Oxford Cambridge and RSA

Monday 13 May 2024 – Morning

AS Level Biology B (Advancing Biology)

H022/01 Foundations of 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 about the fatty acids found in lipids is correct?

A They contain only carbon and hydrogen atoms.

B One fatty acid joins with three glycerol molecules to form a triglyceride.

C Saturated fatty acids contain C=C double bonds.

D The ‘tails’ of fatty acids are hydrophobic.

Your answer ☐ **[1]**

2 A group of students were testing plant extracts for biological molecules.

The table shows the colour of each solution before and after testing the extracts.

Extract	**Colour of Benedict’s solution**		**Colour of biuret reagent**		**Colour of iodine / KI solution**	
	Before	**After**	**Before**	**After**	**Before**	**After**
A	Blue	Blue	Blue	Blue	Yellow	Blue-black
B	Blue	Green	Blue	Blue	Yellow	Blue-black
C	Blue	Orange	Blue	Blue	Yellow	Yellow
D	Blue	Orange	Blue	Violet	Yellow	Yellow

Which of the plant extracts contained both glucose and amylose but did **not** contain any protein?

Your answer ☐ **[1]**

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3 Which statement about water is **not** correct?

A A large amount of heat energy is required to change the temperature of water.

B The forces of attraction between water molecules are hydrogen bonds.

C Water can dissolve ionic compounds.

D Water is a non-polar molecule.

Your answer ☐ **[1]**

4 A person weighing 75 kg contains 45 dm^3 of body fluid.

Approximately 70% of this body fluid is contained within cells as intracellular fluid.

Researchers investigating the effects of water content on cell metabolism concluded that metabolic activity is significantly inhibited when ~20% of its intracellular fluid has been lost.

Which option shows the volume of intracellular fluid at which metabolic activity of cells in this person would be significantly inhibited?

A 6.3 dm^3

B 9.0 dm^3

C 25.2 dm^3

D 31.5 dm^3

Your answer ☐ **[1]**

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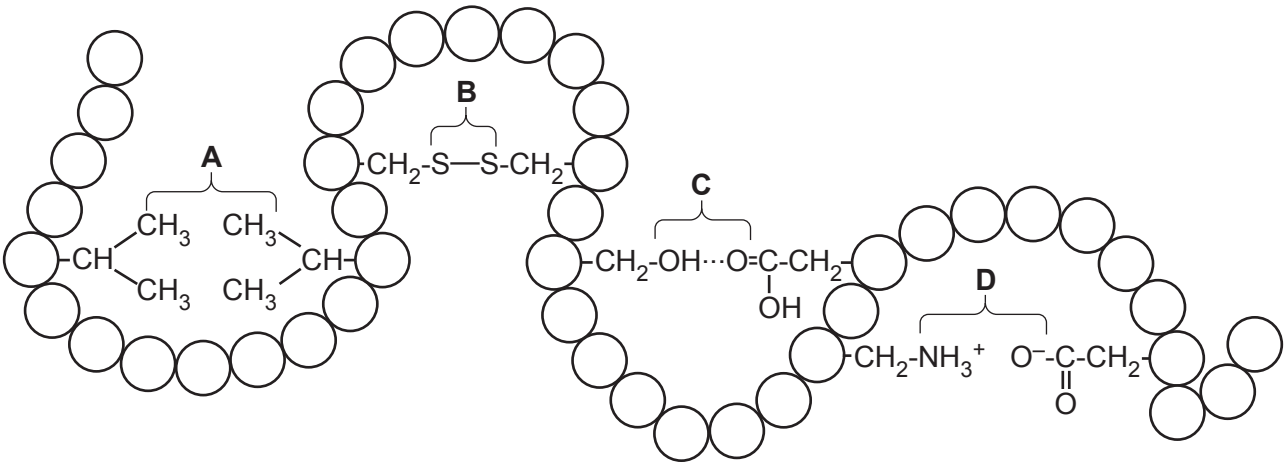
5 The tertiary structure of a protein molecule is shown below.



Which of the options, **A** to **D**, shows a hydrophobic interaction?

Your answer ☐ **[1]**

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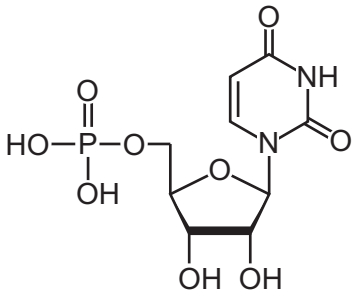
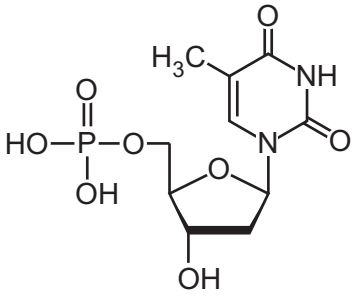
6 Which of the nucleotides would form a complementary base pair with an adenine-containing nucleotide in a DNA molecule?

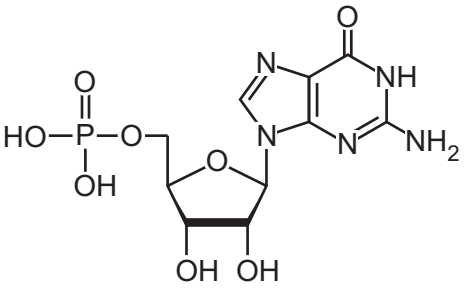
A



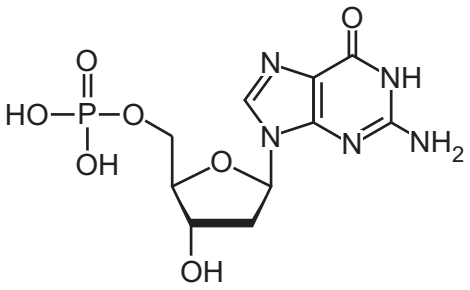
B



C



D



Your answer ☐ **[1]**

7 Which option is a correct stage used in the purification of DNA from onion cells?

A Add protease enzymes to break down the phospholipid bilayer of onion cells.

B Denature the DNA by placing the solution in a water bath at 60 °C.

C Precipitate the DNA from solution using ice-cold ethanol.

D Remove proteins associated with the DNA by filtering the solution.

Your answer ☐ **[1]**

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8 A group of students investigated the effect of nicotine on the heart rate of *Daphnia magna*, a species of water flea.

The students recorded the heart rates of ten individual fleas before and after adding 10% nicotine solution.

The table shows the results.

Individual	Heart rate before adding 10% nicotine solution (bpm)	Heart rate 30 minutes after adding 10% nicotine solution (bpm)
1	85	65
2	88	66
3	90	68
4	89	64
5	88	65
6	86	62
7	88	62
8	87	63
9	90	65
10	89	65
Mean	**88.0**	**64.5**

Which statistical test is the most appropriate for the students to analyse their data?

A Chi squared test

B Paired Student's *t*-test

C Spearman's rank correlation coefficient

D Unpaired Student's *t*-test

Your answer ☐ **[1]**

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9 The following measurements were taken for an athlete at rest:

- Heart rate = 55 beats per minute (bpm)
- Stroke volume = 80 cm^3

During mild exercise the cardiac output for this athlete increased by 90%.

What is the cardiac output for this athlete during mild exercise?

A 122 $cm^3 min^{-1}$

B 257 $cm^3 min^{-1}$

C 3960 $cm^3 min^{-1}$

D 8360 $cm^3 min^{-1}$

Your answer ☐ **[1]**

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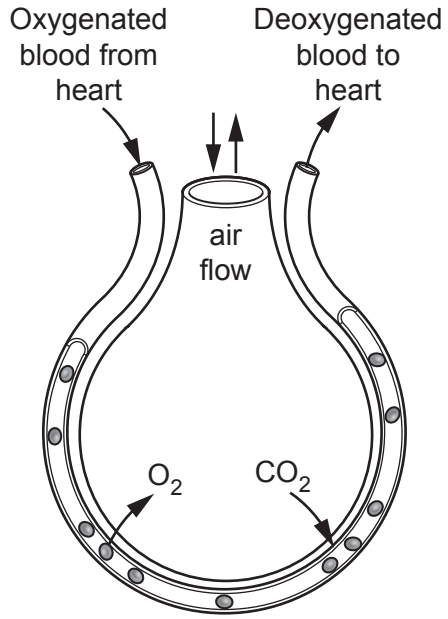
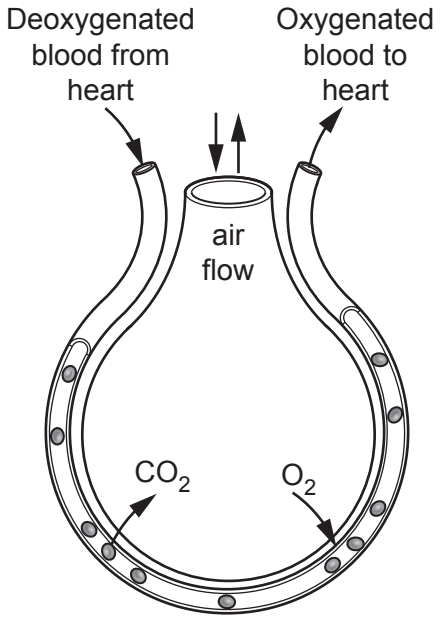
10 Which diagram shows gas exchange between an alveolus and a capillary?

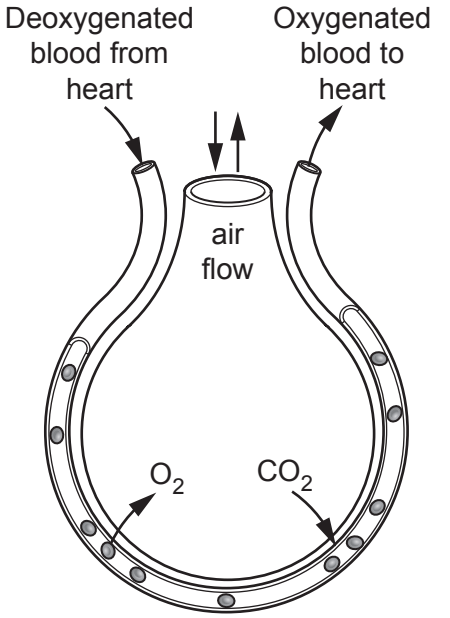
A



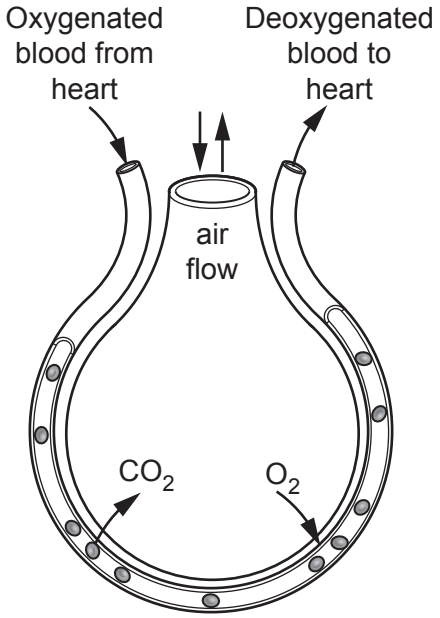
B



C



D



Your answer ☐ **[1]**

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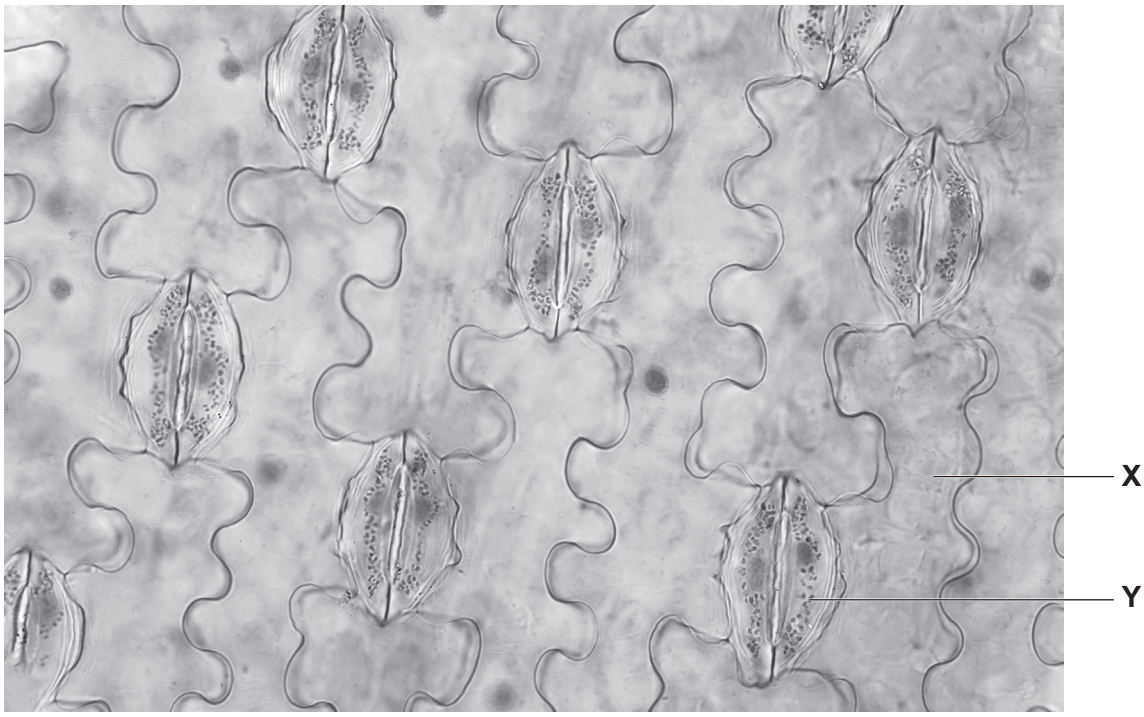
11 The micrograph shows a section of a leaf tissue with two features labelled **X** and **Y**.



Which option correctly identifies the features in the micrograph?

A **X** is a companion cell and **Y** is a guard cell.

B **X** is a guard cell and **Y** is a stoma.

C **X** is an epidermal cell and **Y** is a companion cell.

D **X** is an epidermal cell and **Y** is a guard cell.

Your answer ☐ **[1]**

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12 Which row shows correct information about phloem loading during translocation.

	Ion used as co-transporter	ATP required to transport ions out of companion cell	Molecule being co-transported
A	Ca^{2+}	No	Glucose
B	H^{+}	Yes	Glucose
C	Ca^{2+}	No	Sucrose
D	H^{+}	Yes	Sucrose

Your answer ☐ **[1]**

13 Which statement about amniocentesis and chorionic villus sampling (CVS) is correct?

A Amniocentesis can be carried out much earlier in pregnancy than CVS.

B Both techniques can be used to provide cells for karyotyping.

C Cells are taken from the placenta in both techniques.

D CVS has a much lower risk of miscarriage than amniocentesis.

Your answer ☐ **[1]**

14 Which option is an example of selection pressure most likely to drive evolution of a species?

A Decrease in number of predators

B Increase in availability of food

C Increase in number of predators

D Increase in number of prey species

Your answer ☐ **[1]**

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15 Some of the stages of the Gram staining method used for identifying bacteria are shown below.

1 A counterstain, safranin, is added to the microscope slide.

2 A small sample of bacterial culture is spread on the microscope slide.

3 A stain, crystal violet, is added to the microscope slide.

4 The microscope slide is flooded with iodine and then rinsed with water.

5 The microscope slide is rinsed alternately with water and 95% alcohol solution.

What is the correct order of the stages when carrying out Gram staining?

A 2, 3, 4, 5, 1

B 5, 2, 3, 4, 1

C 2, 4, 3, 1, 5

D 2, 3, 4, 1, 5

Your answer ☐ **[1]**

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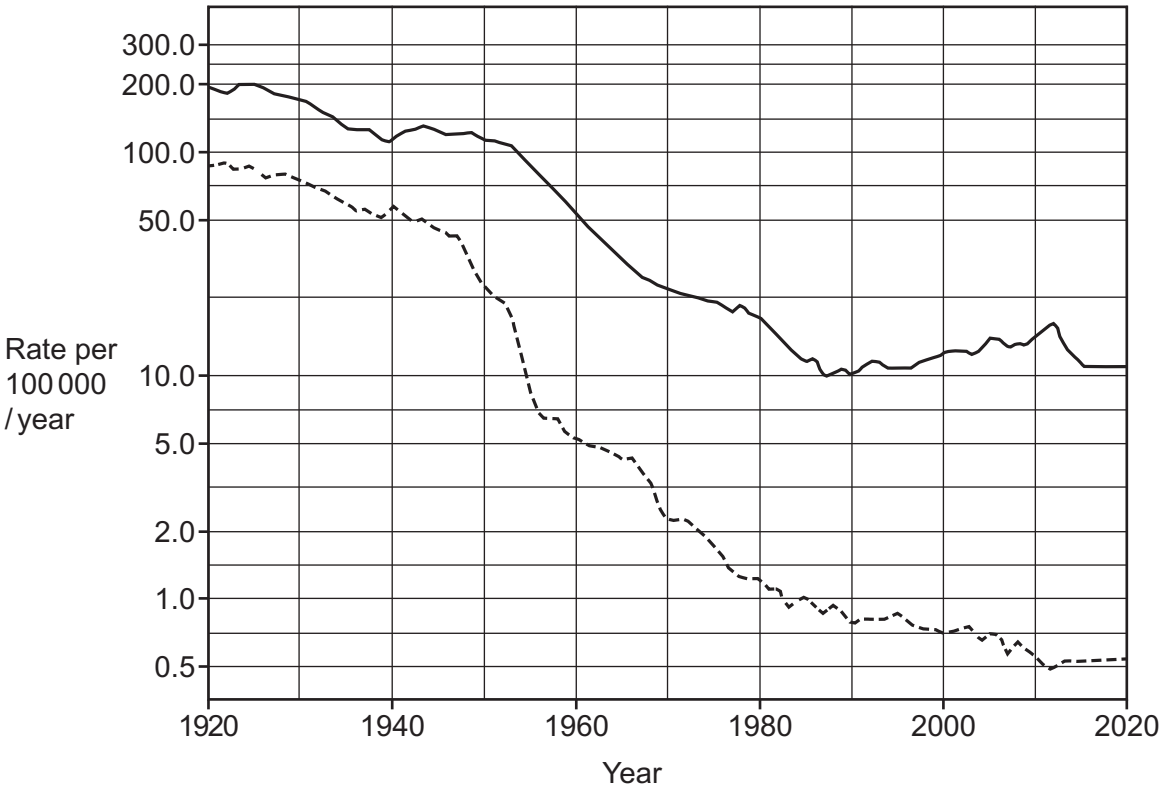
16 These data shows incidence and mortality rates for tuberculosis (TB) in the UK between 1920 and 2020.



Key:

——— Incidence rate per 100 000 / year

- - - - - Mortality rate per 100 000 / year

In what year was there a 10-fold difference between incidence and mortality rate?

A 1920

B 1960

C 1980

D 2000

Your answer ☐ **[1]**

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17 What would **not** be included in a campaign to prevent the spread of tuberculosis (TB)?

A Chest x-rays for diagnosis

B Treatment with antibiotics

C Treatment with antiviral drugs

D Vaccination

Your answer ☐ **[1]**

18 Which statement about an allergic response is correct?

A Allergens release antigen-specific antibodies.

B Mast cells release antigen-specific antibodies.

C Mast cells release histamine.

D Plasma cells release histamine.

Your answer ☐ **[1]**

19 What is an example of an acute condition?

A Asthma attack

B Breast cancer

C Emphysema

D Lung cancer

Your answer ☐ **[1]**

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20 The MMR (Measles, Mumps and Rubella) vaccine uses modified versions of the viruses to give long lasting immunity.

What type of vaccine describes the MMR vaccine?

A Dead virus

B Live-attenuated

C Pathogen fragment

D Toxin

Your answer ☐ **[1]**

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Section B

21 The trachea is an organ in the mammalian respiratory system.

(a) Explain why the trachea is described as an organ.

.....

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.....

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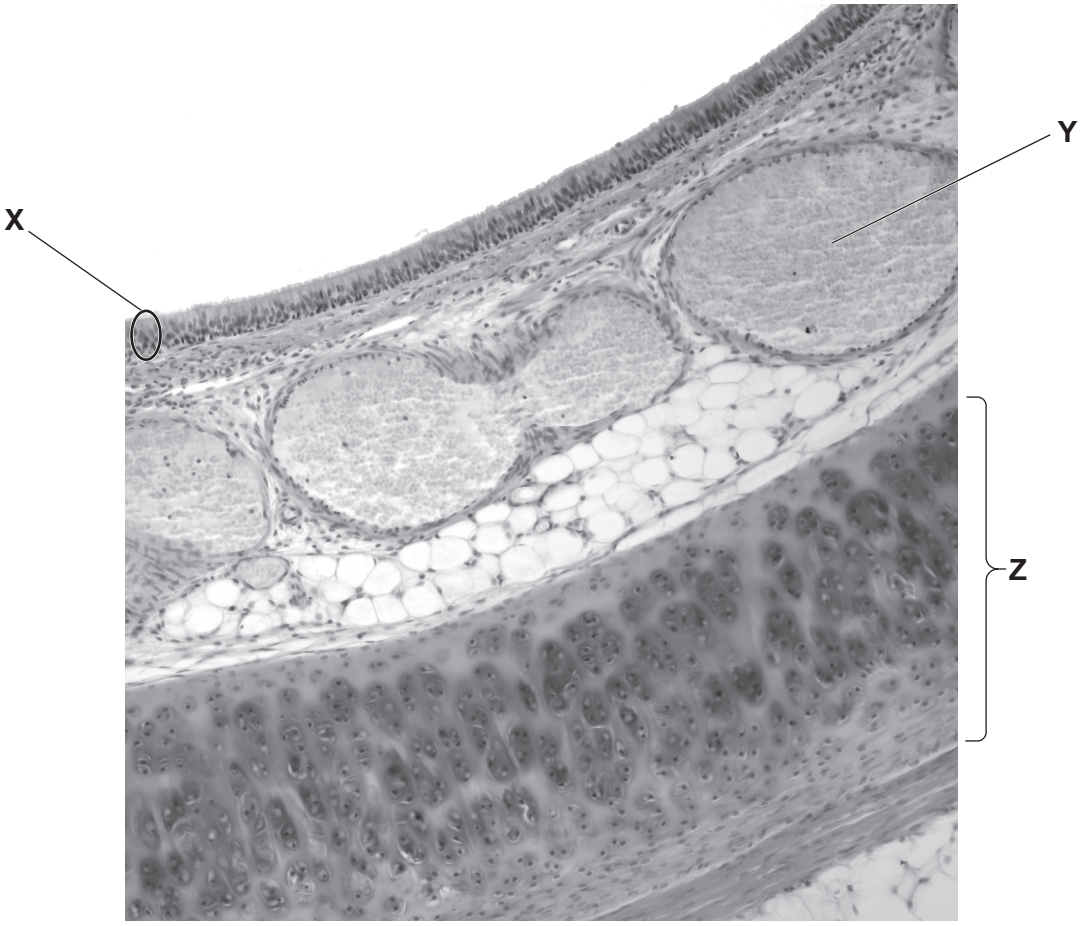
..... **[2]**

(b) **Fig. 21.1** is a photomicrograph showing a section through the wall of a mammalian trachea.

Fig. 21.1



(i) Identify the structure labelled **Y**.

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

(ii) Identify the tissue labelled **Z**.

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

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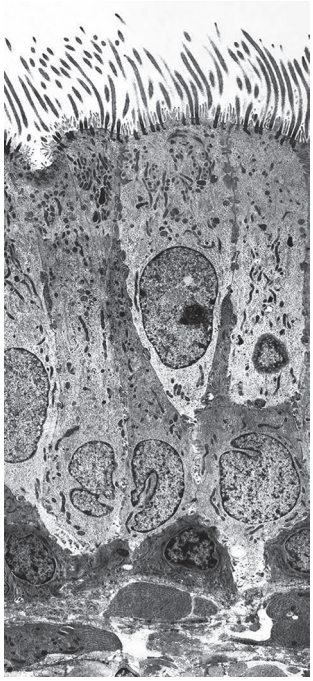
(c) **Fig. 21.2** is a photomicrograph showing cells from the region labelled **X** on **Fig. 21.1**.

Fig. 21.2



Magnification: ×2500

(i) Suggest a type of microscope used to produce the photomicrograph in **Fig. 21.2** and give a reason for your choice.

Type of microscope .....

Reason .....

.....

[2]

(ii) Calculate the actual length of the 1 cm scale bar shown on **Fig. 21.2** and give appropriate units.

Actual length = ... Units = ... **[2]**

(iii) Explain how the function of the cells in **Fig. 21.2** is affected by exposure to pollutants such as cigarette smoke.

.....

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

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22 Blood pressure is determined by measuring both diastolic and systolic pressures.

(a) Describe what is meant by diastolic and systolic pressures.

Diastolic pressure .....

.....

Systolic pressure .....

.....

[2]

(b) High blood pressure is referred to as hypertension.

State a blood pressure reading that could suggest a person has hypertension.

..... mm Hg **[1]**

(c) Young Onset Hypertension (YOH) is common in young people between 20 and 40 years of age.

Studies have shown that:

- 1 in 8 adults between 20 and 40 years old are affected by YOH.
- Hypertension often continues into later life.
- There is evidence to show that YOH causes changes to the cardiovascular system.

(i) It was estimated that 85 000 adults in a population were aged between 20 and 40 years old.

Calculate the number of adults in this age group that are likely to be affected by YOH.

Number of adults affected by YOH = ... **[1]**

(ii) Suggest why young adults with YOH continue to experience hypertension in later life.

.....

.....

.....

.....

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

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(iii) Suggest **two** changes to the cardiovascular system that could be caused by YOH.

1 .....

.....

2 .....

.....

[2]

(iv) One of the outcomes of a study was to recommend randomised controlled trials (RCTs) be carried out.

Discuss the advantages and disadvantages of carrying out RCTs involving YOH.

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

(d) Blood pressure affects the formation of tissue fluid.

Complete the sentences about the formation of tissue fluid using the most appropriate word(s).

When ..... pressure is high at the arteriole end of a capillary network, water and small molecules are forced out of capillaries to form tissue fluid. Large protein molecules remain in blood plasma and cause an ..... pressure that helps to return fluid back into the capillary at the venule end. Some tissue fluid drains into the .... rather than returning to the blood.

[3]

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23 Scientists investigated the permeability of chloroplast membranes to carbon dioxide (CO_2) using the method below.

- Chloroplasts were isolated from spinach leaves and placed in a buffer solution.
- Radioactively labelled sodium hydrogen carbonate ($NaH^{13}CO_3$) solution was used as the source of CO_2.
- 10 mm^3 of $NaH^{13}CO_3$ solution was added to 10 mm^3 of fresh buffer solution and a stopwatch started.
- A sample was immediately taken and placed in a machine to measure the radioactivity corresponding to the concentration of CO_2 every 50 s.
- After 200 s a sample of the chloroplast solution was added and measurement of CO_2 concentration continued for a further 150 s.

(a)
(i) Suggest why a buffer was used in this investigation.

.....

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

(ii) Suggest **one** reason why the scientists waited 200 s before adding the chloroplast solution.

.....

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

(b) The results of the investigation are shown in the table.

Time (s)	Concentration of carbon dioxide ($\mu mol\ dm^{-3}$)
0	0
50	0.5
100	1.6
150	1.6
200	1.6
250	0.9
300	0.8
350	0.8

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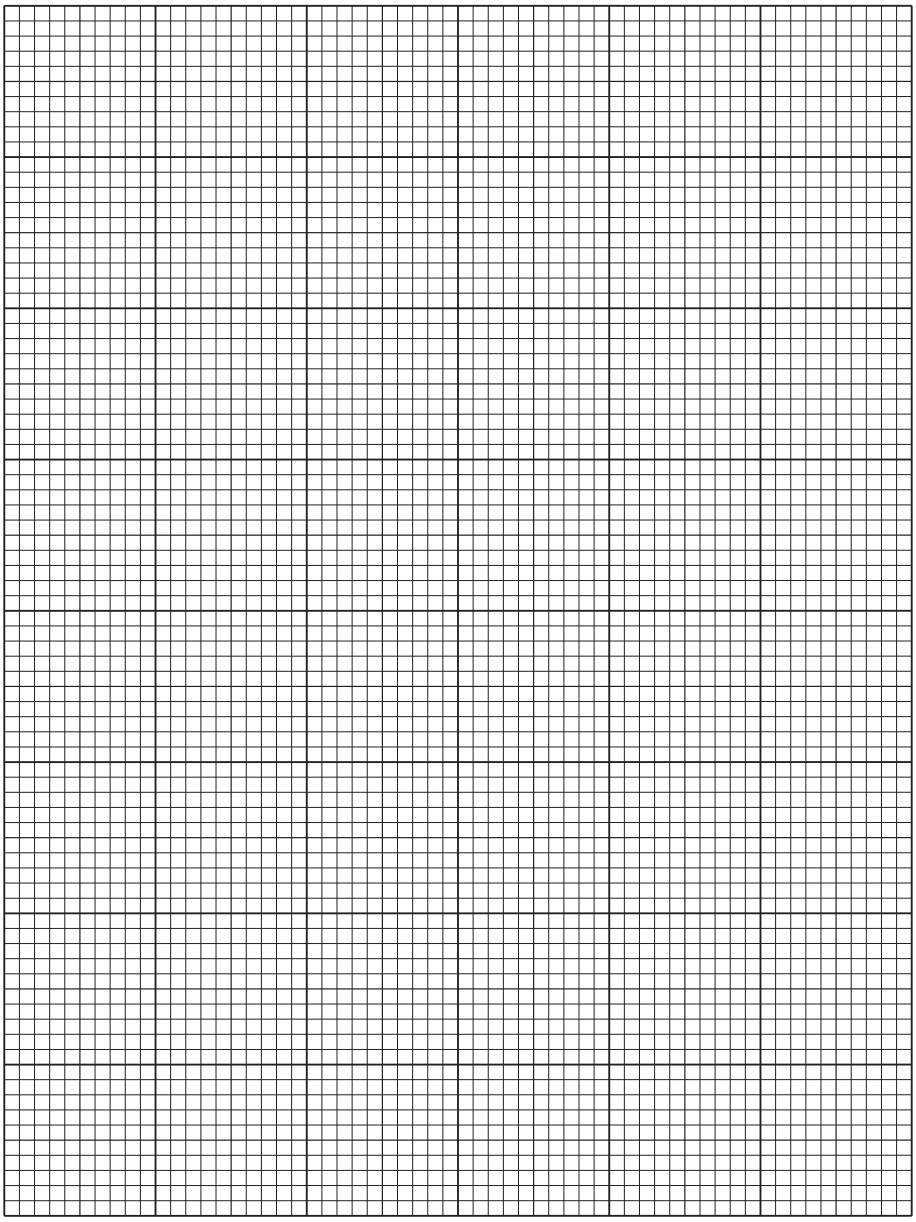
(i) Use the grid to plot an appropriate graph for these data.



[3]

(ii) Use your graph to calculate the rate of uptake of CO_2 at 275 s.

Give your answer **in standard form**.

Rate of uptake of CO_2 = ... $\mu mol\ dm^{-3}\ s^{-1}$ **[2]**

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(iii) Use your graph to suggest a mechanism of transport for CO_2 across the membrane and comment on the permeability of chloroplast membranes to CO_2.

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

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24 During the growth of duck and chicken embryos the appearance of the feet starts to differ after a certain stage in development.

Fig. 24.1 shows a foot in early stages of development that can be seen in both species.

Fig. 24.1

Fig. 24.2 shows the feet of adult birds.

Fig. 24.2

Adult Duck

Adult Chicken

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(a) Explain how differences in the feet of the two species occur during the growth and development of the embryos.

.....

.....

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

(b) Chickens have been intensively bred for meat production.

Genetic selection for rapid growth has caused health issues such as weak bones and reduced muscle development.

Researchers studied a type of stem cell called mesenchymal stem cells (MSCs) isolated from day-old chicks to provide information for improving the skeletal health of these chickens.

(i) MSCs are multipotent stem cells.

Explain what is meant by the term **multipotent**.

.....

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

(ii) State **one** part of the body of day-old chicks where MSCs could be found.

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

(iii) Suggest how MSCs could be used to improve the skeletal health of adult chickens.

.....

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

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25 The three levels of biodiversity are stated in the table below.

(a) Complete the table by writing a definition for each level of biodiversity.

Level of biodiversity	**Definition**
Ecosystem diversity	....
Genetic diversity	....
Species diversity	....

[3]

(b) *Salix taishanensis* is a species of tree that grows in mountainous regions of China.

The species is at risk of extinction and scientists collected data from individual trees from three distinct populations to assess the genetic diversity.

Some of these data are shown in the table.

	Population 1	**Population 2**	**Population 3**
Number of monomorphic genes	.....	5	6
Number of polymorphic genes	13	4	5
Percentage of polymorphic genes (%)	54	.....	.....

(i) Complete the data for the three populations in the table. **[2]**

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(ii) The scientists calculated the percentage of polymorphic genes for the species *S. taishanensis* at 74%.

Comment on how genetic diversity within the three populations of *S. taishanensis* varies from that of the species as a whole.

.....

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

END OF QUESTION PAPER

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EXTRA ANSWER SPACE

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

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