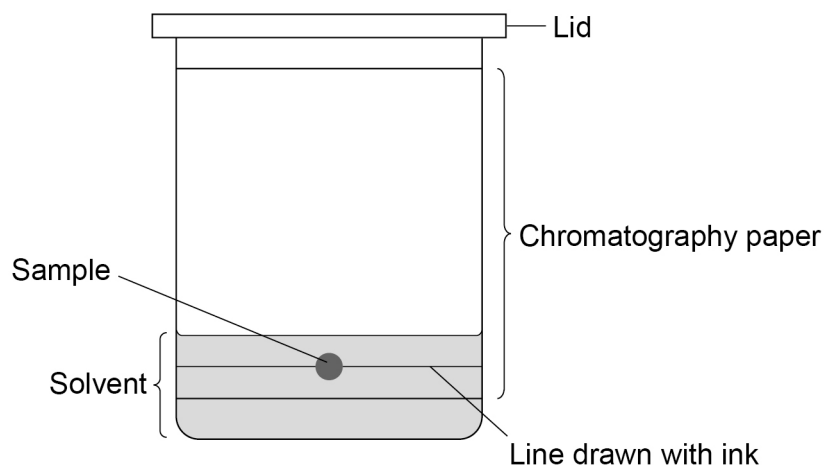


0 3

Students use chromatography to investigate the amino acid content of a sports drink.

The students set up the equipment as shown in **Figure 6**.

Figure 6



0 3 . 1

Identify **two** errors in how the students set up the equipment **and** state how the errors can be corrected.

[4 marks]

Error 1 *The starting line was drawn with ink (a pen).*

Correction 1 *Draw the starting line with a pencil (pencil does not dissolve and move with the solvent).*

Error 2 *The level of the solvent is above the sample (the sample spot is below the solvent surface).*

Correction 2 *Use less solvent, so the solvent level is below the sample (starting line).*

Question 3 continues on the next page

Turn over ►



The teacher repeats the investigation and carries out the chromatography correctly.

Figure 7 shows the results produced by the teacher and **Table 1** shows R_f values for some amino acids.

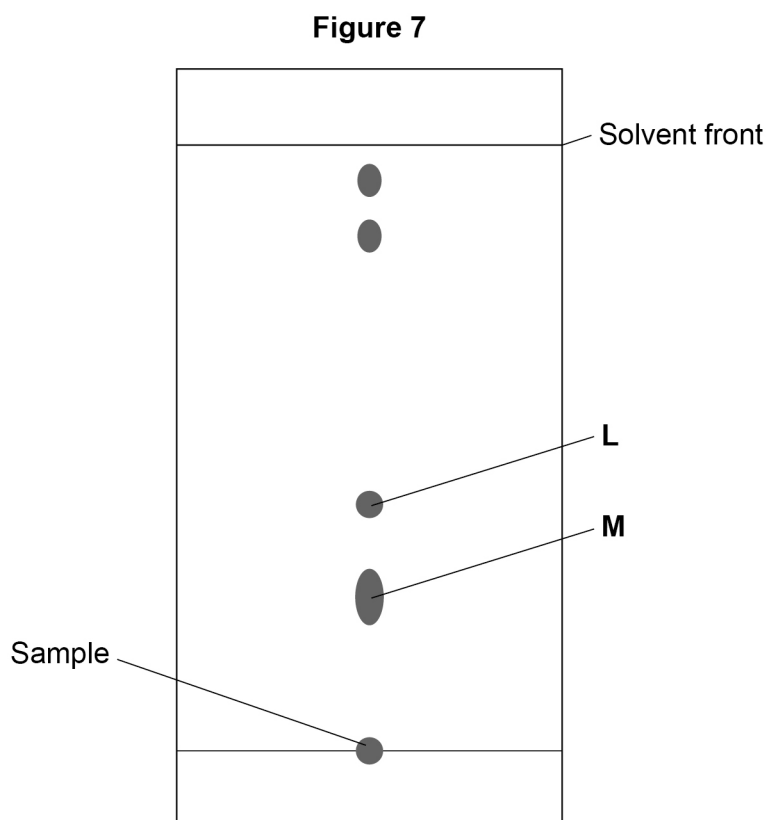


Table 1

Amino acid	R_f value
Alanine	0.38
Asparagine	0.50
Cysteine	0.40
Glycine	0.26
Leucine	0.73

0 3 . 2

Name the amino acid labelled **L**.

Give a reason for your answer.

[2 marks]

Name of amino acid labelled **L** Cysteine

Reason $R_f = \text{distance moved by L} \div \text{distance moved by the solvent} =$

0.4, which is the same R_f value as cysteine (0.40).



0 3 . 3

The teacher suggests that the spot labelled **M** is actually two different amino acids.

Give **two** methods the teacher could use to find out if **M** is two different amino acids.

[2 marks]

1 *Use two-way chromatography: rotate the paper 90° and run it in a second solvent.*

2 *Use a different solvent (or use longer paper and leave it for a longer time).*

8

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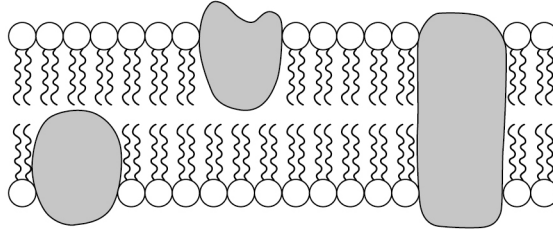


0 4

The cell surface membrane can be described by the fluid mosaic model.

Figure 8 shows the structure of a cell surface membrane.

Figure 8



0 4 . 1

Explain why the following terms are used to describe a membrane.

[2 marks]

Fluid The phospholipid and protein molecules can move; they are not in a fixed position (flexible).

Mosaic It contains proteins scattered among the phospholipids.

0 4 . 2

Table 2 shows the functions of some molecules found in a cell surface membrane.

Complete **Table 2**.

[3 marks]

Table 2

Molecule	Function
<i>Phospholipid</i>	Allows the movement of non-polar molecules through the membrane.
Cholesterol	<i>Regulates the fluidity (stability) of the membrane</i>
<i>Protein (glycoprotein)</i>	Can be a receptor or a channel.



0 4 . 3 Membranes are also found inside cells.

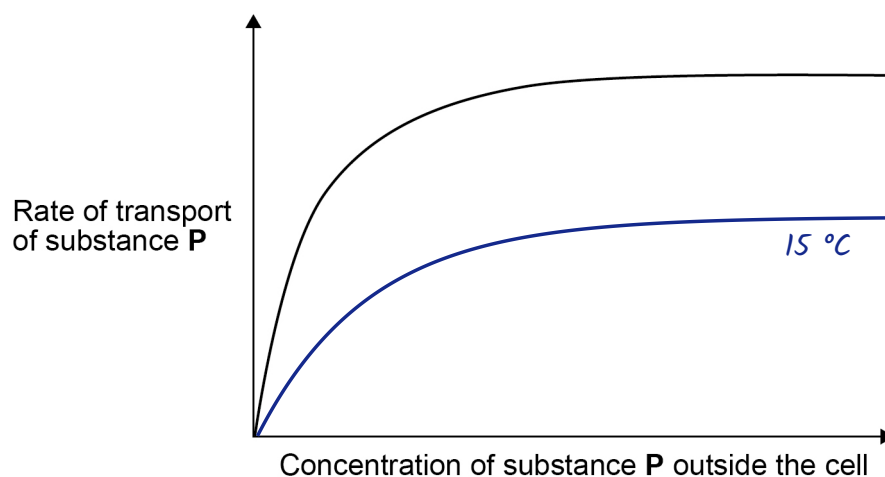
State **two** functions of membranes **inside** cells.

[2 marks]

- 1 *Separates (isolates) substances from the cytoplasm, e.g. enzymes in lysosomes, or forms vesicles.*
- 2 *Controls what enters and leaves organelles, and provides a site for attachment, e.g. of ribosomes or ATP synthase.*

Figure 9 shows the rate of transport of substance **P** into a cell at 25 °C

Figure 9



0 4 . 4 Give the method of transport shown in **Figure 9** for substance **P** and suggest why the graph levels off at high concentrations.

[2 marks]

Method of transport *Facilitated diffusion*

Reason why the graph levels off *At high concentrations all the carrier proteins (channels) are occupied (saturated).*

0 4 . 5 Sketch a line on **Figure 9** to show how decreasing the temperature to 15 °C would change the results.

[2 marks]

Turn over ►



0 5

Read the following passage:

Blood vessels in the human circulatory system include arteries, arterioles, capillaries, venules and veins. Blood is transported in blood vessels to and from tissues, including the muscles involved in movement.

The human body contains approximately 5 dm³ of blood. The blood can be moved around the body to where it is needed the most using a mechanism called the 'vascular shunt'. During exercise, the vascular shunt causes blood to be transported away from the digestive system and towards the working muscles. 5

The arterioles that supply the capillaries of the digestive system with blood can constrict (narrow) and the arterioles that supply the capillaries of the working muscles with blood can dilate (widen). Blood contains red blood cells that are flexible and have a mean diameter of 7 µm 10

Red blood cells contain haemoglobin, a protein that has a quaternary structure and contains haem groups. Haemoglobin associates with oxygen in the lungs where the partial pressure of oxygen is high, and dissociates from oxygen at the respiring tissues where the partial pressure of oxygen is lower. When associated with oxygen, haemoglobin is called oxyhaemoglobin. 15

Use the information from the passage and your own knowledge to answer the questions.

0 5 . 1

Explain the advantage of the vascular shunt to an athlete who is running a long distance (lines 4–8).

[2 marks]

More blood, so more oxygen, is supplied to the working muscles for aerobic respiration (more ATP production, more energy released).

So the athlete is able to exercise harder (faster) for longer, and less lactic acid is made and more carbon dioxide is removed.



0 5 . 2

The lumen of a capillary has a radius of approximately $4\text{ }\mu\text{m}$

Suggest an advantage of the lumen of a capillary being this size (lines 9–12).

[2 marks]

The lumen is about $8\text{ }\mu\text{m}$ across, a similar diameter to a red blood cell ($7\text{ }\mu\text{m}$), so red blood cells are squeezed against the capillary wall. This gives a shorter diffusion distance and more surface area in contact for gas exchange, and slows the blood flow, giving more time for gas exchange.

0 5 . 3

Explain how the haem groups in the haemoglobin molecule are involved in the transport of oxygen (lines 14–16).

[2 marks]

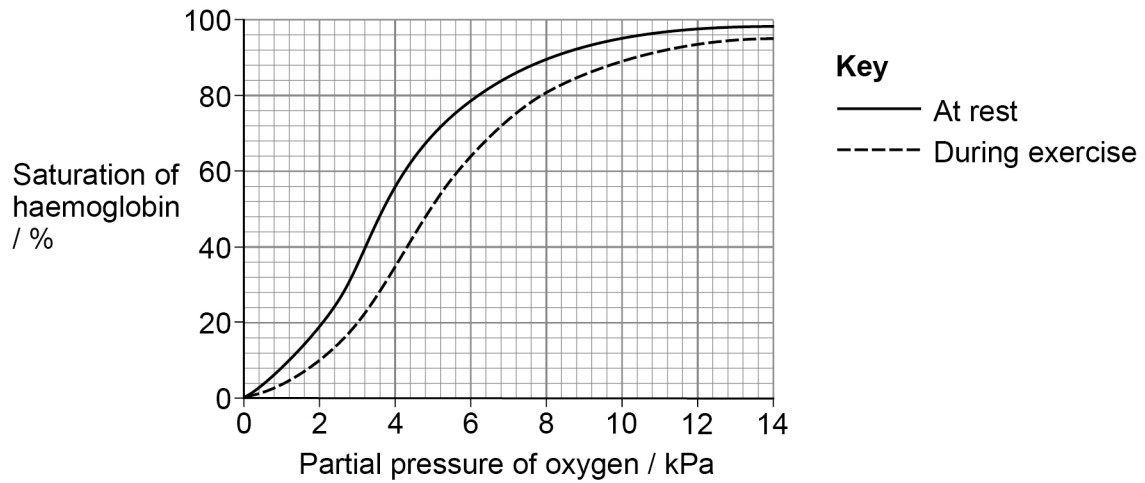
Each haem group contains an iron ion (Fe^{2+}). The iron ion binds reversibly to an oxygen molecule, so oxygen is picked up in the lungs and released at the respiring tissues.

Question 5 continues on the next page

Turn over ►

Figure 10 shows an oxygen dissociation curve. This represents the percentage saturation of haemoglobin with oxygen at different partial pressures of oxygen. During exercise the position of the dissociation curve shifts to the right.

Figure 10



0 5 . 4

The saturation of haemoglobin is directly affected by the partial pressure of oxygen inside the tissue.

Complete **Table 3** using data from **Figure 10**.

[2 marks]

Table 3

Tissue	Saturation of haemoglobin / %	Partial pressure of oxygen / kPa
At rest	56	4.0
During exercise	28	3.6



0 5 . 5

During exercise, the position of the oxygen dissociation curve is to the right of the oxygen dissociation curve at rest.

Use **Figure 10** to suggest the advantage of the position of the curve during exercise.

[2 marks]

At the same (lower) partial pressure of oxygen the haemoglobin has a lower affinity for oxygen, so more oxygen dissociates (is unloaded) from it.

So more oxygen is released to the respiring muscle tissues for aerobic respiration (ATP production).

10

Turn over for the next question

Turn over ►



0 6

Pike are predatory freshwater fish.

One species of pike is *Esox lucius*.

0 6

1

Table 4 shows the classification of *Esox lucius*.

Table 4 is not complete.

Complete **Table 4**.

[2 marks]

Table 4

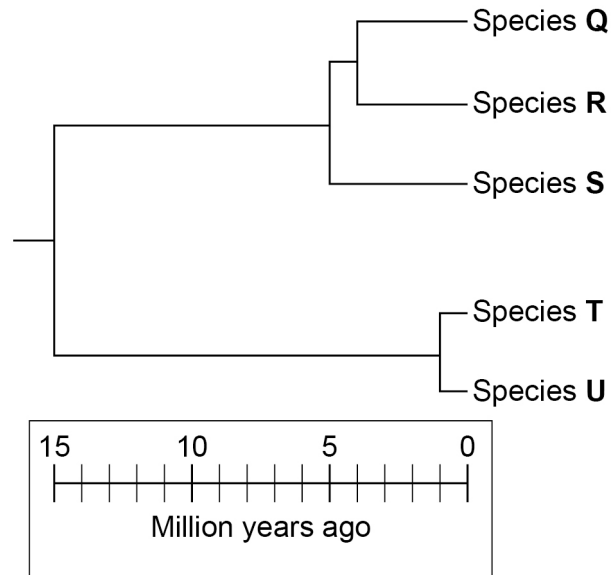
Group	Name
Domain	Eukaryota
Kingdom	<i>Animalia</i>
Phylum	Chordata
<i>Class</i>	Actinopterygii
<i>Order</i>	Esociformes
Family	Esocidae
Genus	<i>Esox</i>
Species	<i>lucius</i>



0 6 . 2

Figure 11 shows the relationship of five species of pike.

Figure 11



Describe the relationship of the five species of pike.

Use information from **Figure 11**.

[3 marks]

All five species share a common ancestor (about 15 million years ago).

Q and R are the most closely related of Q, R and S; Q, R and S share a common ancestor and are closely related to each other.

T and U share a common ancestor and are closely related to each other; T and U diverged most recently (about 1 million years ago).

Question 6 continues on the next page

Turn over ►



0 6 . 3

Scientists discovered a small population of pike living in a lake in Italy.

In 2011, they classed these pike as a new species and named it *Esox cisalpinus*.

Give **one** method they could have used to identify *Esox cisalpinus* as a new species.

[1 mark]

Compare differences in their DNA base sequences (or proteins) with those of the other pike species.

0 6 . 4

The scientists sampled all the prey species in the lake to see if *Esox cisalpinus* has a variety of different food to eat.

The scientists used the following equation to calculate the index of diversity of the prey species in the lake.

$$d = \frac{N(N-1)}{\sum n(n-1)}$$

Give the meaning of the symbols N and n used in the equation.

[2 marks]

$N =$ *Total number of individuals of all species in the sample*

$n =$ *Number of individuals of one species in the sample*

0 6 . 5

The scientists took a large number of random samples of the prey species in different areas of the lake.

Explain the importance of:

[2 marks]

taking a large number of samples *The samples are representative, and it reduces the effect of anomalies.*

taking random samples *Random sampling removes (avoids) bias.*



07.1

One model of enzyme action involves a change in shape of the enzyme's active site to allow the substrate to bind.

Name this model.

[1 mark]

Induced fit model

07.2

When a substrate binds to an enzyme's active site, a chemical bond can be broken in the substrate using a molecule of water.

Name the process of breaking chemical bonds using water.

[1 mark]

Hydrolysis

07.3

Endopeptidase and exopeptidase are two different enzymes that can bind and break down the same protein substrate.

Suggest **two** reasons why different enzymes are able to bind to the same substrate.

[2 marks]

1 *The shape of the substrate may be complementary to both active sites (it fits both).*

2 *The active sites might bind to different parts of the substrate: endopeptidase to the middle and exopeptidase to the end.*

Question 7 continues on the next page

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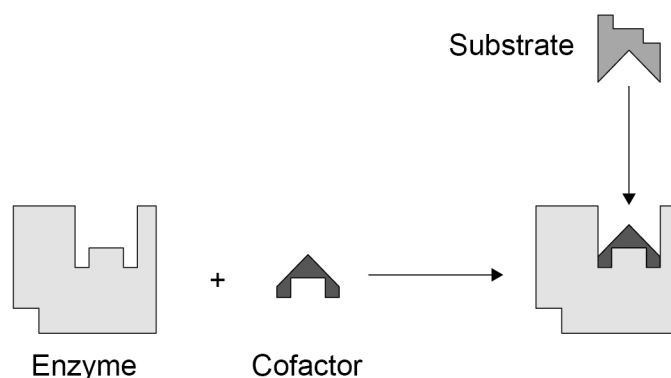
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07.4

Figure 12 shows an enzyme-controlled reaction involving a type of molecule called a **cofactor**.

Figure 12



Use **Figure 12** to explain how adding a cofactor allows the enzyme–substrate complex to form.

[2 marks]

The cofactor binds to the active site and changes the shape of the active site.

The active site becomes complementary to the substrate (the substrate fits), so the substrate can bind and an enzyme–substrate complex forms.

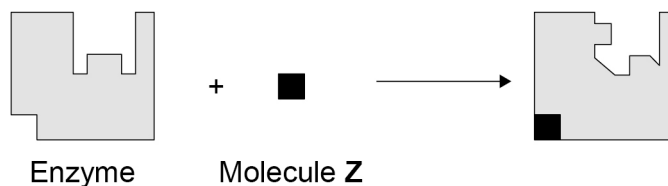
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Figure 13 shows the effect of molecule **Z** on the enzyme shown in **Figure 12**.

Figure 13



0 7 . 5

Describe how the action of molecule **Z** results in the changes shown in the diagram.

Use information from **Figure 13**.

[3 marks]

Molecule Z is a non-competitive inhibitor.

It binds to an allosteric site, a site on the enzyme that is not the active site.

This changes the tertiary (3-D) structure of the enzyme, so the shape of the active site changes and the substrate can no longer bind (no enzyme-substrate complexes form).

0 7 . 6

Suggest a practical step that a scientist could use to reduce the effect of molecule **Z** on the enzyme-catalysed reaction.

[1 mark]

Increase the concentration of the enzyme.

10

END OF QUESTIONS



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