AQA

SPECIMEN MATERIAL v1.0

Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

Surname _____

Forename(s) _____

Candidate signature _____

A-level BIOLOGY

Paper 1

Specimen materials (set 2)

Time allowed: 2 hours

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 the 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.
- 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 91.

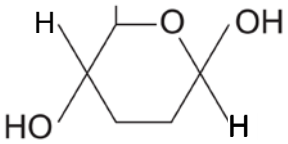
For Examiner's Use	
question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
TOTAL	

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

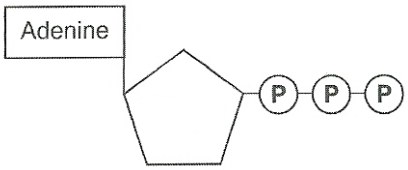
0 1 **Figure 1** shows four biological molecules.

Figure 1

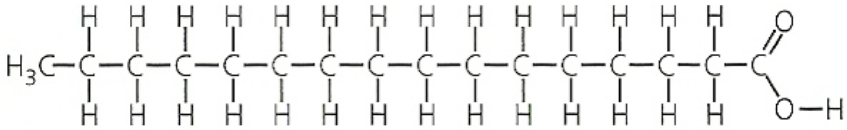
Molecule **A**



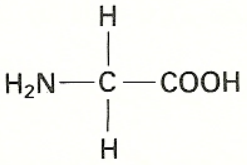
Molecule **B**



Molecule **C**



Glycine



0 1 . 1 Give the **full** name of:

[2 marks]

Molecule **A** _____

Molecule **B** _____

0 1 . 2 What type of molecule is molecule **C**?

[2 marks]

_____

0 1 . 3 Glycine, shown in **Figure 1**, is an amino acid.

In the space below, draw a diagram to show the dipeptide produced when two molecules of glycine are joined together.

[2 marks]

0 1 . 4 Name the other molecule formed when two molecules of glycine are joined together.

[1 mark]

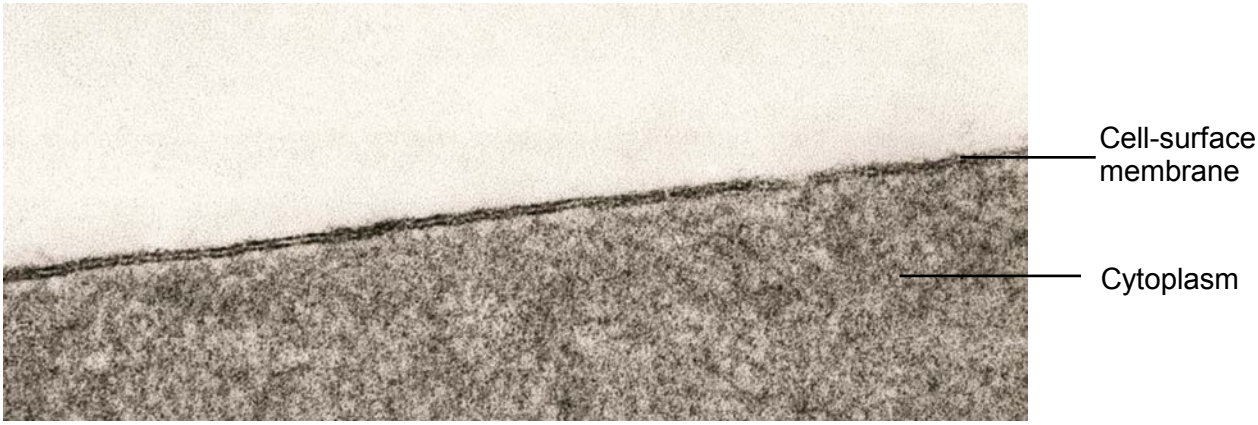
_____

7

Turn over for the next question

0 2 **Figure 2** shows the cell-surface membrane of a red blood cell seen with a transmission electron microscope.

Figure 2



0 2 . 1 The cell-surface membrane can be seen with a transmission electron microscope but **not** with an optical microscope.

Explain why.

[1 mark]

0 2 . 2 No organelles are visible in the cytoplasm of this red blood cell.

Suggest why.

[1 mark]

0 2 . 3 Before the cell was examined using the electron microscope, it was stained. This stain caused parts of the structure of the cell-surface membrane to appear as two dark lines.

Suggest an explanation for the appearance of the cell-surface membrane as two dark lines.

[3 marks]

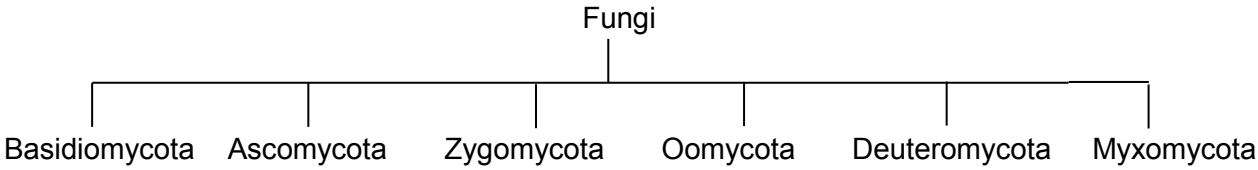
0 2 . 4 Describe how substances move across cell-surface membranes by facilitated diffusion.

[3 marks]

8

0 3 **Figure 3** shows one way in which the kingdom Fungi can be classified.

Figure 3



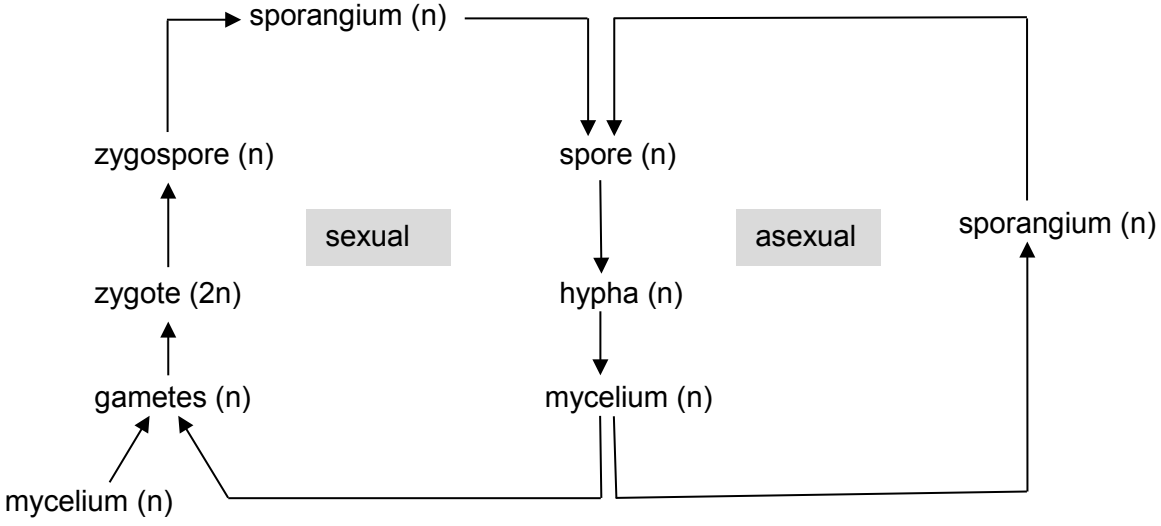
0 3 . 1 Name the taxon represented by Zygomycota.

[1 mark]

Rhizopus is a member of the Zygomycota. It has thread-like hyphae that form a mass, called a mycelium, across its food source. Vertical hyphae form spore-carrying sporangia. A new hypha grows from each spore.

Figure 4 shows the life cycle of *Rhizopus.*

Figure 4



0 3 . 2 Write the letter **M** on **Figure 4** to show where meiosis occurs.

[1 mark]

0 3 . 3 **Figure 4** shows that *Rhizopus* is able to reproduce both asexually and sexually. Suggest and explain **one** advantage of asexual reproduction and **one** advantage of sexual reproduction in this life cycle.

[2 marks]

Asexual _____

_____

_____

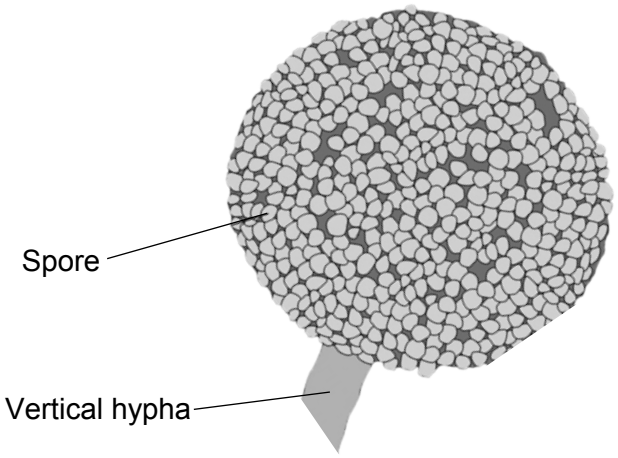
Sexual _____

_____

_____

Figure 5 shows one spore-carrying sporangium from *Rhizopus*. The magnification of **Figure 5** is × 700.

Figure 5



0 3 . 4 The hypha supporting the spore-carrying sporangium is vertical. Suggest **one** advantage of the hypha being vertical.

[1 mark]

_____

_____

Question 3 continues on the next page

0 3 . 5 A scientist wanted to calculate the mean volume of *Rhizopus* spores.
Describe how she could use **Figure 5** do this.
You may assume the spores are perfectly spherical.

[3 marks]

8

Turn over for the next question

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

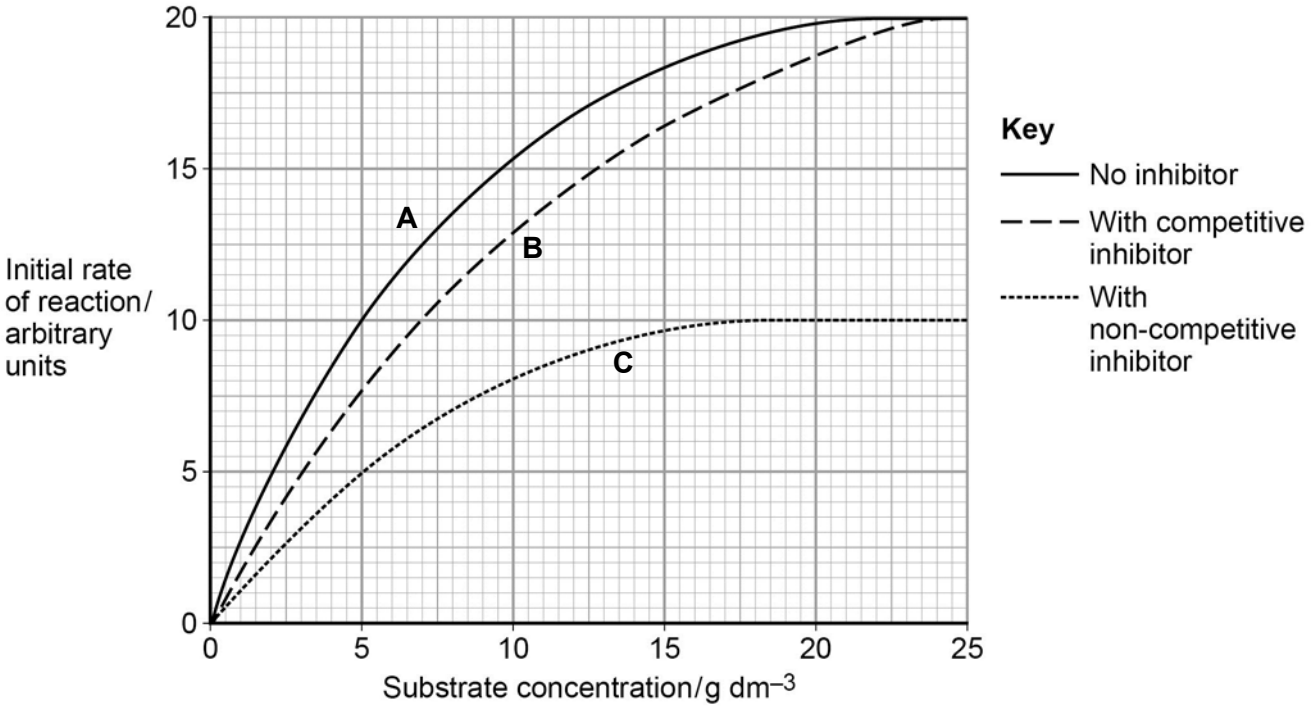
0 4 A student investigated the effect of substrate concentration on the initial rate of an enzyme-catalysed reaction.

She added 10 cm^3 of an enzyme solution to 10 cm^3 of substrate solutions of different concentrations. At 30-second intervals, she tested samples of each mixture for the presence of substrate.

- **A** – in the absence of an inhibitor.
- **B** – with a competitive inhibitor added to the substrate solution.
- **C** – with a non-competitive inhibitor added to the substrate solution.

Her results are shown in **Figure 6**.

Figure 6



0 4 . 1 Explain the results **without** inhibitor (curve **A**) shown in **Figure 6**.

[2 marks]

0 4 . 2 **Figure 6** shows that the maximum initial rate of reaction (V_{max}) when a competitive inhibitor was present (curve **B**) is different from that when a non-competitive inhibitor was present (curve **C**).

Explain this difference.

[4 marks]

0 4 . 3 The Michaelis constant (K_m) is the substrate concentration at which the initial rate of reaction is half its maximum value (V_{max}).

How could you use the Michaelis constant to determine the type of inhibition occurring in an enzyme-catalysed reaction?

Use information from **Figure 6** to support your answer.

[1 mark]

7

There are no questions on this page

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ANSWER IN THE SPACES PROVIDED

0 5 The UK government pays farmers to leave grassy strips around the edges of fields of crops. These grassy strips contain a variety of plant species. Leaving the strips is an attempt to encourage biodiversity of animals.

0 5 . 1 Give **two** reasons why the grassy strips increase the biodiversity of animals.

[2 marks]

1 _____

2 _____

A group of scientists investigated the effect of grassy strips on the biodiversity of soil animals.

- They divided a field into plots measuring 25 m × 5 m, with a 5-metre-wide grassy strip of land between each plot.
- Each year, they planted wheat in each of the plots.
- In the fifth year, they removed samples of soil from each plot where wheat was growing and from the grassy strips around them.
- They sorted each soil sample by hand for 40 minutes to collect the soil animals within the sample.

0 5 . 2 The scientists decided to collect animals from the soil samples for 40 minutes.

Suggest how the scientists decided that 40 minutes was an appropriate time.

[2 marks]

_____

_____

_____

_____

_____

Question 5 continues on the next page

0 5 . 3 **Table 1** shows how the scientists published their results. They calculated mean values and two times the standard deviation (SD) of the mean.

Two standard deviations above and below the mean includes 95.4% of the data.

Table 1

Group of animals	Mean number of animals per m^2 (± 2 × SD)		Mean number of species per m^2 (± 2 × SD)	
	Soil under wheat crop	Soil under grassy strips	Soil under wheat crop	Soil under grassy strips
Beetles	41.2 (± 6.4)	80.1 (± 10.1)	10.0 (± 1.6)	17.3 (± 1.0)
Centipedes	18.4 (± 3.6)	13.5 (± 1.0)	1.8 (± 0.3)	2.1 (± 0.2)
Earthworms	244.5 (± 27.1)	281.2 (± 39.4)	3.8 (± 0.3)	5.1 (± 0.2)
Millipedes	38.4 (± 12.2)	36.2 (± 2.9)	3.5 (± 0.3)	3.2 (± 0.2)
Woodlice	0.0	73.9 (± 8.5)	0.0	2.8 (± 0.2)

It would **not** be possible to calculate an index of diversity from the results in **Table 1**.

Explain why.

[1 mark]

0 5 . 4 A summary of this research was published in a farming magazine. The journalist concluded that creating grassy strips around fields had little effect on the diversity of soil animals.

Do you agree with this conclusion?

Use evidence from **Table 1** to justify your answer.

[4 marks]

9

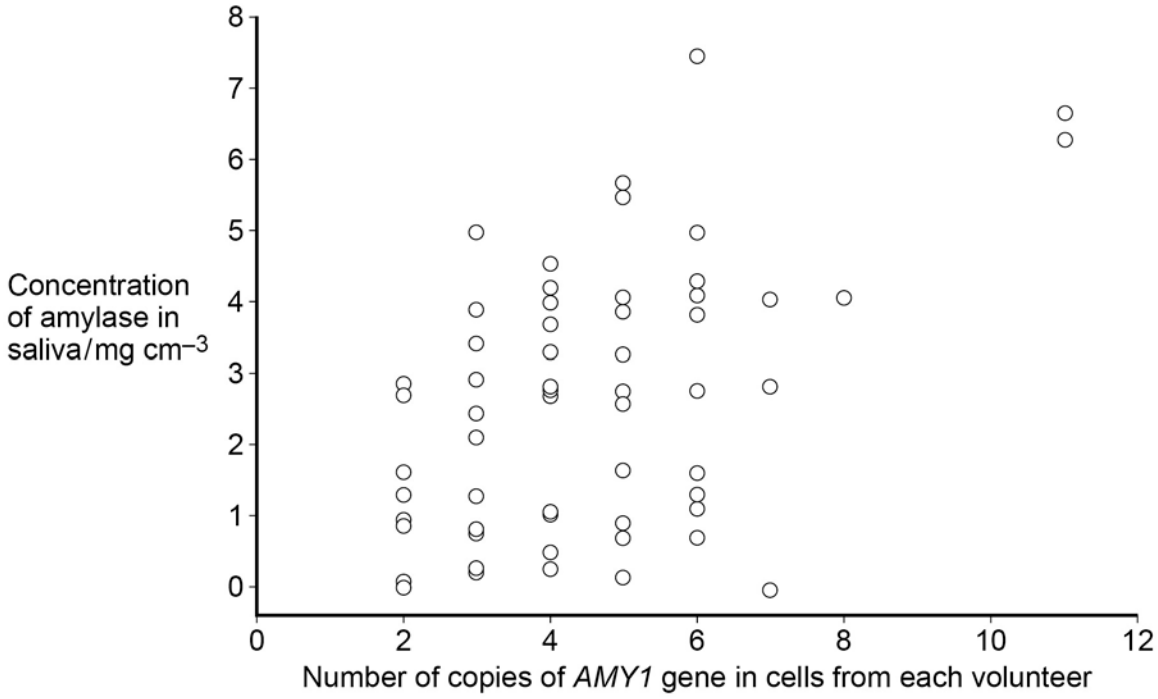
Turn over for the next question

0 6 The saliva of most humans contains α-amylase. The gene encoding α-amylase is called *AMY1;* it is located on chromosome 1.

As a result of mutation, humans might have more than one copy of the *AMY1* gene on one, or both, of their copies of chromosome 1. A team of scientists investigated whether the number of copies of the *AMY1* gene was associated with the concentration of α-amylase in the saliva of 58 human volunteers.

Figure 7 shows their results. Each circle represents one volunteer.

Figure 7



0 6 . 1 What was the range in the number of copies of the *AMY1* gene?

[1 mark]

0 6 . 2 The scientists found the mean number of copies of gene *AMY1* was 4.4 genes per person.

Four values of the standard deviation of this mean are given below.
Estimate which of the four values for the standard deviation is most likely for this mean.
Indicate your choice by placing a tick in the appropriate box.

Use evidence from **Figure 7** to justify your answer.

[2 marks]

☐ ± 0.002 ☐ ± 0.02 ☐ ± 0.20 ☐ ± 2.00

Justification _____

0 6 . 3 The scientists calculated a correlation coefficient, R, from their data. They found R = 0.50, with P <0.0001

Explain the meaning of the result of their calculations.

[3 marks]

0 6 . 4 The number of copies of the *AMY1* gene is unlikely to affect people's ability to digest starch.

Explain why.

[3 marks]

9

0 7 DNA is a polymer of nucleotides. Each nucleotide contains an organic base.

0 7 . 1 Explain how the organic bases help to stabilise the structure of DNA.

[2 marks]

0 7 . 2 Triplets of bases in a DNA molecule code for the sequence of amino acids in a polypeptide. The genetic code is frequently written as the three bases on mRNA that are complementary to a triplet on DNA. **Table 2** shows what different combinations of bases on mRNA code for. The names of amino acids are abbreviated. For example, 'Ala' stands for alanine.

Table 2

First base	Second base				Third base
	Guanine (G)	**Adenine (A)**	**Cytosine (C)**	**Uracil (U)**	
G	GGG Ala	GAG Glu	GCG Ala	GUG Val	**G**
	GGA Gly	GAA Glu	GCA Ala	GUA Val	**A**
	GGC Gly	GAC Asp	GCC Ala	GUC Val	**C**
	GGU Gly	GAU Asp	GCU Ala	GUU Val	**U**
A	AGG Arg	AAG Lys	ACG Thr	AUG Met	**G**
	AGA Arg	AAA Lys	ACA Thr	AUA Iso	**A**
	AGC Ser	AAC Asn	ACC Thr	AUC Iso	**C**
	AGU Ser	AAU Asn	ACU Thr	AUU Iso	**U**
C	CGG Arg	CAG Gln	CCG Pro	CUG Leu	**G**
	CGA Arg	CAA Gln	CCA Pro	CUA Leu	**A**
	CGC Arg	CAC Hist	CCC Pro	CUC Leu	**C**
	CGU Arg	CAU Hist	CCU Pro	CUU Leu	**U**
U	UGG Trp	UAG **stop**	UCG Ser	UUG Leu	**G**
	UGA **stop**	UAA **stop**	UCA Ser	UUA Leu	**A**
	UGC Cyst	UAC Tyr	UCC Ser	UUC Phe	**C**
	UGU Cyst	UAU Tyr	UCU Ser	UUU Phe	**U**

Suggest **one** advantage of showing the genetic code as base sequences on mRNA, rather than triplets on DNA.

[1 mark]

0 7 . 3 What name is given to a group of three bases on mRNA that codes for an amino acid?

[1 mark]

0 7 . 4 Use information from **Table 2** to explain why the genetic code is described as degenerate.

[2 marks]

0 7 . 5 Suggest the role of the mRNA base triplets UGA, UAG and UAA.

[2 marks]

Question 7 continues on the next page

0 7 . 6 **Table 3** shows the sequence of mRNA bases forming part of a single gene.

Table 3

Base on DNA template									
Base on mRNA	G	U	G	U	A	C	U	G	G
Encoded amino acid									

Complete **Table 3** to show the base sequence of the DNA template from which this mRNA was transcribed and the encoded amino acid sequence.

[2 marks]

10

Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

0 8 Haemoglobin transports oxygen around the body of many animals.

0 8 . 1 Haemoglobin is a protein with a quaternary structure.

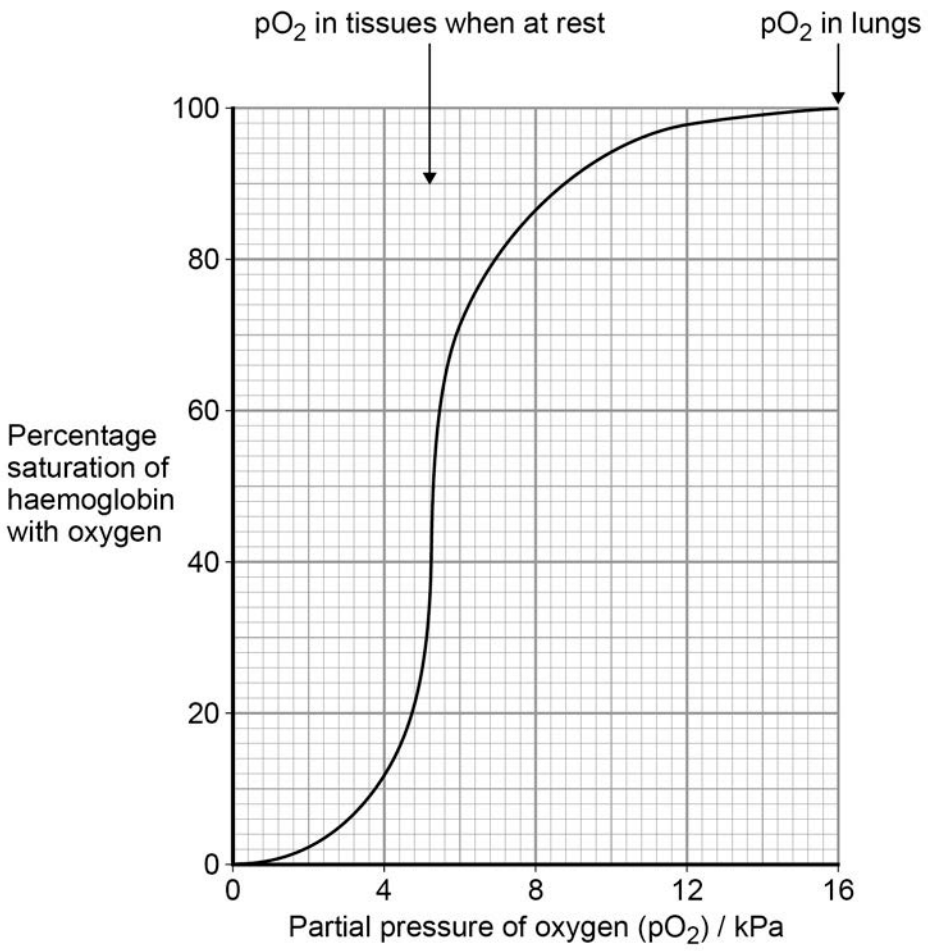
Explain the meaning of **quaternary structure**.

[1 mark]

0 8 . 2 When fully saturated, each molecule of haemoglobin is bound to four molecules of oxygen.

Figure 8 shows the percentage saturation of haemoglobin with oxygen at different partial pressures.

Figure 8



Give the formula for calculating the percentage saturation of haemoglobin with oxygen.

[1 mark]

Percentage saturation of haemoglobin with oxygen =

0 8 . 3 The first molecule of oxygen to bind causes a change in the shape of the haemoglobin molecule.

This change of shape makes it easier for other oxygen molecules to bind to the haemoglobin molecule.

Explain how **Figure 8** provides evidence for this.

[2 marks]

0 8 . 4 Suggest **one** advantage of this change in the affinity of haemoglobin for oxygen.

[1 mark]

Question 8 continues on the next page

0 8 . 5 Tests on the man whose blood was used to construct **Figure 8** gave the following data.

- Concentration of haemoglobin in blood = 150 g dm^{-3}.
- Volume of oxygen carried by fully saturated haemoglobin = 1.35 cm^3 g^{-1}.
- Resting heart rate = 60 beats $minute^{-1}$.
- Volume of blood pumped out of left ventricle each beat = 60 cm^3.

Use these data and information from **Figure 8** to calculate the volume of oxygen released to the man's tissues per minute whilst he was at rest.

Show your working.

[3 marks]

Answer = _____ cm^3 $minute^{-1}$

8

Turn over for the next question

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0 9 Boron is an element that is needed in very small amounts for normal plant growth.

One group of scientists tested a hypothesis that boron combines with sucrose to produce a sucrose-borate complex that is translocated more effectively than sucrose molecules.

They grew tomato plants in nutrient-poor sand. Prior to starting their experiment, they left the mature plants in a dark room for 48 hours.

For each plant, the scientists put one of its leaves into a solution of sucrose that was radioactively labelled. These leaves were left attached to the plants. They used two radioactively labelled sucrose solutions:

- solution **A** contained boron at a concentration of 10 parts per million.
- solution **B** contained no boron.

After a period of time, the scientists removed samples from parts of the plants, dried them in an oven and ground each into a powder. They then measured the radioactivity in each powdered sample. The scientists' results are shown in **Table 4**.

Table 4

Part of plant	**Mean radioactivity / counts minute^{-1} g^{-1}**	
	Plants with leaf immersed in solution A (with boron)	**Plants with leaf immersed in solution B (no boron)**
Stem tip	14.2	1.7
First leaf above treated leaf	3.3	0.0
Upper stem	31.2	8.3
Lower stem	28.3	13.3
First leaf below treated leaf	21.7	0.0
Roots	3.5	1.7

0 9 . 1 Explain the following steps in the scientists' method.

[2 marks]

They grew tomato plants in nutrient-poor sand.

They left the mature plants in the dark for 48 hours before starting their experiment.

0 9 . 2 The scientists dried the plant samples in an oven at 100 °C.

Give **two** reasons why they used this temperature.

[2 marks]

1 _____

_____

2 _____

_____

0 9 . 3 Do the scientists' results support their hypothesis?

Use evidence from **Table 4** to support your answer.

[4 marks]

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

0 9 . 4 Suggest how the scientists could adapt their method to determine which tissue carried the radioactively labelled sucrose.

[2 marks]

_____

_____

_____

_____

_____

10

1 0 Bacterial meningitis is a potentially fatal disease affecting the membranes around the brain. *Neisseria meningitidis* (Nm) is a leading cause of bacterial meningitis.

1 0 . 1 In the UK, children are vaccinated against this disease. Describe how vaccination can lead to protection against bacterial meningitis.

[6 marks]

[Extra space]

1 0 . 2 Penicillin has been the antibiotic of choice for the treatment of bacterial meningitis. Since the year 2000, strains of *Neisseria meningitidis* that are resistant to penicillin, sulfonamides and rifampin have been discovered in the UK.

Describe how a population of *Neisseria meningitidis* (Nm) can become resistant to these antibiotics.

[4 marks]

[Extra space]

1 0 . 3 Contrast the structure of a bacterial cell and the structure of a human cell.

[5 marks]

[Extra space]

15

END OF QUESTIONS

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Figure 2: Science photo library