

## Thursday 22 May 2025 – Morning

### AS Level Biology A

#### H020/02 Depth in biology

Time allowed: 1 hour 30 minutes



**You can use:**

- a scientific or graphical calculator
- a ruler (cm/mm)



Please write clearly in black ink. **Do not write in the barcodes.**

Centre number

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Candidate number

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First name(s)

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Last name

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### INSTRUCTIONS

- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.
- Answer **all** the questions.
- Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.

### INFORMATION

- The total mark for this paper is **70**.
- The marks for each question are shown in brackets [ ].
- Quality of extended response will be assessed in questions marked with an asterisk (\*).
- This document has **24** pages.

### ADVICE

- Read each question carefully before you start your answer.

1

(a) The table describes features of molecules.

Complete the table. Use ticks (✓) to identify if the feature describes starch or cellulose.

Description	Starch	Cellulose
Is made of amylose and amylopectin	✓	
Is a long unbranched chain		✓
Is made from $\beta$ glucose molecules		✓

[3]

(b) Students complete paper chromatography on carbohydrates.

The table shows the  $R_f$  values for known carbohydrates.

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The measurements recorded for an unknown carbohydrate were:

Distance travelled by solvent = 8.50 cm

Distance travelled by carbohydrate = 4.34 cm

Calculate the  $R_f$  value of the unknown carbohydrate and use the table to identify it.

Give your answer to 2 decimal places.

$$R_f = \frac{\text{distance travelled by solute}}{\text{distance travelled by solvent}} = \frac{4.34}{8.50} = 0.5106$$

$R_f$  value = ..... 0.51 .....

Name of carbohydrate = ..... fructose .....

[2]

(c) Outline the role of the solvent in paper chromatography.

Solvent dissolves the carbohydrates  
Solvent carries carbohydrates through  
Stationary phase. Different carbohydrates  
will travel different distances and will  
have higher/lower affinity for solvent [2]

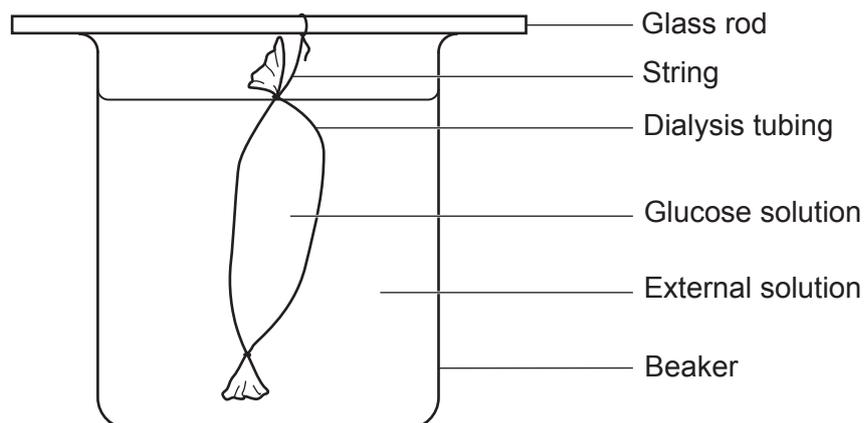
2

- (a) Students use a model cell to investigate the effect of the thickness of the exchange surface membrane on the rate of diffusion across the membrane.

The students are provided with dialysis tubing of different thicknesses, grade 1, grade 3 and grade 5, where grade 5 is the thickest.

They set up the apparatus as shown.

The students remove a sample of the external solution at 30 second intervals and determine the concentration of glucose ( $\text{mmol dm}^{-3}$ ) in the sample.



The table shows their results.

Grade of dialysis tubing	Concentration of glucose found in the samples of external solution taken at 30 s intervals ( $\text{mmol dm}^{-3}$ )				
	0 s	30 s	60 s	90 s	120 s
1	0.00	1.31	2.52	3.59	4.80
3	0.00	0.82	2.24	2.39	3.31
5	0.00	0.31	0.64	0.96	1.22

- (i) Identify the independent variable **and** the dependent variable in this experiment.

Independent variable

Thickness of dialysis tubing

Dependent variable

Concentration of glucose

[2]

- (ii) Suggest **two** improvements to this experiment to increase the accuracy of the results.

Improvement 1 repeated investigation with wider range of grade of dialysis tubing

Improvement 2 carry out investigation in water bath.

[2]

- (iii) Suggest a conclusion that can be drawn from the data in the table.

You should give evidence to support your conclusion.

The Thicker the tubing, the slower the rate of diffusion across the membrane.

[2]

- (b) State **one** similarity and **one** difference between simple diffusion and facilitated diffusion.

Similarity Both are passive processes

Difference facilitated diffusion allows the transport of larger molecules

[2]

- (c) Using your knowledge of the phospholipid bilayer in plasma membranes, explain how an increase in temperature affects the permeability of the membrane.

affect: membrane becomes more permeable.

explanation:-

phospholipid molecules will gain more kinetic energy so more gaps form between the phospholipid molecules

so more small molecules can cross the membrane

[3]

- (d) Exocytosis is an active process.

Explain why ATP is needed for exocytosis.

As energy is needed for movement of secretory vesicles along cytoskeleton

so energy is needed for membrane fusion.

[2]

7  
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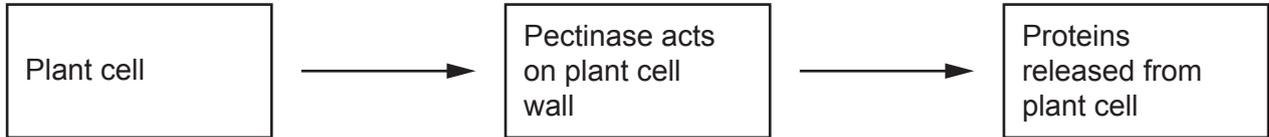
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3

(a)

- (i) Enzymes can be used to extract proteins from plant cells. These proteins can be used for food products.

The diagram shows how the enzyme pectinase can be used to extract some plant proteins.



Complete the sentences using the most appropriate term(s).

Use the diagram and your knowledge of enzymes.

In living organisms, enzymes usually speed up reactions involved in the

..... *metabolism* ..... of the cells.

From the location of the enzyme pectinase shown in the diagram, the action of pectinase can be

described as ..... *extracellular* .....

[2]

- (ii)\* The table shows some data on different methods that can be used to extract plant proteins.

Protein source	Extraction method	Percentage yield of protein extracted
Mung beans	chemical only	77.3
Potatoes	chemical and enzyme assisted	88.8
Soya beans	chemical only	48.7
Split peas	chemical and enzyme assisted	80.7

A student concluded:

'The data proves that the enzyme assisted extraction method always gives a greater yield of plant protein'.

Evaluate this conclusion.

⇒ point in support of the statement

- Enzyme assisted extraction gives the highest yield
- yield for potatoes is 88.8%, the highest value
- yield for split peas is 88.7, the second highest value.
- yield for soya beans with no enzyme is 48.7%, which is much lower than the enzyme assisted method.

⇒ points that undermine the statement

- yield for mung beans is still quite high at 77.3%, though not enzyme assisted
- No detail on other variables (uncontrolled)
- No control experiment was done, so we do not know if the potatoes and

[6]

Extra answer space if required.

split peas would have been high without enzymes

- Assumption have been made that the same mass of protein source was used

⇒ Conclusion:- Disagree with statement e.g. insufficient data, Agree with statement: yield in potatoes and peas are highest.

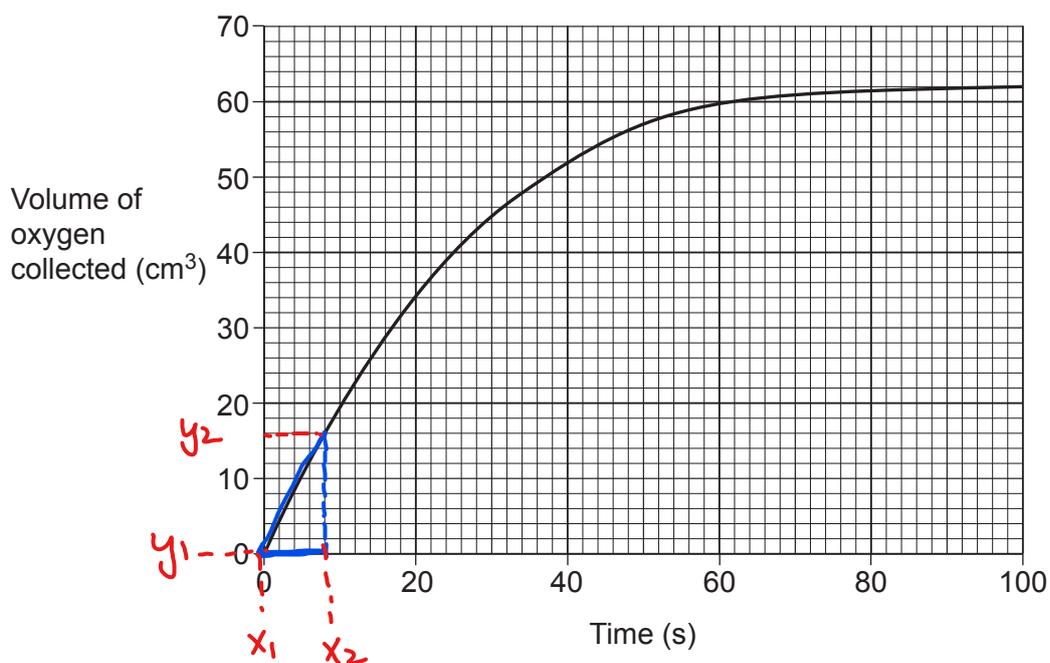
(b) Peas can be used in experiments as a source of catalase.

Catalase is an enzyme that catalyses the breakdown of hydrogen peroxide to water and oxygen gas.

A student mashes some peas in distilled water to release the catalase.

They investigate the effect of temperature on the rate of the enzyme reaction.

The graph shows the results they obtain at 20 °C.



(i) Use the graph to calculate the initial rate of the reaction.

Give your answer to 2 significant figures.

$$\text{initial rate} = \frac{16}{8} = 2.0 \text{ cm}^3 \text{ s}^{-1}$$

Initial rate of the reaction = ..... 2.0 .....  $\text{cm}^3 \text{ s}^{-1}$  [3]

- (ii) The student repeats this experiment at 30°C and finds the initial rate of reaction to be 4.34 cm<sup>3</sup>s<sup>-1</sup>.  
Calculate the Q<sub>10</sub> for catalase.

Give your answer to 2 significant figures.

$$\frac{4.34}{2.1} = 2.06666 = 2.1$$

Q<sub>10</sub> for catalase = ..... 2.1 ..... [1]

- (c) The student completes a different experiment to investigate the effect of pH on enzyme action.

Suggest how they would vary **and** detect the pH in their experiment.

vary by: adding acid or alkali solutions

Detect by: universal indicator paper

..... [2]

- (d) Explain how increasing the substrate concentration affects the enzyme activity.

as substrate concentration

⇒ affect: rate of reaction increases.

⇒ explanation:- increases the collision between substrate and active site, so more enzyme substrate complexes form.

At very high concentration of substrate all the active sites become occupied.

So the rate of reaction plateaus and enzyme concentration becomes the limiting factor.

[4]

4

(a)

- (i) The European dust mite is an insect with the binomial name *Dermatophagoides pteronyssinus*.

State **one** advantage of the binomial naming system.

Each organism has its own unique name  
avoid confusion in naming species

[1]

- (ii) Complete the table with the names of the taxa for the European dust mite.

Taxa	Name
Kingdom	Animalia.
Genus	Dermatophagoides
Species	pteronyssinus

[2]

- (b) Organisms were originally classified into five kingdoms.

State **two** general features of organisms classified in the Plantae kingdom that are **not** features of organisms that are classified in the Fungi kingdom.

Feature 1 ... contain chlorophyll

Feature 2 ... cell wall composed of cellulose

[2]

- (c) State the relationship between classification and phylogeny.

Classification is based on phylogeny

[1]

(d) State **two** differences between the five kingdom and three domain classification systems.

1 Three domain system has six Kingdom.

2 Domains are based on similarities in biological molecules.

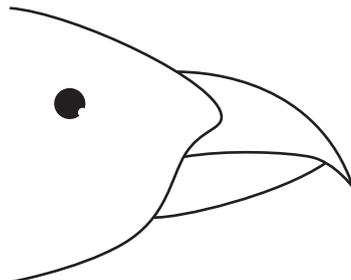
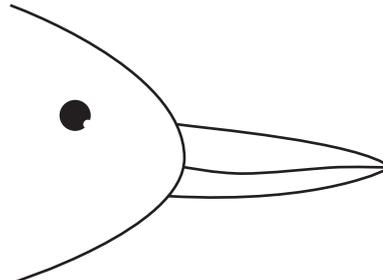
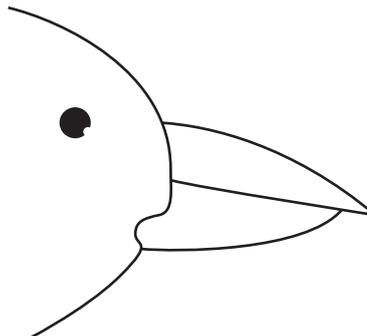
[2]

(e)\* Darwin observed birds called finches on the Galapagos Islands.

All the different species of finches evolved from one species of finch that arrived from mainland South America about one million years ago.

The table shows the type of beak and the preferred food of three of the finch species.

Each of these three finch species lives in a different environment.

Finch species	Diagram of beak shape	Beak type	Food
Vegetarian finch		Crushing beak with biting tips	Buds, leaves and fruit growing on trees
Warbler finch		Probing beak with probing tips	Flying insects and grass dwelling insects
Cactus finch		Probing beak with crushing tips	Cactus flowers and nectar

Using the information in the table, explain Darwin's theory of evolution by natural selection.

- Variation existed within the finch population
- mutation leading to genetic variation.
- Different food sources acts as the selection pressure
- These finches were able to breed
- The allele for the beneficial characteristic was passed on to the next generation.
- This led to speciation.

⇒ Example of beneficial beak shape linked to food availability

e.g those finches with a probing beak with probing tips will have the selective advantage when flying insects are in abundance

⇒ Examples of disadvantageous beak shape

e.g those finches with crushing beak with biting tips will have a selective disadvantage when buds [6]

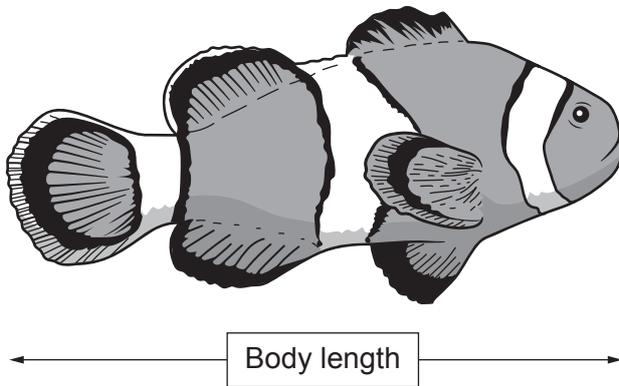
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leaves and fruits are in short supply.

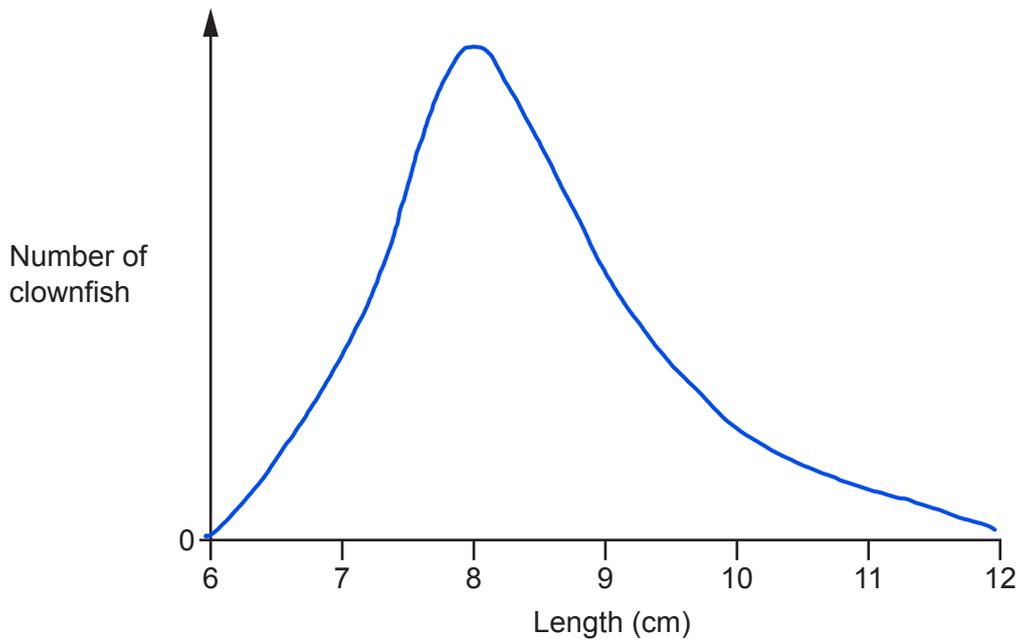
⇒ Example of how beak shape enables finch to feed successfully e.g. vegetarian finch has a crushing beak with biting tips which can crush fruit.

- 5  
 (a) Clownfish, *Amphiprion ocellaris*, live in the Indian Ocean. They have a mean body length of 8 cm.

A student looks at data on variation in the body length of adults in a species of clownfish.



- (i) Using the axes, sketch the shape of the graph you would expect the student to find.



[1]

- (ii) Individuals in a population show variation.

Name **two** causes of variation.

Cause 1 Genetics

Cause 2 Random mating

[1]

- (b) Clownfish are multicellular bony fish.

Explain why multicellular organisms need a specialised exchange surface.

Diffusion distance is too large  
due to Low surface area to  
volume ratio.

[2]

- (c) State **one** feature that both gill lamellae **and** root hairs have that makes them efficient as an exchange surface.

Large surface area.

[1]

- (d) Explain why bony fish need water to flow over their gills for gaseous exchange to take place.

- To maintain a steep concentration gradient
- To maximize the rate of diffusion
- blood flows in opposite direction to water
- Gill filaments need a flow of water to keep them apart.

[4]

6

- (a) Spirometer readings were taken from a person at rest and during exercise.
- Their tidal volume at rest was  $480 \text{ cm}^3$ .
  - Their ventilation rate at rest was  $5 \text{ dm}^3$  per minute.
  - During exercise their tidal volume increased by 70%.

- (i) Calculate the breathing rate of the person at rest.

Give your answer to the nearest whole number.

$$\text{Breathing rate} = \frac{\text{ventilation rate}}{\text{Tidal volume}}$$

$$\text{Breathing rate} = \frac{5000}{480} = 10$$

Breathing rate =  $\overset{10}{\dots\dots\dots}$  breaths per minute [2]

- (ii) Calculate the person's tidal volume during exercise.

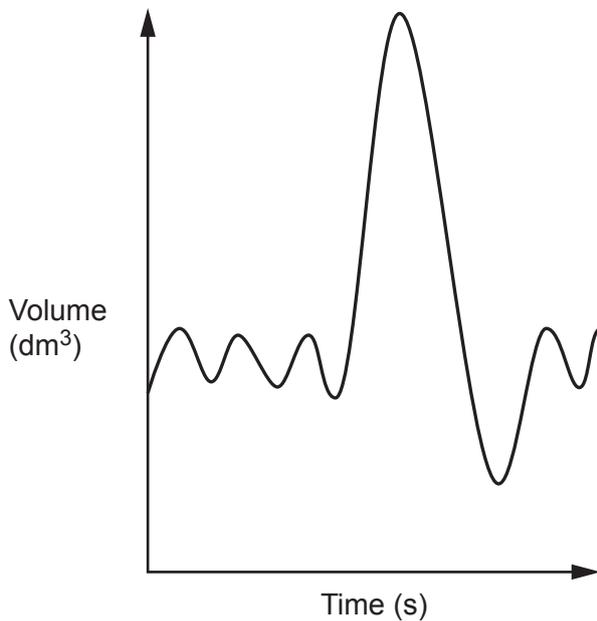
$$\text{Increase in tidal volume} = \frac{480}{100} \times 70 = 336 \text{ cm}^3$$

$$\text{New tidal volume} = 480 + 336 = 816 \text{ cm}^3$$

Tidal volume during exercise =  $\overset{816}{\dots\dots\dots}$   $\text{cm}^3$  [1]

- (b) A study shows that long term exposure to dust affects a person's lung function by reducing their vital capacity.

The graph shows a spirometer trace for a person with healthy lung function.



Suggest how a spirometer trace would be different for a person with long term exposure to dust.

The large peak will be lower and trough will be smaller

[1]

- (c) A student makes the following statement about ventilation in humans:

“During inspiration the diaphragm contracts and flattens. Internal intercostal muscles contract, moving the ribs upwards. The volume of the thorax increases, so the pressure in the thorax is now higher than atmospheric pressure. This forces air into the lungs.”

Identify **and** correct the **two** errors in this statement.

Error and correction 1 external intercostal muscle contract, not internal

Error and correction 2 pressure in thoxax is now lower than atmospheric pressure, not higher

[2]

(d) The table shows components in the mammalian gaseous exchange system.

Complete the table by stating **one** role of each component.

Components	Role
Incomplete rings of cartilage in the trachea	Stop trachea from collapsing
Smooth muscle in the bronchioles	Contract and relax to control the size of lumen
Elastic fibres in the alveoli	Recoils to force the air out

[3]

END OF QUESTION PAPER

**EXTRA ANSWER SPACE**

If you need extra space use these lined pages. You must write the question numbers clearly in the margin.

This section of the page is a large, empty area for writing answers. It consists of a vertical solid line on the left side, creating a margin, and a series of horizontal dotted lines extending across the page to the right. The dotted lines are spaced evenly down the page, providing a guide for writing.





A large area of the page is filled with horizontal dotted lines, providing a space for writing answers. A solid vertical line runs down the left side of this area, creating a margin.

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