OCR
Oxford Cambridge and RSA

Thursday 9 June 2022 – Afternoon

A Level Biology B (Advancing Biology)

H422/01 Fundamentals of biology

Time allowed: 2 hours 15 minutes

You can use:
- a ruler (cm/mm)
- a scientific or graphical calculator

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 **110**.
- 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 **40** pages.

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

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SECTION A

You should spend a maximum of 40 minutes on this section.

Write your answer for each question in the box provided.

Answer **all** the questions.

1 Stomatal conductance is a measure of the rate of diffusion of water vapour through the stomata of a leaf.

Which of the environmental factors would cause an increase in stomatal conductance?

A Decrease in temperature

B Increase in humidity

C Increase in wind speed

D Reduced light intensity

Your answer ☐

[1]

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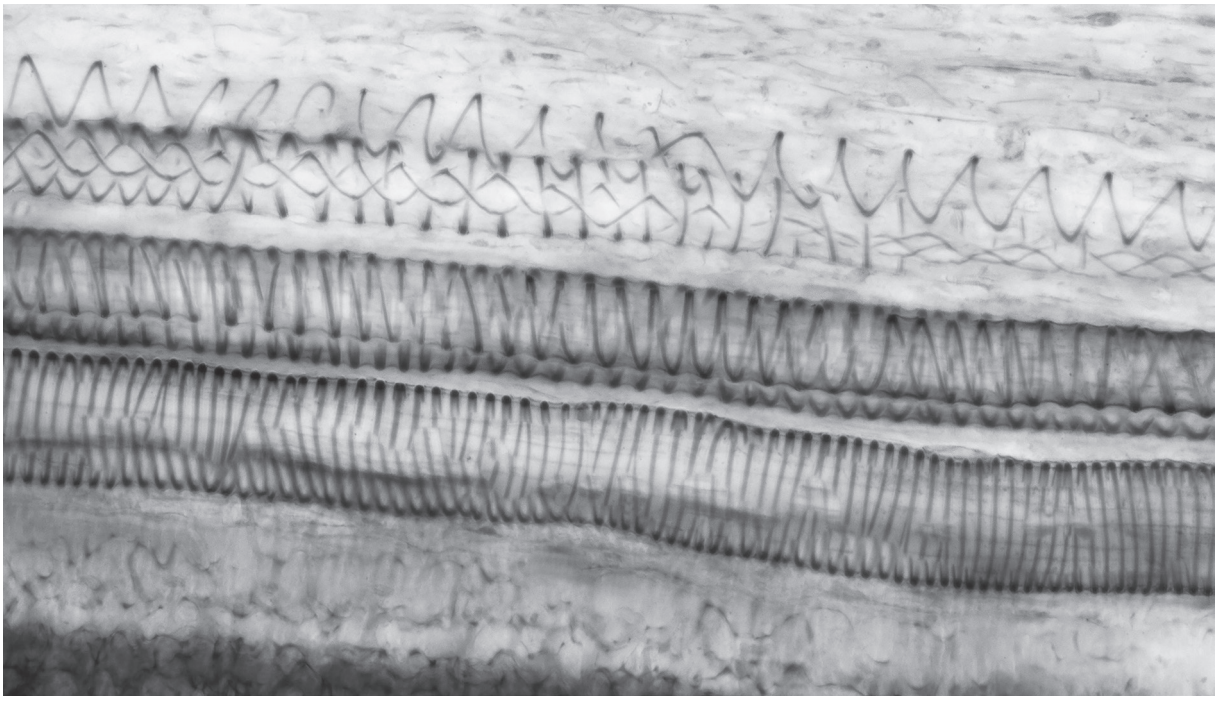
2 The photomicrograph shows a section through the stem of a sunflower, *Helianthus annuus*.



Which of the options correctly identifies what is shown in the photomicrograph?

A It shows phloem tissue in longitudinal section.

B It shows phloem tissue in transverse section.

C It shows xylem tissue in longitudinal section.

D It shows xylem tissue in transverse section.

Your answer ☐

[1]

3 Which part of a chloroplast contains the enzymes required for the light-independent reaction?

A Granum

B Inner membrane

C Intergranal lamella

D Stroma

Your answer ☐

[1]

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4 Which of the options would **not** prevent a climax community from forming?

A Animal grazing

B Coppicing

C Pine forest plantation

D Volcanic eruption

Your answer ☐

[1]

5 Which nitrogenous base pairs with adenine during DNA replication?

A Cytosine

B Guanine

C Thymine

D Uracil

Your answer ☐

[1]

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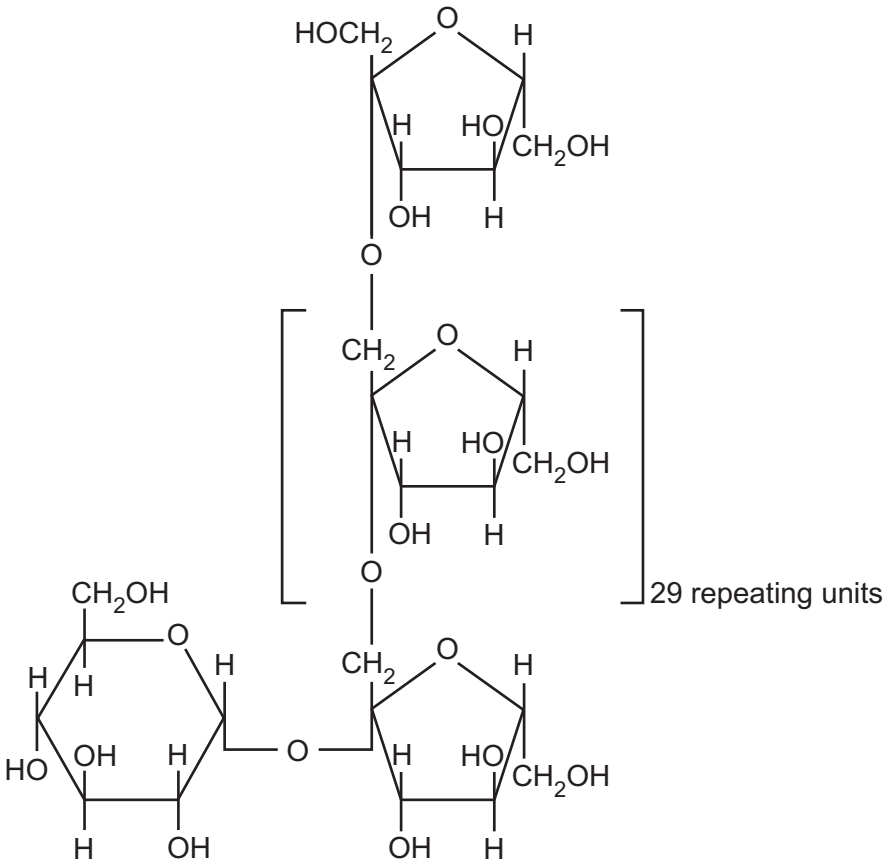
6 The structure of a polymer is shown below.



Which type of bond is broken down during the hydrolysis of this polymer?

A Ester

B Glycosidic

C Peptide

D Phosphodiester

Your answer ☐

[1]

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7 Water forms pleural fluid, a lubricant that reduces the friction between the lungs and the thoracic cavity during ventilation.

Which of the statements about the properties of water explains its function as a lubricant?

A A large amount of energy is required to change its temperature.

B A large amount of energy is required to change liquid water into a vapour.

C Adhesion allows water molecules to bond to surfaces.

D It is a solvent.

Your answer ☐

[1]

8 A scientist used a colorimeter during an investigation to measure the concentration of glucose in samples of urine.

Which of the statements is/are correct?

1 The scientist used Benedict's solution as a reagent.

2 The scientist checked the zero value of the colorimeter with distilled water to reduce systematic error.

3 The scientist assessed repeatability by repeating the measurements and calculating a mean.

A 1, 2 and 3 are correct

B Only 1 and 2 are correct

C Only 2 and 3 are correct

D Only 1 is correct

Your answer ☐

[1]

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9 Chelating agents are chemical compounds that target and react with metal ions in the body allowing them to be excreted.

A chelating agent has been shown to reduce tissue damage caused by a protease enzyme in snake venom by preventing zinc ions (Zn^{2+}) binding to the enzyme.

Which of the statements about the protease enzyme is correct?

A The chelating agent is a cofactor for the protease enzyme.

B The chelating agent is a competitive inhibitor of the protease enzyme.

C Zn^{2+} is a cofactor for the protease enzyme.

D Zn^{2+} is a competitive inhibitor of the protease enzyme.

Your answer ☐

[1]

10 The reaction shows the breakdown of ATP to release energy.

$$ATP \longrightarrow ADP + P_i$$

Which type of reaction is involved in the breakdown of ATP?

A Condensation

B Hydrolysis

C Oxidation

D Phosphorylation

Your answer ☐

[1]

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11 Flow cytometry can be used to determine the concentration of bacterial cells in a sample by comparing fluorescently-stained bacterial cells with a known concentration of fluorescent beads by recording the number of events.

An event occurs when a single cell or particle is detected by the flow cytometer.

The results are shown in the table.

	Number of events
Fluorescent beads	1500
Bacterial cells	3500

$$\text{Concentration of bacterial cells} = \frac{\text{number of cell events}}{\text{number of bead events}} \times \text{concentration of beads}$$

The known concentration of fluorescent beads is 15 000 per cm^3.

Which option shows the correct concentration of bacterial cells in 1 cm^3 of the sample?

A 6.4×10^3

B 1.6×10^{-4}

C 3.5×10^4

D 2.9×10^{-5}

Your answer ☐

[1]

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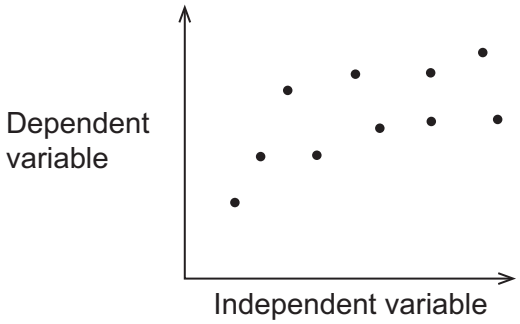
12 The following scattergram was plotted using a set of data obtained during a practical investigation.



Which option describes the correlation shown between the independent and dependent variable?

A No correlation

B Strong positive correlation

C Weak negative correlation

D Weak positive correlation

Your answer ☐

[1]

13 A student investigating the effect of ageing on short-term memory collected data from two groups of adults of different age ranges. Each group contained 15 adults.

The student analysed their data with a Student's unpaired *t*-test and used a critical values table at a 5% significance level to determine whether to reject their null hypothesis.

What is the correct number of degrees of freedom used by the student when using the critical values table?

A 14

B 15

C 28

D 30

Your answer ☐

[1]

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14 Researchers studying a population of mona monkeys, *Cercopithecus mona*, noticed that one of the 490 monkeys had black fur rather than the usual grey and white fur.

The researchers concluded that the monkey with black fur had a homozygous recessive genotype.

What is the correct method to estimate the percentage of the mona monkey population who were heterozygous for fur colour?

A Chi squared test

B Hardy-Weinberg principle

C Spearman's rank correlation coefficient

D Student's paired *t*-test

Your answer ☐

[1]

15 Which of the options is a correct definition of the genetic term it describes?

A Genotype is the genetic composition of an organism.

B Heterozygous is having two different genes of an allele.

C Locus is an organism's observable characteristics.

D Phenotype is the position of a gene on a chromosome.

Your answer ☐

[1]

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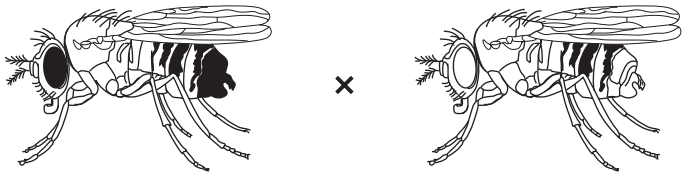
16 A group of students were investigating the inheritance of eye colour in *Drosophila melanogaster*, fruit flies.

- The gene for eye colour is sex-linked.
- The allele, **R**, for red eyes is dominant.
- The allele, **r**, for white eyes is recessive.

The students carried out the following cross and observed the eye colour of the offspring.



X^RY × X^rX^r

Which of the options about the eye colour of the offspring is correct?

A All female offspring will have white eyes.

B All male offspring will have white eyes.

C All the offspring, male and female, will have red eyes.

D Of the female offspring, 50% will have white eyes and 50% will have red eyes.

Your answer ☐

[1]

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17 The evolution of language in humans is a difficult topic for scientists to study.

Which of the statements about the methods used to study language evolution is/are correct?

1 Genes known to be involved in speech and language can be studied.

2 Scientists can make comparisons with other species.

3 Scientists can study similarities in cytochrome c.

A 1, 2 and 3 are correct

B Only 1 and 2 are correct

C Only 2 and 3 are correct

D Only 1 is correct

Your answer ☐

[1]

18 DNA ligase is an enzyme used in genetic engineering to produce human proteins from bacterial cells.

Which of the statements about DNA ligase is/are correct?

1 It is used to join ‘sticky ends’ of DNA fragments.

2 It is a type of restriction enzyme.

3 It produces a single strand of DNA (cDNA) from mRNA.

A 1, 2 and 3 are correct

B Only 1 and 2 are correct

C Only 2 and 3 are correct

D Only 1 is correct

Your answer ☐

[1]

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19 The thermoregulatory centre has a role in controlling body temperature.

Which structure contains the thermoregulatory centre?

A Adrenal gland

B Hypothalamus

C Pancreas

D Pituitary gland

Your answer ☐

[1]

20 Which statement explains how the release of thyroxine helps to raise body temperature in cold conditions?

A It causes an increase in metabolic rate.

B It causes contraction of erector muscles in hair follicles.

C It causes vasoconstriction.

D It causes vasodilation.

Your answer ☐

[1]

21 Which hormone is released by the kidney?

A Antidiuretic hormone (ADH)

B Erythropoietin

C Glucagon

D Insulin

Your answer ☐

[1]

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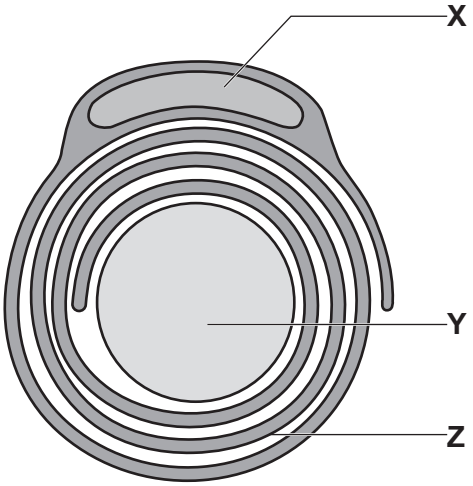
22 The diagram shows a section through the axon of a motor neurone with structures labelled **X**, **Y** and **Z**.



Which of the rows correctly identifies structures **X**, **Y** and **Z**?

	Structure X	Structure Y	Structure Z
A	Nucleus of cell body	Axon nucleus	Myelin sheath
B	Nucleus of Schwann cell	Axon cytoplasm	Axon membrane
C	Nucleus of Schwann cell	Axon cytoplasm	Myelin sheath
D	Nucleus of Schwann cell	Axon nucleus	Axon membrane

Your answer ☐

[1]

23 The table shows drugs used to treat asthma and the mechanisms of action.

	Type of drug	Mechanism of action	Use
A	Beta-agonist	Bronchodilator	Before exercise or for acute asthma
B	Beta-agonist	Reduce inflammation	Long term use
C	Corticosteroid	Bronchodilator	Long term use
D	Corticosteroid	Reduce inflammation	Before exercise or for acute asthma

Which row shows the correct type of drug, its mechanism of action and its use?

Your answer ☐

[1]

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24 Which of the options would cause an oxygen dissociation curve to shift to the right?

A Decrease in H^+ ions

B Hyperthermia

C Hypothermia

D Increase in pH

Your answer ☐

[1]

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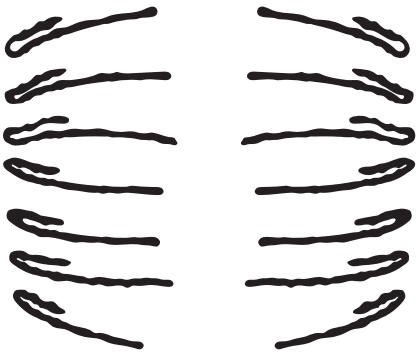
Questions **25 and 26** refer to the diagram.

The diagram shows a cell in a stage of meiosis.



25 What stage of meiosis is shown in the diagram?

A Anaphase I

B Anaphase II

C Metaphase I

D Prophase II

Your answer ☐

[1]

26 The number of possible combinations of chromosomes in a gamete of this species can be calculated using 2^n where n is the haploid number of chromosomes.

What is the number of possible chromosome combinations in a gamete of this species?

A 14

B 28

C 128

D 16 384

Your answer ☐

[1]

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27 Rod and cone cells are specialised cells (photoreceptors) found in the retina of the eye.

Which of the statements about rod and cone cells is/are correct?

1 Rod cells contain the pigment, iodopsin but cone cells contain the pigment, rhodopsin.

2 The inner segment of both rod and cone cells contains mitochondria.

3 Cone cells need more photons of light than rod cells to generate an action potential.

A 1, 2 and 3 are correct

B Only 1 and 2 are correct

C Only 2 and 3 are correct

D Only 1 is correct

Your answer ☐

[1]

28 Blood pressure is measured using a special instrument.

The blood pressure of a patient was measured as $\frac{130}{90}$ mmHg.

Which statement correctly identifies the instrument and measurements?

A A sphygmomanometer was used to take readings of 130 for systolic pressure and 90 for diastolic pressure.

B A sphygmomanometer was used to take readings of 90 for systolic pressure and 130 for diastolic pressure.

C A spirometer was used to take readings of 130 for systolic pressure and 90 for diastolic pressure.

D A spirometer was used to take readings of 90 for systolic pressure and 130 for diastolic pressure.

Your answer ☐

[1]

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29 Which option explains why damage or inflammation to the epididymis in the male reproductive system can lead to infertility?

A Alkaline fluid to counteract acidity of the vagina will not be secreted.

B Fluid containing proteins and fructose will not be secreted.

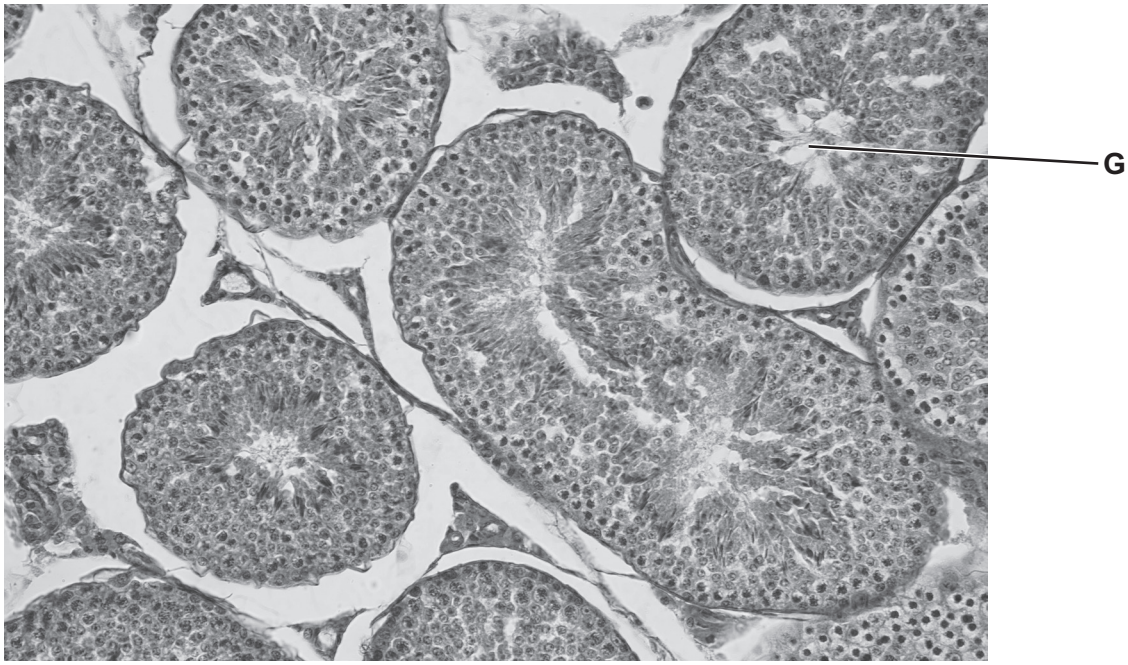
C Sperm cannot be produced.

D Storage of sperm prior to ejaculation will be affected.

Your answer ☐

[1]

30 The photomicrograph shows human testis tissue.



Which structure is labelled **G** on the photomicrograph?

A Prostate gland

B Seminal vesicle

C Seminiferous tubule

D Urethra

Your answer ☐

[1]

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SECTION B

Answer **all** the questions.

31 The size of a human population is determined by the relationship between birth and death rates.

(a) **Fig. 31.1** is a demographic model showing the relationship between birth and death rates for a developed country such as the UK.

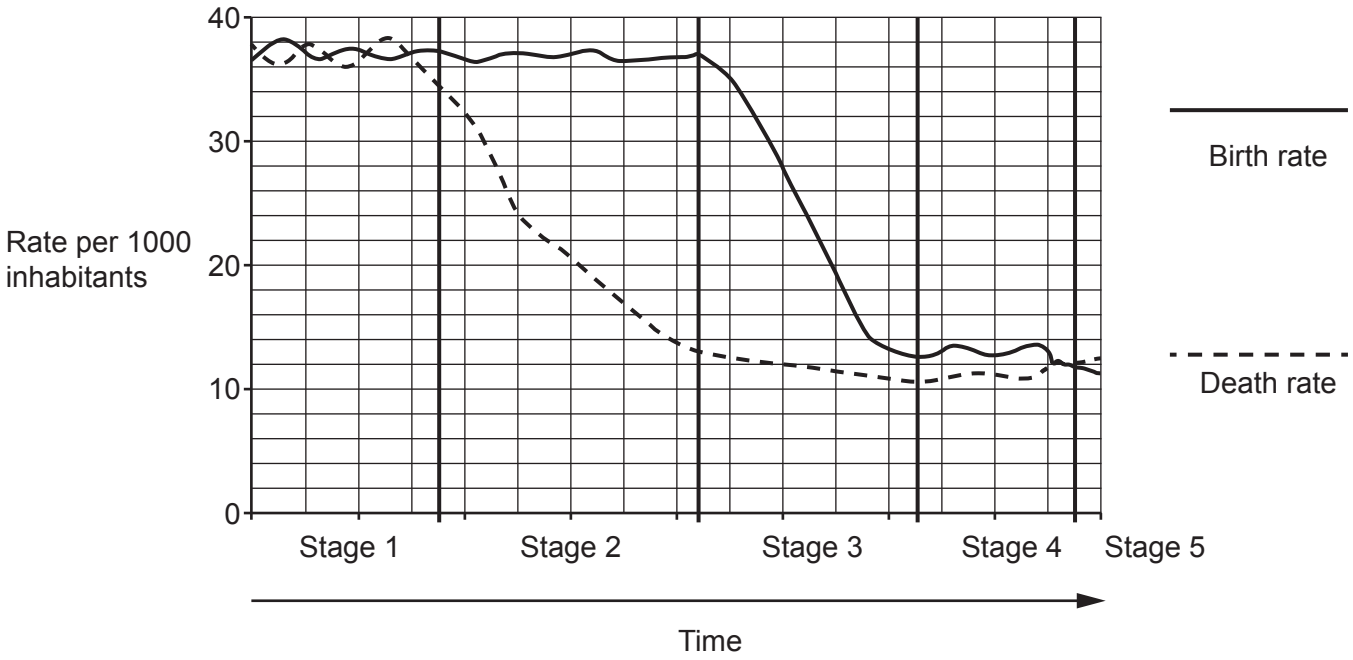

Fig. 31.1

(i) On **Fig. 31.1**, draw a curve to show estimated changes in the size of this population.

Write your answer on Fig. 31.1. **[2]**

(ii) Suggest why there are differences in the birth rates for stages 2 and 3.

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

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(iii) Suggest **one** reason why birth rate has dropped below death rate in stage 5.

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

(b)* In 2019 it was estimated that 19.3% of people living in low to middle-income countries were food insecure. Organisations are working towards global food security and have a target of reducing food insecurity to 9.2% by 2029.

Discuss the challenges in reducing food insecurity as the human population continues to rise, including the impact on the environment **and** how organisations could measure success.

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..... **[6]**

Additional answer space if required.

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(c) The use of antibiotics is a factor that contributed to declining death rates in developed countries during the 20th century.

Daptomycin is an antibiotic that was discovered in the 1980s.

The structure of daptomycin is shown in **Fig. 31.2**.

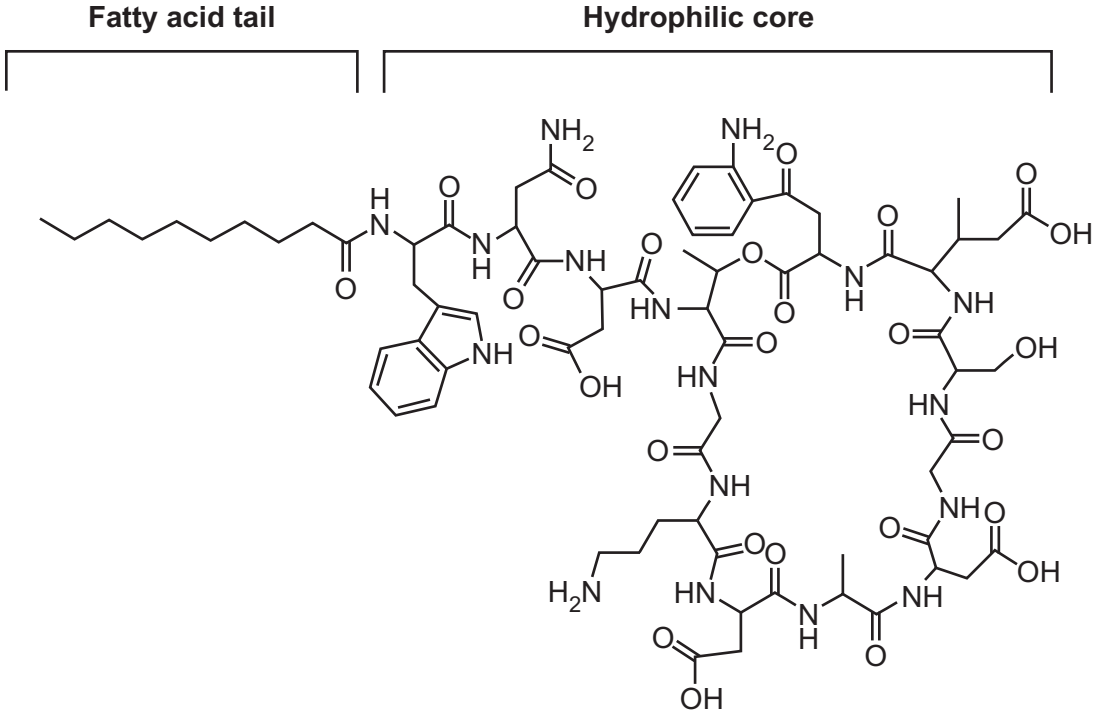

Fig. 31.2

(i) Using the information in **Fig. 31.2**, suggest a type of biological molecule found in the hydrophilic core of daptomycin.

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

(ii) Daptomycin has a bactericidal effect on gram positive bacteria by causing cytosol to leak out of bacterial cells.

Using the information in **Fig. 31.2**, suggest how daptomycin can cause leakage of cytosol from bacterial cells.

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

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(iii) Suggest **one** reason why daptomycin may **not** be effective against gram negative bacteria.

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

(d) The bactericidal activity of some antibiotics is concentration-dependent which means that the higher the concentration of antibiotic given to a patient, the greater the bactericidal effect.

Fig. 31.3 shows the concentration of antibiotic in the plasma of a patient following one dose.

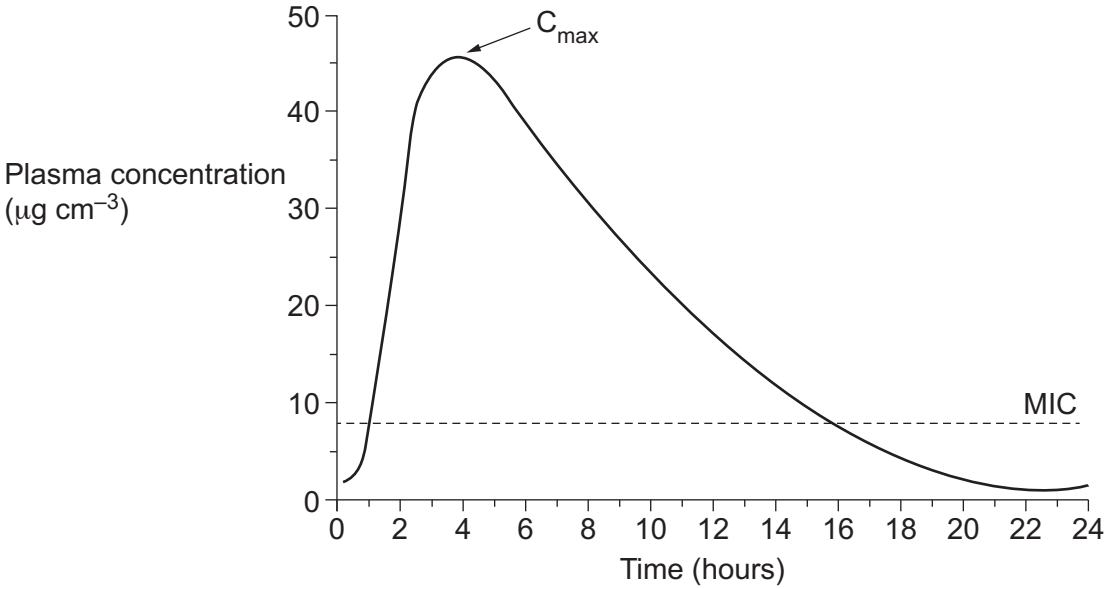

Fig. 31.3

The antibiotic shows optimal bactericidal effect when the dose given to the patient produces a peak concentration (C_{max}) that is 10 times greater than the minimum inhibitory concentration (MIC).

Using the information in **Fig. 31.3**, comment on whether the dose given to the patient is sufficient to kill the bacteria.

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

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32 At the onset of menopause changes occur to hormone levels in women.

(a) **(i)** Name one hormone that increases **and** one hormone that decreases in concentration during the onset of menopause.

Hormone that increases in concentration .....

Hormone that decreases in concentration .....
[2]

(ii) Ageing of the reproductive system is the main cause of menopause.

Name **one** other factor that may result in menopause.

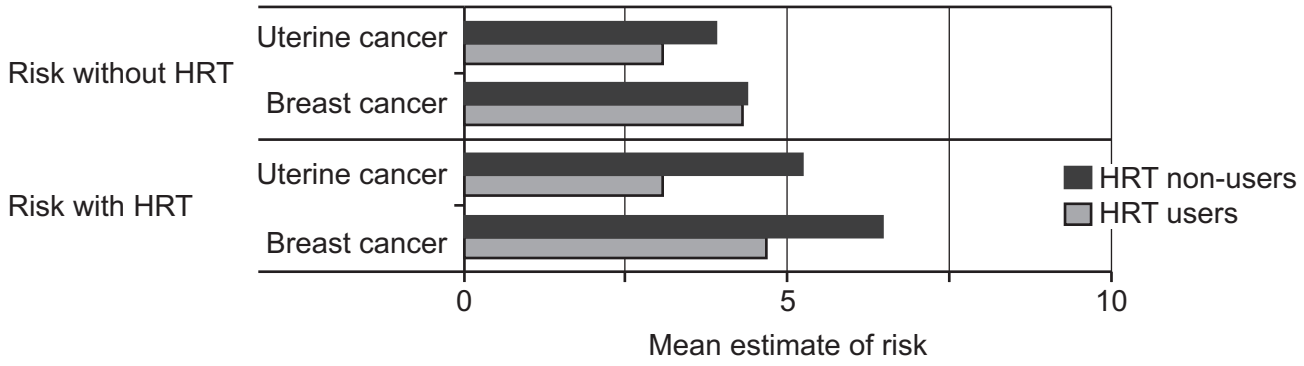
..... **[1]**

(b) Hormone replacement therapy (HRT) is commonly used to relieve the symptoms of menopause but many women are concerned about the risks.

In one investigation, researchers studied the attitudes of women towards the risks of HRT by using a questionnaire.

- The same questionnaire was given to two groups of women, non-HRT and HRT users.
- All the women were aged 40 or above and there were 150 women in each group.
- The women were asked to estimate what they thought the risk of developing uterine cancer or developing breast cancer were, either without HRT or with HRT.
- They were asked for estimates of risk based on a scale of 1 to 10.

Some of the data from this study are shown in the graph.



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Use the data in the graph to draw conclusions **and** suggest reasons for differences in estimates of risk associated with HRT for the two groups of women.

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

(c) The male reproductive system is also affected by ageing. Changes to the prostate gland resulting in benign prostatic hyperplasia (BPH) is thought to occur in approximately 50% of men.

(i) Explain how BPH causes symptoms such as inability to completely empty the bladder.

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

(ii) Apart from changes to the prostate gland, state **one** other change caused by ageing on the male reproductive system.

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

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(iii) The risk of prostate cancer also increases with age.

Suggest why national screening programmes for prostate cancer are currently not available in the UK.

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

(d) The table compares different methods for treating cancer.

Complete the table by putting a tick (✓) in each box for a statement that applies to each method and a cross (✗) for a statement that does not apply.

The first row has been done for you.

Method	**Statement**			
	Specifically targets cancer cells	Does not destroy healthy cells	Monoclonal antibodies linked to anti-cancer drugs	DNA is damaged by ionising radiation
Complementary therapy	✗	✓	✗	✗
Chemotherapy				
Immunotherapy				
Radiotherapy				

[3]

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33 **(a)** A group of students investigated the effect of different light wavelengths on seed germination using the following method.

1. Five petri dishes labelled **A** to **E** were lined with cotton wool soaked in 25 cm^3 of nutrient solution.
2. Twenty seeds of the species *Vigna unguiculata*, a variety of black-eyed pea, were placed in each petri dish.
3. The petri dishes were placed in boxes containing a different light source.
4. Dish **A** was placed in normal (white) light, dish **B** in red light, dish **C** in yellow light, dish **D** in green light and dish **E** in blue light.
5. The seeds were checked for signs of germination at the same time each day for 5 days.
6. Seeds showing signs of germination were counted and removed from the petri dishes.

The results of the investigation are shown in the table.

Time (hr)	**Number of seeds showing signs of germination in each light source**				
	Normal (white)	Red	Yellow	Green	Blue
24	2	2	2	0	3
48	6	4	2	0	7
72	8	6	6	0	1
96	2	4	1	0	2
120	1	2	0	1	1

(i) State **two** conclusions that can be drawn from the data.

1 .....

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2 .....

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[2]

(ii) Describe how the method could have been improved to reduce random error.

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

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(iii) Calculate the increase in percentage of seeds that germinated in blue light between 48 and 96 hours.

Increase = ... % **[2]**

(iv) The students processed their results and plotted a line graph to show the effect of light wavelength on cumulative percentage germination.

State the labels given to each axis of the graph.

x-axis .....

.....

y-axis .....

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[2]

(v) One of the students suggested that weighing the petri dishes each day and calculating the mass of the seeds would be a better method of measuring germination than counting the number of seeds that germinate.

Evaluate this suggestion.

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

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(b) Germinating seeds need oxygen which they take in from the surrounding soil.

(i) Explain why oxygen is required for germination.

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

(ii) Suggest the mechanism by which germinating seeds take in oxygen from the soil.

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

(iii) Give **one** reason why, as seedling leaves appear, less oxygen is taken in from the surrounding soil even though the need for oxygen increases.

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

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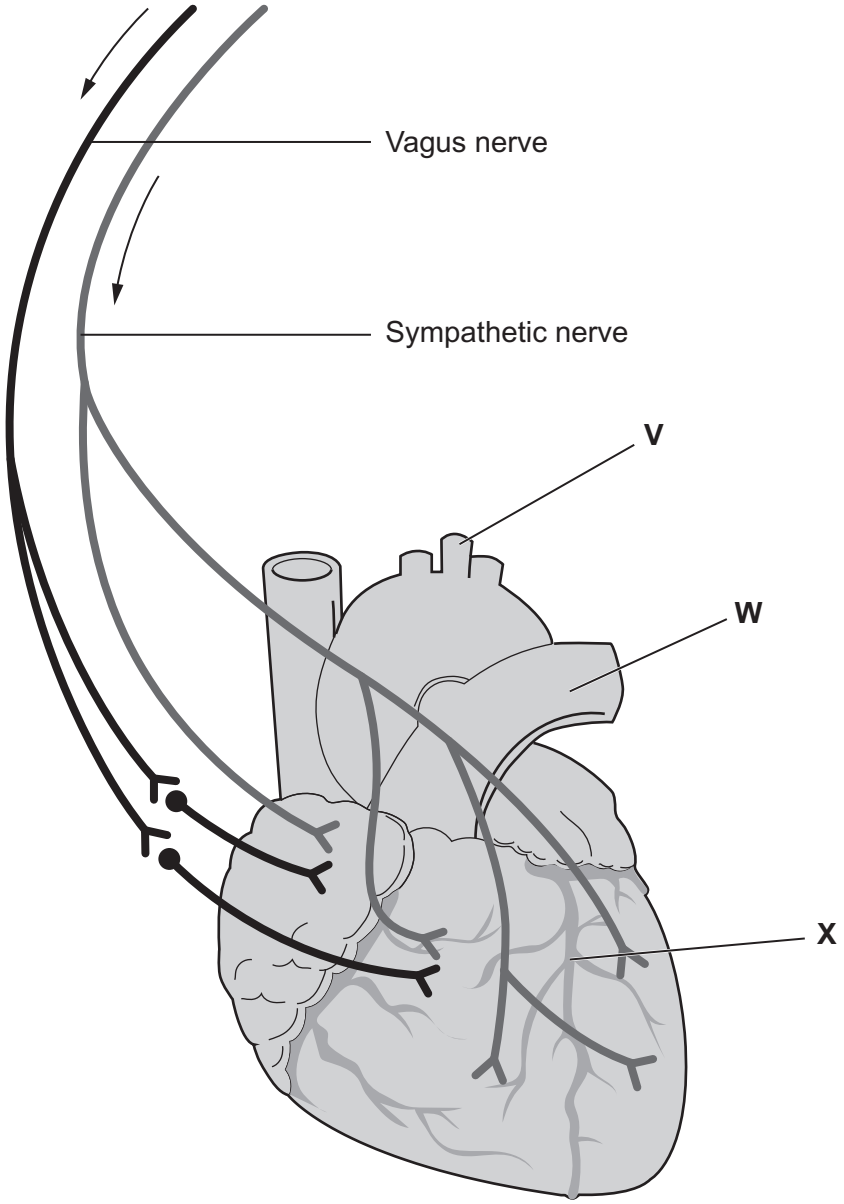
34 This is a diagram of the external structure of a mammalian heart.



(a) **(i)** Use the diagram to complete the missing structures, letters and function in the table.

Structure	Letter	Function
		Supplies heart muscle with oxygen
	V	Has receptors in its walls that detect changes in pH
Pulmonary artery		

[3]

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(ii) The nerves seen on the diagram originate in cardiovascular centres in the brain.

Name the structure in the brain where the cardiovascular centres are located.

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

(b)* Adrenaline has a role in controlling heart rate.

Compare the action of the nerves in the diagram with adrenaline in controlling heart rate.

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..... **[6]**

Additional answer space if required.

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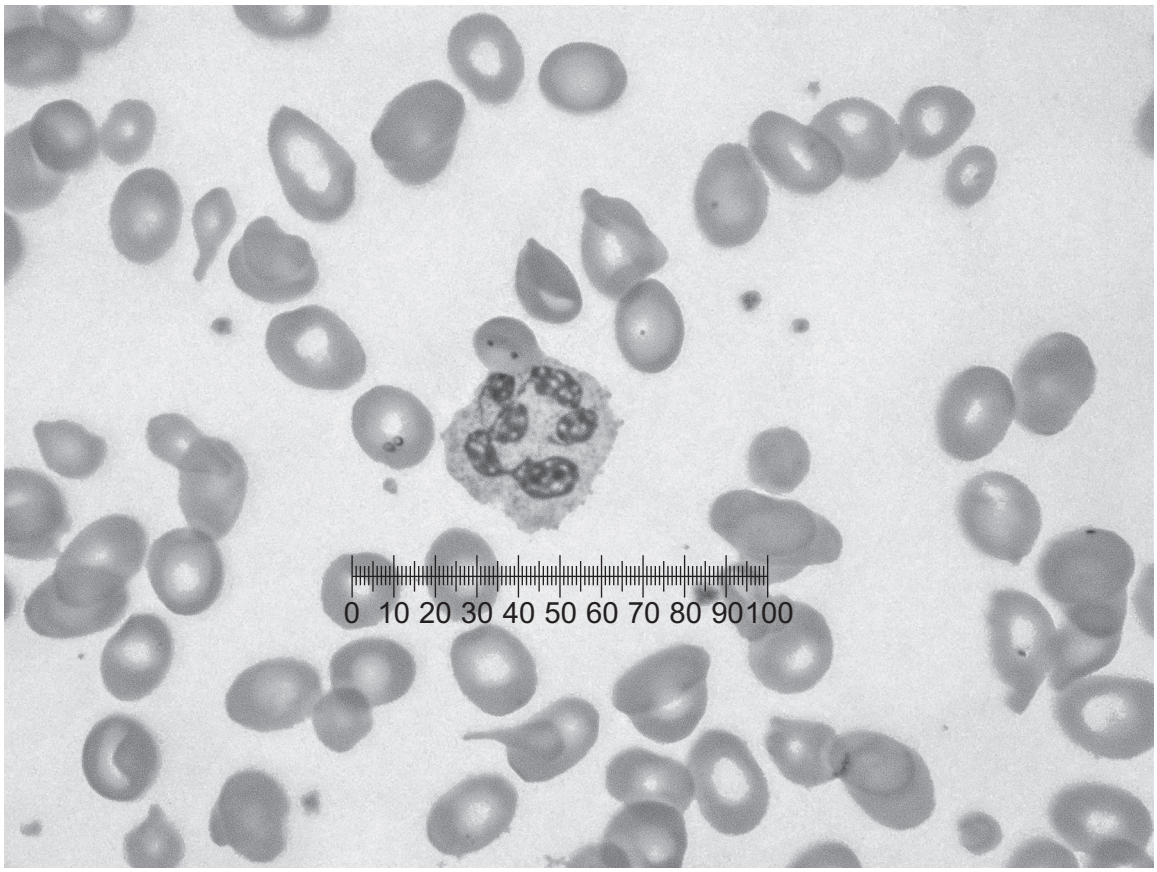
35 **(a)** The photomicrograph shows blood components as seen using a light microscope with an eyepiece graticule.



(i) Name the type of leucocyte shown.

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

(ii) Make an annotated drawing of the leucocyte.

[2]

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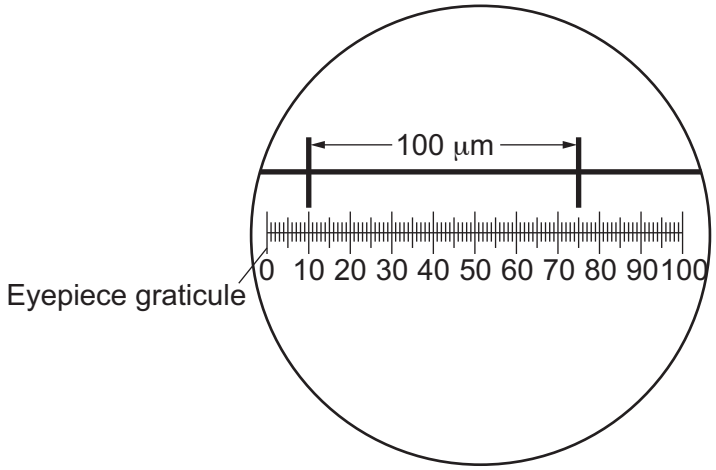
The eyepiece graticule used was calibrated as shown in the diagram.



(iii) Name the apparatus used to calibrate the eyepiece graticule.

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

(iv) Calculate the diameter of the leucocyte.

Give your answer to **2** significant figures.

Diameter = ... μm **[2]**

(b) When blood vessels are damaged a clot is formed to prevent excessive blood loss.

Complete the sentences about blood clotting using the most appropriate word or words.

Damage to the blood vessel activates platelets and the enzyme ..... is released.

This enzyme catalyses the conversion of prothrombin into thrombin. Thrombin is an enzyme

that hydrolyses the soluble protein ..... into the insoluble protein

..... .

This hydrolysis reaction requires ..... ions.

[4]

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(c) Plasma is a blood product that can be given to treat women who have suffered blood loss during childbirth.

(i) Suggest **one** advantage and **one** disadvantage of using plasma to replace blood lost during childbirth.

Advantage .....

.....

Disadvantage .....

.....
[2]

(ii) Apart from replacing lost blood, state **one** other use for donated plasma.

.....

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

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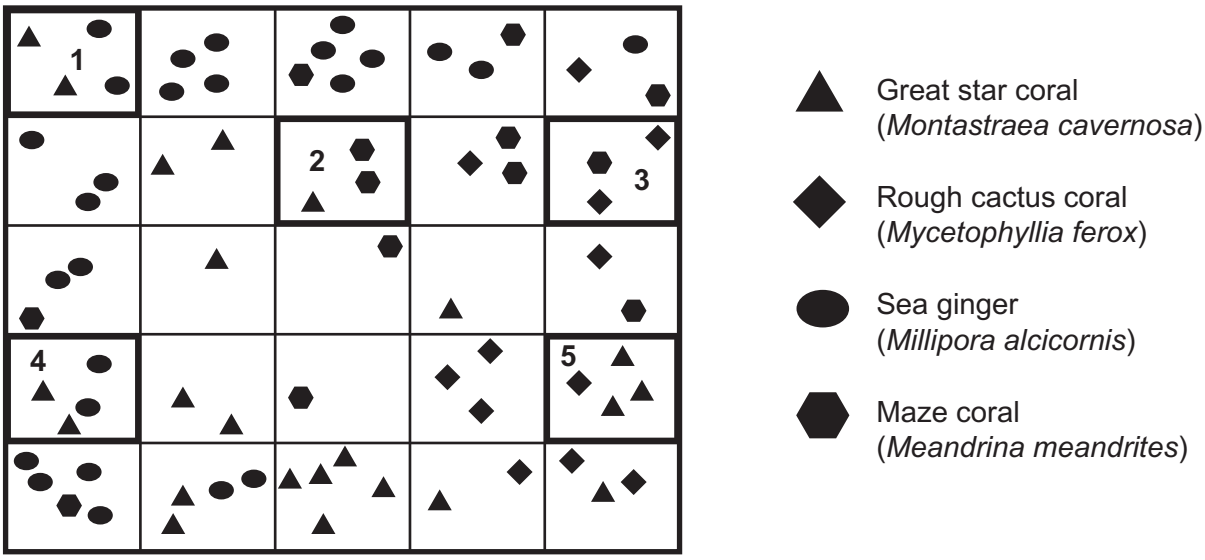
36 Tobago is an island in the Caribbean sea. The reefs of Tobago represent some of the southernmost reefs still dominated by coral species.

Researchers used the random sampling method shown in the figure to estimate population density and percentage cover of different species of corals and hydrocorals living on one of the reefs.

1. Divers located a 100 m^2 area of the reef for the study.
2. Tape measures were used to form grid lines.
3. Five areas were selected and labelled **1** to **5**.
4. The species were identified using a key and then counted.



(a) **(i)** Comment on the suitability of using this sampling method in the study.

.....

.....

.....

.....

.....

.....

.....

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

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(ii) Using the method shown, estimate the population density of sea ginger.

Population density = ... m^{-2} **[2]**

(b) Further data collected by the researchers is shown in the table.

Species	**Percentage species cover (*n*)**	**$(n/N)^2$**
Round starlet coral (*Siderastrea siderea*)	14	
Mountainous star coral (*Orbicella faveolata*)	30	
Great star coral (*Montastraea cavernosa*)	16	
Sea ginger (*Millipora alcicornis*)	15	
Brain coral (*Diploria strigosa*)	13	
Rough cactus coral (*Mycetophyllia ferox*)	5	
Maze coral (*Meandrina meandrites*)	7	

(i) Calculate the Simpson's index of diversity of the reef.

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

D = ... **[2]**

(ii) Due to their proximity to the South American coastline, freshwater run off from the Amazon river reaches the reefs of Tobago.

Using your answer to **(b)(i)**, suggest the likely impact of freshwater run off on the coral reef and give a reason for your suggestion.

.....

.....

.....

.....

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

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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