OCR
Oxford Cambridge and RSA

Monday 15 May 2023 – Morning

AS Level Biology A

H020/01 Breadth 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 | | | | | | Candidate number | | | | |

First name(s) _____

Last name _____

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 **[ ]**.
- This document has **28** pages.

ADVICE
- Read each question carefully before you start your answer.

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Section A

You should spend a **maximum** of **25 minutes** on this section.

Write your answer for each question in the box provided.

1 Which statement describes a problem that has resulted from the increased use of antibiotics?

A Penicillin can no longer be used to treat infections.

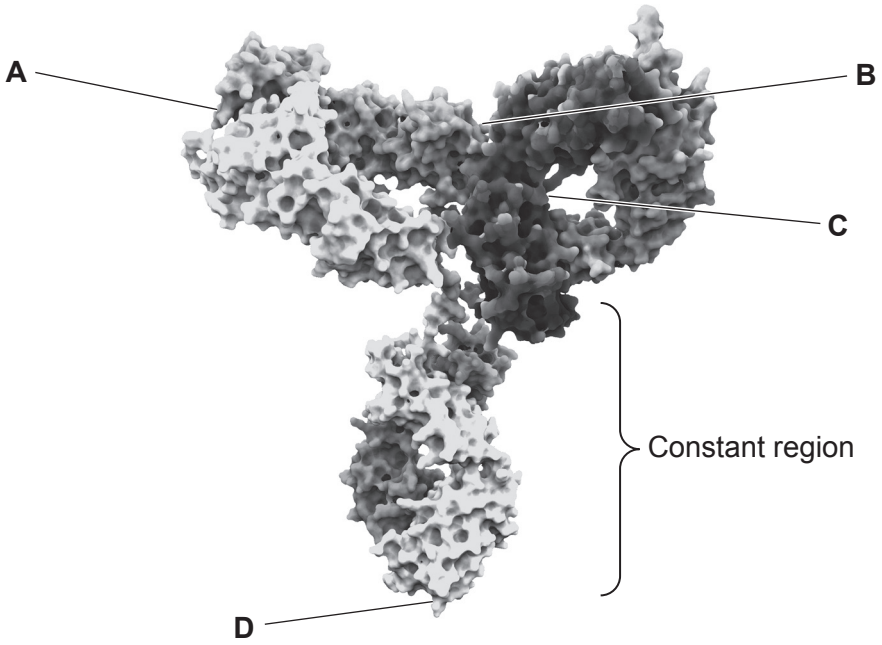
B Rates of MRSA infection have increased.

C Some bacteria and fungi have evolved resistance to antibiotics.

D Viral infections can no longer be treated with antibiotics.

Your answer ☐ **[1]**

2 The diagram shows a computer model of the structure of an antibody.



Which part of the antibody, **A**, **B**, **C** or **D**, is an antigen-binding site?

Your answer ☐ **[1]**

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3 Simpson's Index of Diversity (D) can be used to estimate the biodiversity of a habitat.

$$D = 1 - \left(\sum\left(\frac{n}{N}\right)^2\right)$$

Scientists calculated D for a grassland habitat. One year later, the scientists calculated D again for the same habitat.

The number of plants recorded from one of the species increased from 100 to 400. All the other values remained the same.

What would be the result of this change?

A Species richness would increase.

B The estimate of biodiversity would increase.

C The value of D would decrease.

D The value of N would decrease.

Your answer ☐ **[1]**

4 What is an example of *in situ* conservation?

A A botanical garden

B A breeding programme in a zoo

C A marine conservation zone

D A seed bank

Your answer ☐ **[1]**

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5 The giraffe is a species of mammal with the species name ‘camelopardalis’ and the genus name ‘Giraffa’.

What is the correct format for the binomial name of the giraffe?

A *camelopardalis giraffa*

B Camelopardalis giraffa

C G. camelopardalis

D *Giraffa camelopardalis*

Your answer ☐ **[1]**

6 Which kingdom contains species that are heterotrophic and composed of hyphae?

A Fungi

B Plantae

C Prokaryotae

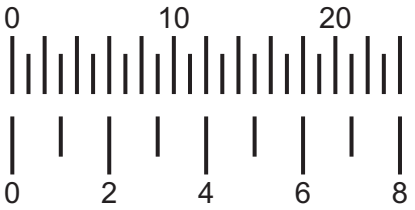
D Protoctista

Your answer ☐ **[1]**

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7 A student observes xylem tissue under a microscope. The student uses an eyepiece graticule and a stage micrometer to measure the diameter of a xylem vessel.

Eyepiece graticule scale



Stage micrometer scale: 1 division = 10 µm

The xylem vessel has a diameter of 21 units on the eyepiece graticule scale.

What is the actual diameter of the xylem vessel in micrometres?

A 7

B 65

C 70

D 210

Your answer ☐ **[1]**

8 What is the pathway taken by a protein that has been made and is to be secreted from a cell?

A Ribosome → vesicle → Golgi apparatus → cytoplasm

B Ribosome → vesicle → rough ER → vesicle → smooth ER → vesicle → plasma membrane

C Rough ER → vesicle → Golgi apparatus → vesicle → plasma membrane

D Rough ER → vesicle → smooth ER → vesicle → Golgi apparatus → vesicle → plasma membrane

Your answer ☐ **[1]**

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9 What are the roles of the cytoskeleton in a human skin cell?

A Movement of the cell through its environment and providing mechanical strength to the cell

B Movement of the cell through its environment and transport of organelles within the cell

C Providing mechanical strength to the cell and transport of organelles within the cell

D Supporting the cell wall and synthesis of collagen

Your answer ☐ **[1]**

10 Which feature is associated with a prokaryotic cell?

A Cell walls made of chitin

B Extrachromosomal DNA that is circular

C Linear DNA that can form plasmids

D 70S ribosomes present in endoplasmic reticulum

Your answer ☐ **[1]**

11 Which statement is a correct description of polymers?

A A polymer is broken down by condensation reactions.

B A polymer is formed when two monomers bond together.

C All polymers are classified as either a carbohydrate or a protein.

D Some polymers are composed of several monomers that are similar in structure but **not** identical.

Your answer ☐ **[1]**

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12 A scientist analysed and recorded **all** of the chemical elements in one particular amino acid.

Which elements did the scientist record?

A C, H, N, S

B C, H, O, N

C C, H, O, N, P

D C, H, O, N, S, P

Your answer ☐ **[1]**

13 Which description of the structure of a glucose molecule is correct?

A It contains 5 OH groups and has a C:O ratio of 1:1.

B It contains 6 OH groups and has a C:H ratio of 1:2.

C It contains 6 oxygen atoms and has a C:H ratio of 1:1.

D It contains 12 hydrogen atoms and has a C:O ratio of 1:2.

Your answer ☐ **[1]**

14 Which description of the structure of cellulose is correct?

A Alternate α-glucose monomers rotate 180°

B Branched polymer forms from β-glucose monomers

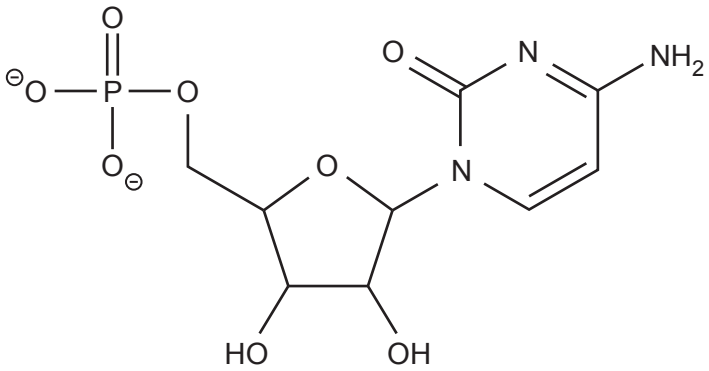
C Hydrogen bonds form between coiled polymer chains

D Straight chains contain 1,4-glycosidic bonds

Your answer ☐ **[1]**

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15 Which nucleotide is shown in the diagram?



A DNA nucleotide with a purine base

B DNA nucleotide with a pyrimidine base

C RNA nucleotide with a purine base

D RNA nucleotide with a pyrimidine base

Your answer ☐ **[1]**

16 Which statement is a correct description of the structure of ADP?

A A pyrimidine is part of its structure.

B It contains deoxyribose.

C It is a nucleotide.

D One phosphate group is present.

Your answer ☐ **[1]**

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A student investigates the effect of pH on the activity of the enzyme catalase.

Oxygen is one of the products of the reaction catalysed by catalase. The student measures the volume of oxygen produced over a 10-minute period. The student uses these data to calculate the rate of oxygen production.

Questions **17** and **18** refer to this method.

17 Which row in the table shows the different types of variables in the student's investigation?

	Control variable	**Dependent variable**	**Independent variable**
A	pH	Temperature	Volume of oxygen produced in 10 minutes
B	Volume of oxygen produced in 10 minutes	Catalase concentration	pH
C	Temperature	pH	Volume of oxygen produced in 10 minutes
D	Catalase concentration	Volume of oxygen produced in 10 minutes	pH

Your answer ☐ **[1]**

18 The student determines catalase activity by calculating the rate of oxygen production.

Which units of measurement are appropriate to show the rate of oxygen production?

A cm^{-3}

B $cm^3\ s^{-1}$

C $h\,dm^{-3}$

D $mol\,dm^{-3}$

Your answer ☐ **[1]**

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19 Which statement is true of stem cells?

A All stem cells can naturally divide to produce a new organism.

B Stem cells are differentiated and specialised cells.

C Stem cells are found only in early embryos.

D Stem cells in adult humans can divide into a limited range of cell types.

Your answer ☐ **[1]**

20 Which of the options is an adaptation of a hydrophyte?

A A thick waxy cuticle

B Fewer leaves, which results in a reduced SA:V ratio

C Many stomata on the upper surfaces of leaves

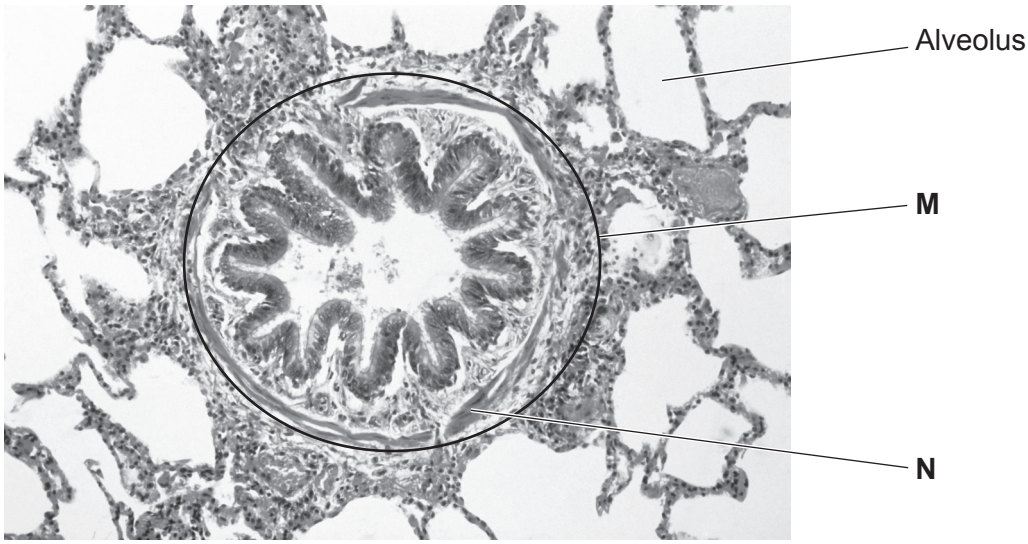
D Storage of water in parenchyma tissue in roots and stems

Your answer ☐ **[1]**

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Section B

21 The light micrograph shows a transverse section through human lung tissue.



(a) Alveoli provide an efficient gas exchange surface because of their large surface area.

State **one other** feature of alveoli that provides an efficient gas exchange surface.

.....

..... **[1]**

(b) The human lung is part of the gas exchange system.

Name the component of the gas exchange system in the circle labelled **M** in the light micrograph.

..... **[1]**

(c) Name the tissue labelled **N** in the light micrograph **and** outline its function in component **M**.

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..... **[2]**

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22 Fungal pathogens such as black sigatoka infect plants.

Many plants produce the enzyme chitinase as a defence against fungal pathogens. Chitinase catalyses the breakdown of chitin in the cell walls of fungi.

(a) Scientists have discovered that when chitin binds to chitinase:

- two amino acids in chitinase move closer together to form a hydrophobic region around the chitin substrate
- other amino acid interactions cause the active site of the enzyme to partially cover the chitin substrate.

(i) Name the hypothesis of enzyme action that is supported by the mechanism observed in chitinase.

..... **[1]**

(ii) Explain how the mechanism of enzyme action observed in chitinase increases the rate of chitin breakdown.

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..... **[2]**

(b) A student investigates how the concentration of chitinase in plant tissue changes at different stages of fungal infection.

The student prepares a plant extract solution to be able to record the concentration of chitinase present.

(i) The student uses a volumetric flask to measure 250 cm^3 of the solution.

The volumetric flask has an absolute uncertainty of ±0.12 cm^3.

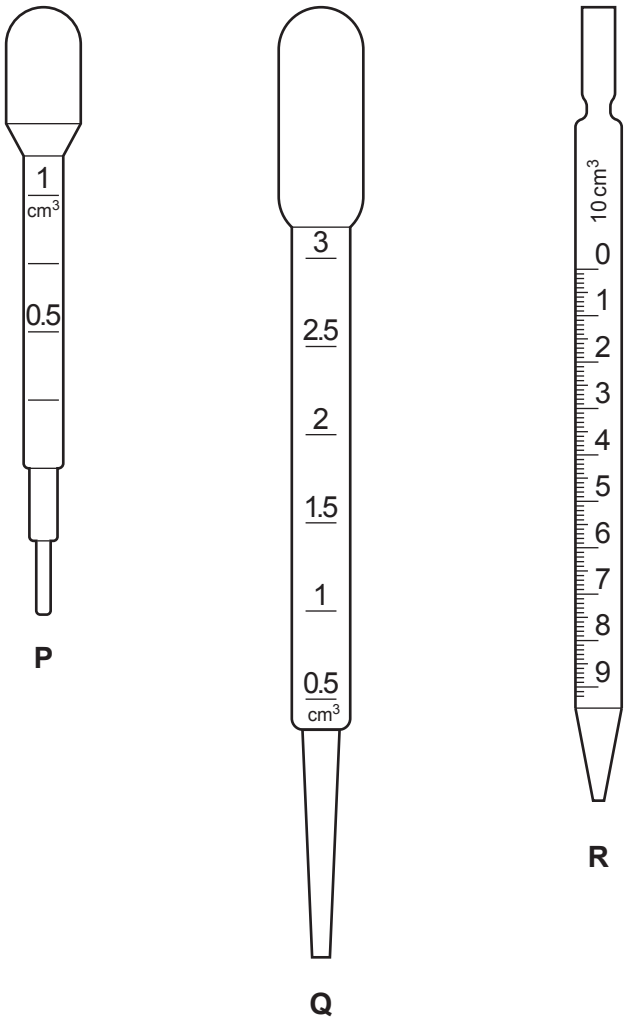
Calculate the percentage error associated with the student's measurement.

Percentage error = ... % **[2]**

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(ii) Using a pipette, the student transfers several 5 cm^3 samples of the plant extract solution during their investigation.

The diagram shows three different pipettes, **P**, **Q** and **R**.



Explain which pipette, **P**, **Q** or **R**, would reduce the uncertainty when transferring the plant extract solution.

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..... **[2]**

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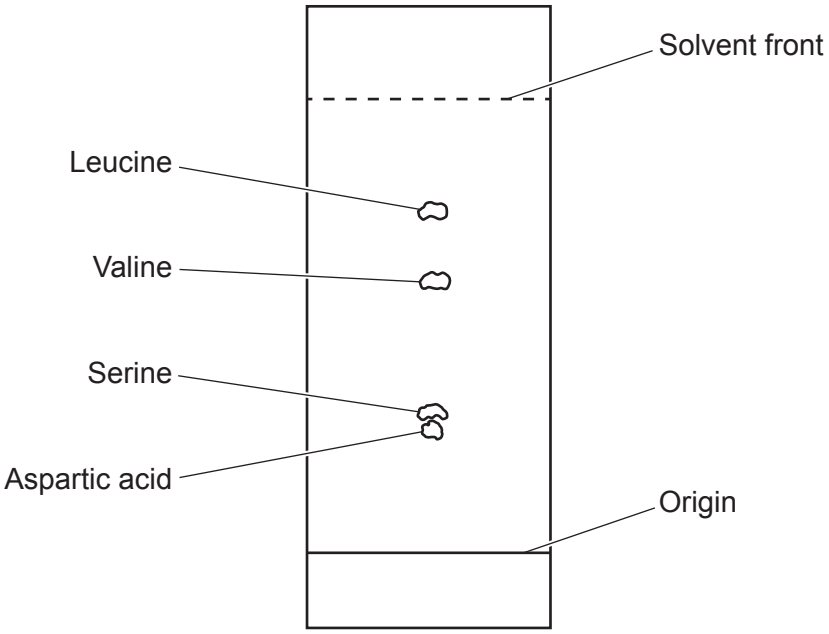
23 Thin layer chromatography (TLC) can be used to separate and identify amino acids.

(a) Name **and** describe the reaction that produces amino acids from polypeptides.

.....

..... **[1]**

(b) The diagram shows the chromatogram that was produced when using TLC to separate a mixture of amino acids.



(i) Use the chromatogram to calculate the Rf value of valine.

Rf = ... **[2]**

(ii) Serine and leucine have different R groups.

With reference to the chromatogram, suggest what can be concluded about the chemical properties of the R groups in serine and leucine.

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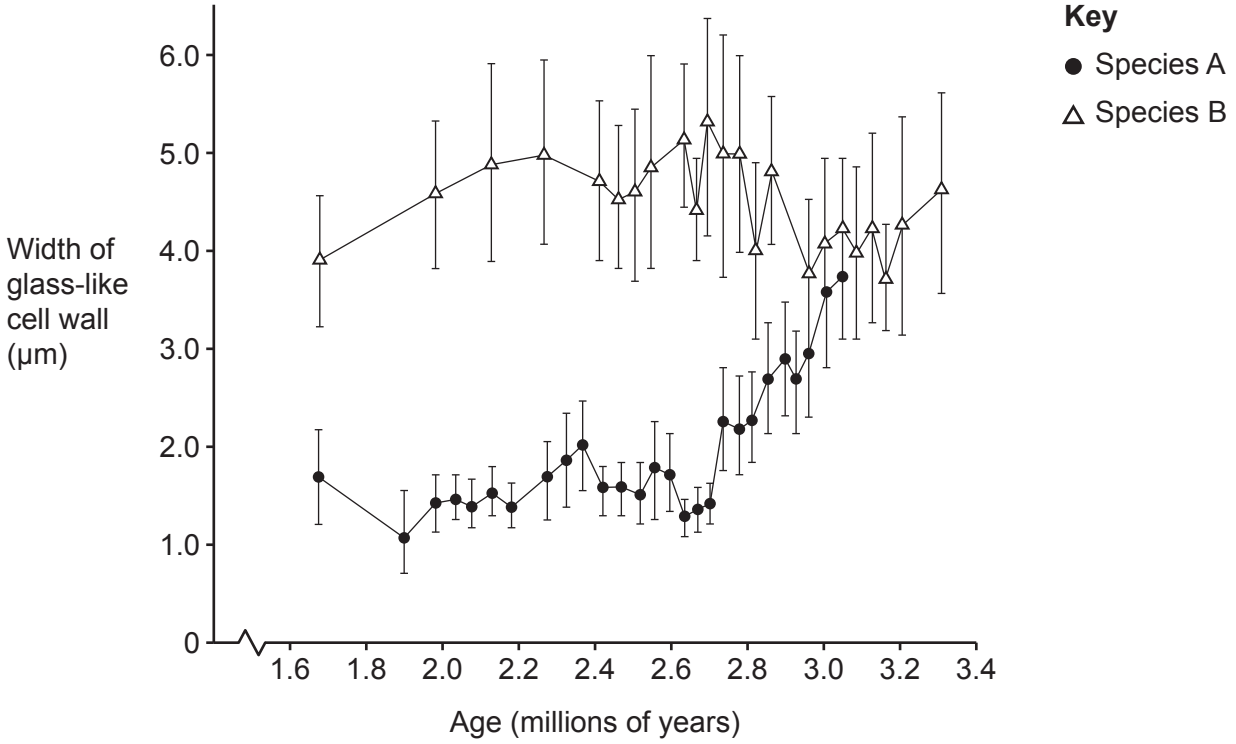
..... **[1]**

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24 The age of a fossil can be calculated based on its position in rock layers in the ground. Fossils of different ages can be compared to provide evidence of evolution and to help construct phylogenies.

(a) Diatoms are single-celled organisms that have glass-like cell walls, which can be preserved as fossils.

The graph shows the fossil record for two species of diatom.



Explain whether the data in this graph show evidence for evolution by natural selection.

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..... **[2]**

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(b) A student analyses the estimated ages of 16 species of diatom. The estimated ages show how long ago the species evolved from an ancestor. The student compares estimated ages from two different sources:

- the position of each species in the fossil record
- molecular and genetic data, which has been used to construct the current phylogenetic tree of diatom species.

The student tests whether a positive correlation exists between the two sets of data for the 16 diatom species using Spearman's rank correlation coefficient.

The student's null hypothesis is:

'There is no correlation between the estimated ages of diatom species based on the fossil record and the estimated ages based on molecular and genetic data.'

The calculated r_s is 0.979.

The student compares the r_s of 0.979 to the critical values in the table.

n	**Probability (*p*)**	
	0.05	**0.01**
14	0.4637	0.6264
15	0.4464	0.6063
16	0.4294	0.5824
17	0.4142	0.5662
18	0.4014	0.5501

Explain what the student can conclude based on their r_s value of 0.979.

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..... **[3]**

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(c) Diatoms are members of the domain Eukarya.

Complete the sentences about domains using the most appropriate terms.

The process of sorting of organisms into taxonomic groups is called ..... .

Domains represent the highest taxonomic level; they are the groups that contain the largest number of species. The number of kingdoms in each domain is different. The domain Eukarya contains ..... different kingdoms. The domains Bacteria and ..... both contain species from only the kingdom Prokaryotae.

[3]

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25 Cell surface membranes are composed of many different components, including cholesterol.

(a) Describe **two** roles of a cell surface membrane.

1 .....

.....

2 .....

.....

[2]

(b) The presence of cholesterol is one of several factors that affect membrane fluidity.

A student examined two different cell surface membranes. One membrane had a higher concentration of cholesterol than the other membrane.

The student concluded that 'the membrane with the higher concentration of cholesterol would have less fluidity than the other membrane'.

Discuss whether the student's conclusion can be supported.

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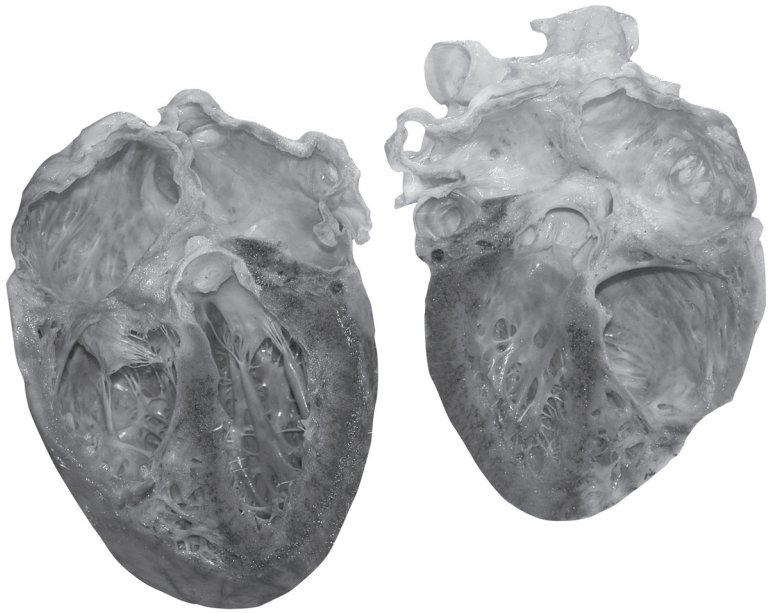
..... **[3]**

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26 (a) **Fig. 26.1** shows a dissected human heart.

Fig. 26.1

Back (dorsal) half of heart Front (ventral) half of heart



Draw a simple diagram of the front half of the heart shown in **Fig. 26.1** in the space below.

On your diagram, label the left ventricle.

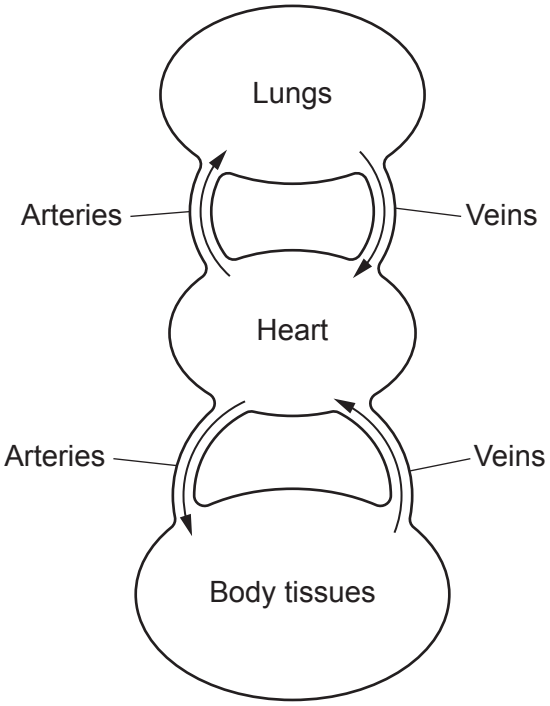
[3]

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(b) Birds have hearts with a similar structure to mammalian hearts.

Fig. 26.2 shows a diagram of the circulatory system of a bird.

Fig. 26.2



(i) Describe the type of circulatory system shown in **Fig. 26.2**.

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..... **[1]**

(ii) Explain why larger organisms, such as a bird, need a circulatory system but some smaller organisms do not need a circulatory system.

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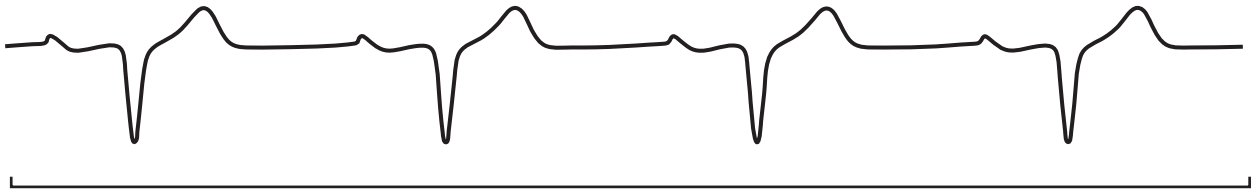
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..... **[2]**

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(c) An electrocardiogram (ECG) trace from a bird and an ECG trace from a human have many differences.

The ECG trace below is from a bird.



Time = 1 second

Describe how the ECG trace from a bird is different from a normal ECG trace from a human.

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..... **[2]**

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27 Enzymes that catalyse the removal of CH_3 groups from cytosine bases in DNA are called TET enzymes. The rate of transcription increases when CH_3 groups are removed from DNA.

During embryo development, TET enzymes remove CH_3 from a large number of genes. This TET activity is essential for the development of embryos.

(a) (i) Suggest how the activity of TET enzymes affects metabolism at both the cellular and whole organism level.

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..... **[2]**

(ii) Vitamin C binds to TET enzymes and increases their catalytic activity.

State the role of vitamin C when it binds to a TET enzyme.

..... **[1]**

(iii) Intracellular and extracellular reactions are catalysed by enzymes.

The table lists three enzymes, including TET.

Complete the table to indicate whether the enzyme catalyses an intracellular reaction or an extracellular reaction.

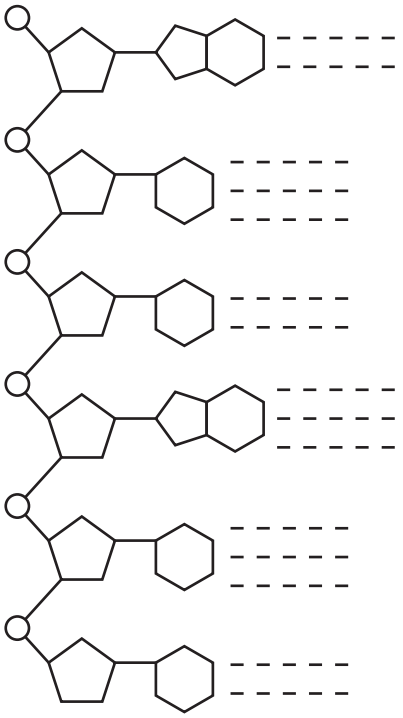
Tick (✓) **one** box in each row.

Enzyme	**Type of reaction catalysed**	
	Intracellular	**Extracellular**
TET		
Catalase		
Trypsin		

[1]

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(b) The diagram shows a section of one strand of DNA.



Key

– – – = hydrogen bonds formed with base in the other strand

(i) Label a phosphodiester bond **in the diagram above** with the letter '**P**'. **[1]**

(ii) TET enzymes remove CH_3 groups from a cytosine base only when it is next to a guanine base in the same DNA strand.

Identify a cytosine base that could have CH_3 removed by TET by adding the letter '**T**' to a base **in the diagram above**. **[1]**

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28 **(a)** Four organelles are listed in the table below.

Complete the table.

For each organelle place a tick (✓) in the box for a correct description and leave the box empty if the description is incorrect.

Organelle	A membrane-bound organelle	Found in both animal and plant cells	Has a role in lipid production
Rough endoplasmic reticulum			
Smooth endoplasmic reticulum			
Ribosome			
Mitochondrion			

[4]

(b) Starch and glycogen are polysaccharides. Starch is present in plant cells, and glycogen is present in animal cells. Glucose is a monosaccharide present in both types of cell.

Outline how the different properties of glucose, starch and glycogen relate to their functions in cells.

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..... **[4]**

END OF QUESTION PAPER

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ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).

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