Oxford Cambridge and RSA

Monday 12 May 2025 – 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 StemUp Model Solution

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 of the statements about peak expiratory flow rate (PEFR) is correct?

A It increases as the age of a person increases.

B It is calculated by multiplying tidal volume by breathing rate.

C It is the maximum rate at which air can be forced out through the mouth.

D It is the volume of air breathed out in the first second of forced exhalation.

Your answer C

[1]

2 Which option about why multicellular plants need transport systems is **not** correct?

A Assimilates must be transported from source to sink

B Diffusion distances are too long

C Multicellular plants have large surface area to volume ratios

D Water and mineral ions must be transported from roots to leaves

Your answer C

[1]

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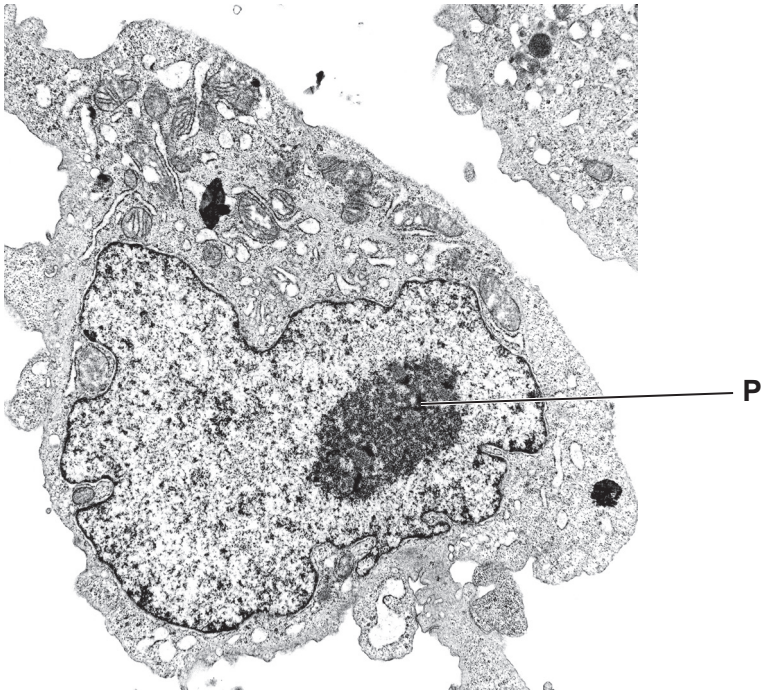
3 The transmission electron micrograph shows the ultrastructure of a mammalian cell.



Which option describes the function of the structure labelled **P**?

A It produces ATP.

B It stores glycogen.

C It synthesises proteins.

D It synthesises ribosomes.

Your answer D

[1]

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4 A student observed a blood sample using a light microscope with a calibrated eyepiece graticule. They measured the diameter of a lymphocyte and calculated its actual diameter as 12 μm.

One unit of the calibrated eyepiece graticule = 2.4 μm.

What is the diameter of the lymphocyte measured by the student in eyepiece graticule units?

A 0.2

B 5.0

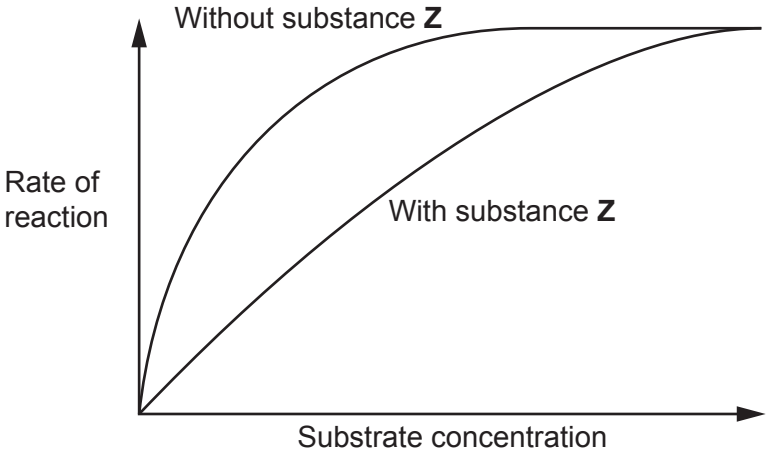
C 9.6

D 28.8

Your answer B

[1]

5 The graph shows the rate of an enzyme-controlled reaction with and without the addition of a fixed quantity of substance **Z**.



What is the molecule in substance **Z**?

A Cofactor

B Competitive inhibitor

C Non-competitive inhibitor

D Prosthetic group

Your answer B

[1]

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6 What would **not** be included in the emergency treatment given to an adult suffering a suspected heart attack?

A Help them take their usual angina medication.

B Offer them an aspirin tablet to chew, if available.

C Sit them up with their knees bent.

D Use a defibrillator to restore the normal rhythm of the heart.

Your answer D

[1]

7 The table shows descriptions of some of the stages and features of apoptosis.

Which of the rows, **A** to **D**, is correct ?

	Karyorrhexis	**Pyknosis**	**Role of phosphatidylserine**
A	nucleus breaks down	nucleus condenses	binds to receptors on lymphocytes
B	nucleus breaks down	nucleus condenses	binds to receptors on macrophages
C	nucleus condenses	nucleus breaks down	binds to receptors on lymphocytes
D	nucleus condenses	nucleus breaks down	binds to receptors on macrophages

Your answer B

[1]

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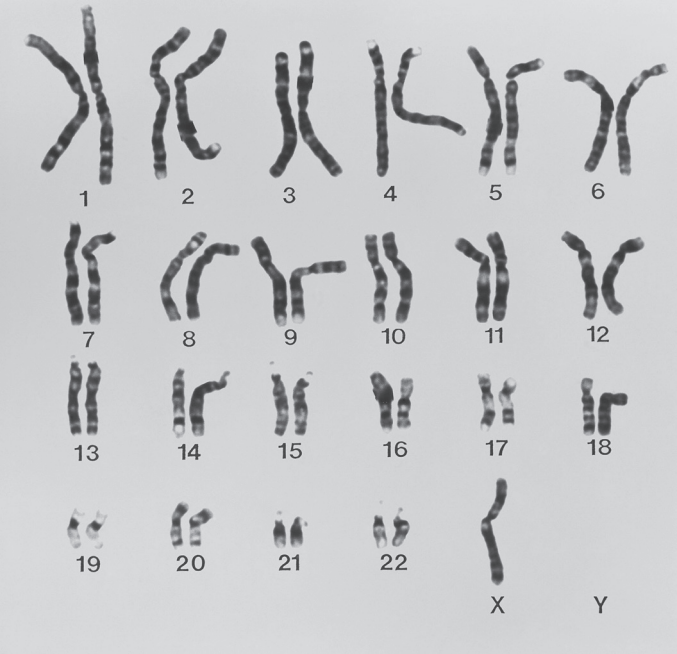
The karyogram shows chromosomes from a human fetus.

Use the karyogram to answer questions **8** and **9**.



8 Which of the statements about stages in the production of the karyogram is correct?

A Fetal cells were extracted using amniocentesis and then stimulated to divide by meiosis.

B Fetal cells were extracted using chorionic villus sampling (CVS) and then stimulated to divide by mitosis.

C Fetal cells were stimulated to divide by mitosis and then extracted using ultrasound.

D Fetal cells were stimulated to divide by mitosis and then extracted using amniocentesis.

Your answer B

[1]

9 What is the correct analysis of the karyogram?

A The fetus is a female with Down's syndrome.

B The fetus is a female with Klinefelter's syndrome.

C The fetus is a female with Turner's syndrome.

D The fetus is a male with Turner's syndrome.

Your answer C

[1]

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10 The prickly pear, *Opuntia ficus-indica*, is a species of cactus adapted to hot, dry habitats.

What is a **physiological** adaptation for surviving in hot, dry habitats?

A Photosynthesis takes place in stems.

B Needle-like leaves to reduce water loss.

C Swollen stems for storing water.

D Waxy surfaces to protect from UV radiation.

Your answer A

[1]

11 The table shows some of the features of the human immunodeficiency virus (HIV).

Which of the rows, **A** to **D**, is correct?

	Feature		
	Central core	**Genetic material**	**Capsid**
A	contains the enzyme, reverse transcriptase	DNA	protein coat surrounding the virus
B	contains the enzyme, reverse transcriptase	RNA	protein coat surrounding the virus
C	contains the nucleus of the virus	DNA	phospholipid membrane surrounding the virus
D	contains the nucleus of the virus	RNA	phospholipid membrane surrounding the virus

Your answer B

[1]

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12 Malaria is a disease in humans.

The table shows data for the incidence rate of malaria in a population over a one-year period.

Number of people in the population	Incidence rate (per 100 000 y^{-1})
2.4×10^7	148

What is the number of new cases of malaria in this population?

A 3.6×10^4

B 1.5×10^5

C 1.6×10^5

D 3.6×10^9

Your answer A

[1]

13 Which molecule is found in the cell wall of a bacterium?

A Cellulose

B Lignin

C Peptidoglycan

D Phospholipid

Your answer C

[1]

14 Gram staining is a method used to classify bacteria.

Which of the statements about Gram negative bacteria is correct?

A They have a thick cell wall and do not have a lipopolysaccharide layer so stain pink.

B They have a thick cell wall and do not have a lipopolysaccharide layer so stain purple.

C They have a thin cell wall and a lipopolysaccharide layer so stain purple.

D They have a thin cell wall and a lipopolysaccharide layer so stain pink.

Your answer D

[1]

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Medicines can be derived from plants such as the white willow tree, *Salix alba*.

Questions **15** and **16** refer to *Salix alba*.

15 The hierarchical classification of *Salix alba* is shown below.

Domain	Eukaryota
↓	Plantae
	Tracheophyta
	Magnoliopsida
	Malpighiales
	Salicaceae
	Salix
Species	*alba*

Which of the statements about the taxons is **not** correct?

A Plantae is the kingdom.

B Salicaceae is the class.

C *Salix* is the genus.

D Tracheophyta is the phylum.

Your answer B

[1]

16 What medicine is derived from *Salix alba*?

A Aspirin

B Quinine

C Theophylline

D Topotecan

Your answer A

[1]

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17 What would occur in a non-specific response to pathogens?

A Clonal expansion

B Clonal selection

C Inflammation

D Production of antibodies

Your answer C

[1]

18 As part of a practical activity about osmosis, two students used different apparatus to measure the volume of solution remaining in the Visking tubing at the end of the activity.

Student 1 chose a measuring cylinder and measured the volume remaining as 10.0 cm^3.

Student 2 chose a burette and measured the volume remaining as 10.35 cm^3.

The students agreed that the burette was better than the measuring cylinder because it could measure smaller changes.

Which of the following statements about the burette is correct?

A The burette has a higher resolution than the measuring cylinder.

B The burette has a lower resolution than the measuring cylinder.

C The burette is more precise than the measuring cylinder.

D The burette is less precise than the measuring cylinder.

Your answer A

[1]

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19 A gene was found to be responsible for the expression of other genes in human cells. Changes to the sequence of nucleotides in this gene resulted in the constant production of transcription factors and proliferation of cells.

Which of the options describes this type of gene?

A It is a mutagen.

B It is an oncogene.

C It is a proto-oncogene.

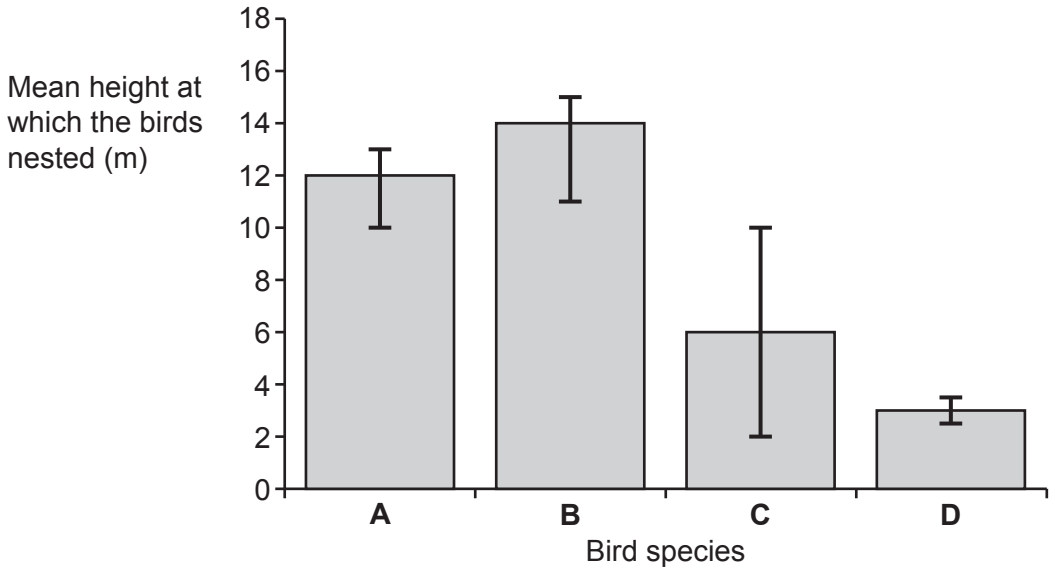
D It is a tumour-suppressor gene.

Your answer B

[1]

20 Researchers were investigating adaptations and evolution in woodland bird species. They observed the nesting activities of four different bird species, **A** to **D**.

The researchers recorded the heights at which each species nested. An analysis of their results is shown in the bar chart.



Which species of bird showed most variation in the heights at which they nested?

Your answer C

[1]

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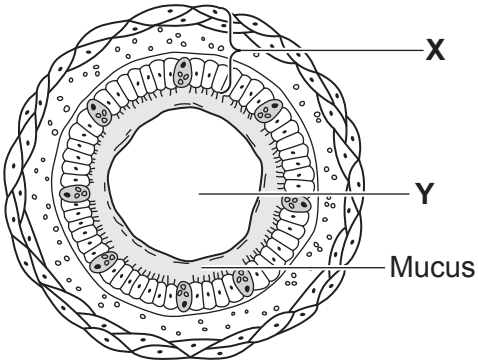
Section B

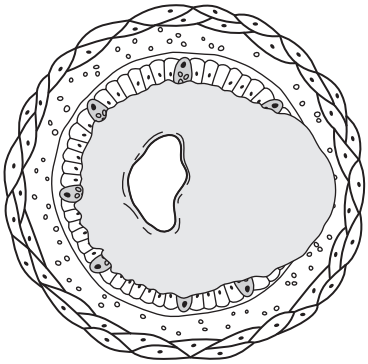
21 Bronchiectasis is a disease that affects the airways of the lungs.

The diagram shows a healthy bronchus and the bronchus of a person with bronchiectasis.

Healthy bronchus



Diseased bronchus



(a)
(i) Describe how the features labelled **X** and **Y** on the healthy bronchus have changed in the diseased bronchus **and** suggest how these changes could have occurred.

X (the cilia on the ciliated epithelium): in the diseased bronchus there are fewer cilia (they are lost), caused by inflammation and damage to the epithelium (epithelial cells), e.g. from repeated infection. The wall (epithelium) is also thinner on one side, caused by loss of / damage to tissues.

Y (the lumen / airway): the airway is widened (dilated), caused by loss of / damage to tissues in the wall, such as elastic fibres and smooth muscle. The open lumen is narrowed by mucus, caused by an increase in mucus production by goblet cells, which builds up as there are no cilia to remove it.

[4]

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(ii) Bronchitis is also a disease that affects the airways of the lungs.

Using your knowledge and the diagram, state **one** similarity **and one** difference between the effects of bronchiectasis and bronchitis on a healthy bronchus.

Similarity Both cause excess mucus production, so the airway is narrowed due to mucus.

Difference In bronchitis the cilia are still present (only paralysed), but in bronchiectasis the cilia are lost.

[2]

(iii) Bronchiectasis and bronchitis are both examples of chronic diseases.

Explain what is meant by the term **chronic disease**.

A disease that lasts a long time (slow onset) and whose symptoms may get worse over time. **[1]**

(b) Lung disease may result in respiratory arrest.

State the procedure used to help a person in respiratory arrest.

Expired air resuscitation (EAR), i.e. rescue breaths as part of CPR. **[1]**

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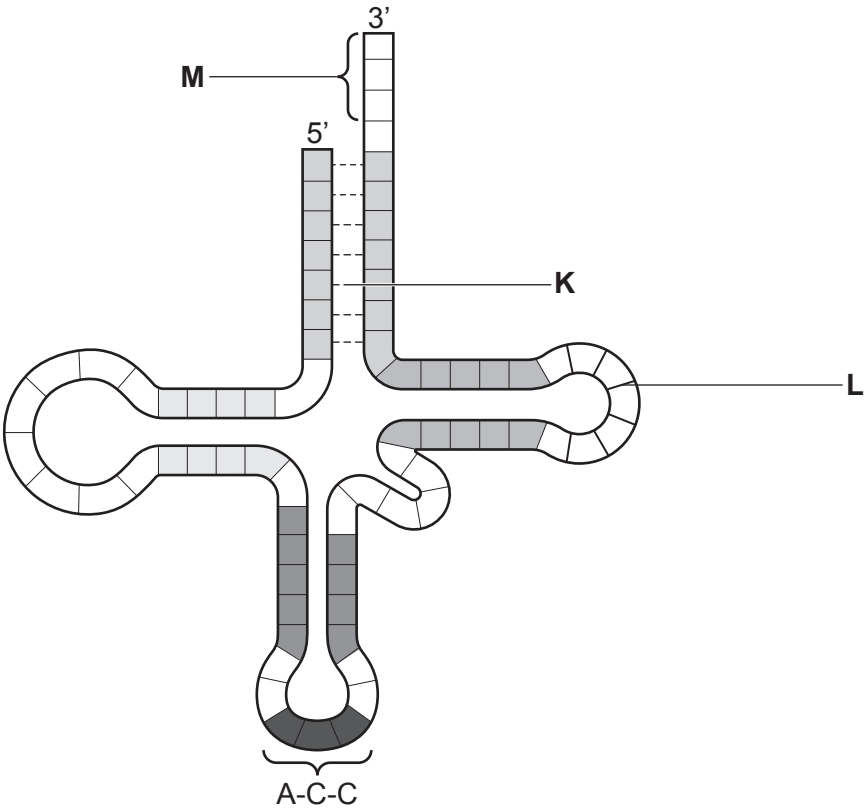
22

(a) This is a diagram of a transfer RNA (tRNA) molecule.



(i) State the names of the types of bond labelled **K** and **L**.

Bond **K** .....hydrogen.....

Bond **L** .....phosphodiester.....

[1]

(ii) State the function of the part of the molecule labelled **M**.

..Attaches to (binds) a specific amino acid.....

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

(iii) State the codon on the DNA antisense strand (template) that would result in this tRNA molecule attaching to mRNA during the process of translation.

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

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(b) Compare the structure of a tRNA molecule to a molecule of DNA.

Similarities: both contain phosphate groups, a pentose (5C) sugar and nitrogenous bases such as adenine, cytosine and guanine; both have phosphodiester bonds and hydrogen bonds between bases.

Differences: tRNA is much smaller than DNA; the sugar is ribose in tRNA but deoxyribose in DNA; thymine in DNA is replaced by uracil in tRNA; tRNA is (mostly) single-stranded with a clover leaf shape, whereas DNA is double-stranded and a double helix.

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

(c) A group of scientists were investigating DNA replication and transcription in the bacterium *Escherichia coli* (*E.coli*).

They found that:

- DNA replication occurs at approximately 1000 base pairs per second
- transcription occurs at approximately 3000 nucleotides per minute.

One of the scientists made the following conclusion about their findings:

'DNA replication is much faster than RNA synthesis.'

Use the data to comment on the scientist's conclusion.

Transcription: 3000 ÷ 60 = 50 nucleotides per second

Replication: 1000 base pairs per second (= 60 000 per minute)

1000 ÷ 50 = 20

The conclusion is correct, because transcription occurs at only 50 nucleotides per second, whereas DNA replication occurs at 1000 base pairs per second, so DNA replication is 20 times faster. ..... **[2]**

(d) ATP is required to provide energy for DNA replication.

Complete the sentences about the structure and function of ATP using the most appropriate word(s).

ATP is a phosphorylated..... nucleotide. It is easily transported in cells and releases energy when it is ..hydrolysed..... to form ADP and .....phosphate..... .

[3]

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23 The evolution of language is a difficult topic to study. Use of experimental data by scientists is limited when studying language evolution in humans and other methods are needed to provide evidence to support or reject their hypotheses.

(a) Fossil evidence is a method used to study language evolution.

(i) State **one** advantage **and one** disadvantage of using fossils to study evolution.

Advantage Fossils can be (carbon) dated to show changes in species over time.

Disadvantage There are missing links in the fossil record, e.g. soft body parts decay and some fossils have not been discovered.

[2]

(ii) State **one** other method used to study language evolution **and** explain how it provides evidence to support or reject hypotheses.

Genetics (DNA analysis), e.g. of the FOXP2 gene. Humans have a unique variant of this gene involved with speech and language, so comparing the gene in humans, extinct hominins and other species shows when the variant appeared, supporting or rejecting hypotheses about when language evolved.

[2]

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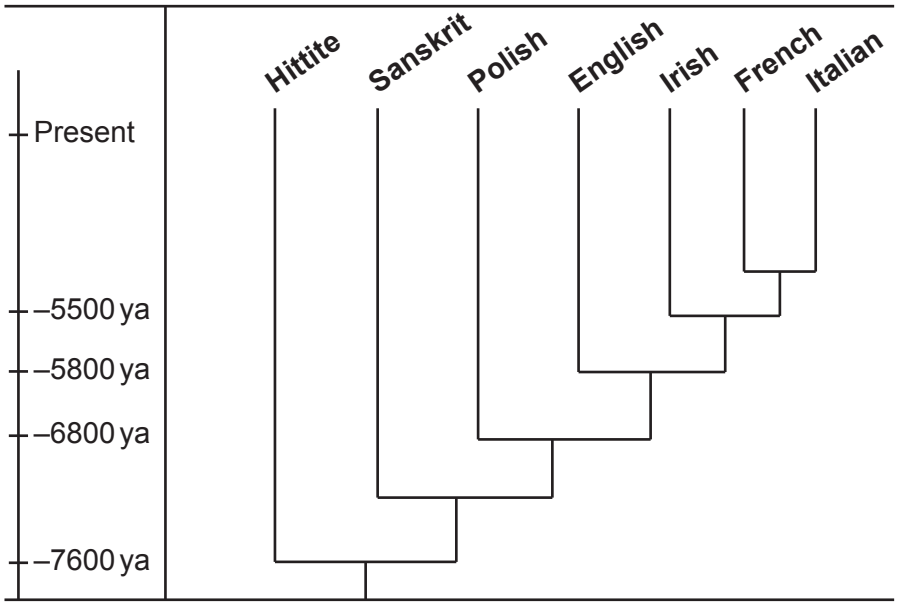
(b) The diagram shows relationships in the evolution of modern languages.



(i) State the name of this type of diagram used to study evolutionary relationships.

Phylogenetic tree ..... **[1]**

(ii) The table shows some conclusions that were drawn from the diagram.

Conclusions that can be supported by information in the diagram are true and others are false.

Complete the table by deciding which conclusions are **True (T)** and which are **False (F)**.

Conclusion	True (T) or False (F)
None of the languages are extinct.	True (T)
Hittite is the common ancestor for all other languages.	False (F)
Polish is more closely related to English than to Sanskrit.	True (T)

[3]

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24

(a) These are some revision notes made by a student about the features of acquired immunodeficiency syndrome (AIDS) and tuberculosis (TB).

1	AIDS is caused by the human immunodeficiency virus (HIV).
2	Antibiotics cannot be used to treat HIV infections or TB.
3	Both AIDS and TB are described as communicable diseases.
4	Many different organs in the body are affected by AIDS, but TB only affects the lungs.
5	HIV can only be spread by direct contact with body fluids.
6	Pathogens causing TB are transmitted by close contact droplet infection.
7	TB is caused by a fungus.
8	The Mantoux test can be used to test for both HIV and TB infections.

Revision note 1 is a correct statement.

Identify **two** incorrect revision notes **and** suggest a correction for each of your choices.

Incorrect revision note .....2.....

Correction ..Antibiotics can be used to treat TB (a bacterial infection), but they.....

..cannot be used to treat HIV (a virus).....

Incorrect revision note .....7.....

Correction ..TB is caused by a bacterium.....

.....

[4]

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(b) Dynamin is a protein found at the site of vesicle formation on cell surface membranes.

Scientists have suggested that dynamin may be involved in the mechanism by which HIV enters host cells.

(i) State the name of a type of cell that is a host cell for HIV.

T helper cell (T lymphocyte) ..... **[1]**

(ii) Suggest the mechanism of transport across cell surface membranes that involves dynamin.

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

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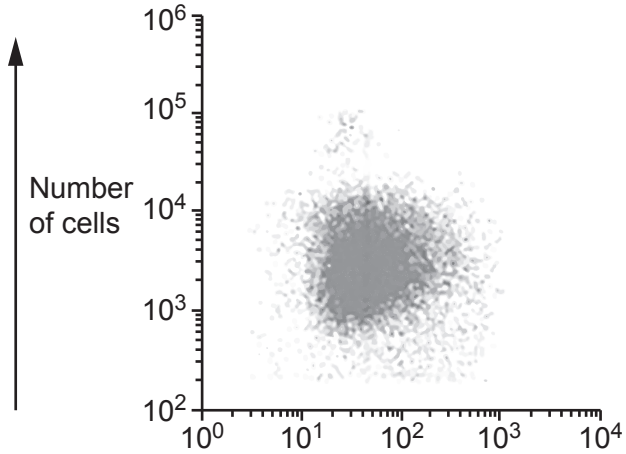
In a recent study into the role of dynamin in the infection of host cells by HIV, researchers prepared the following cell cultures:

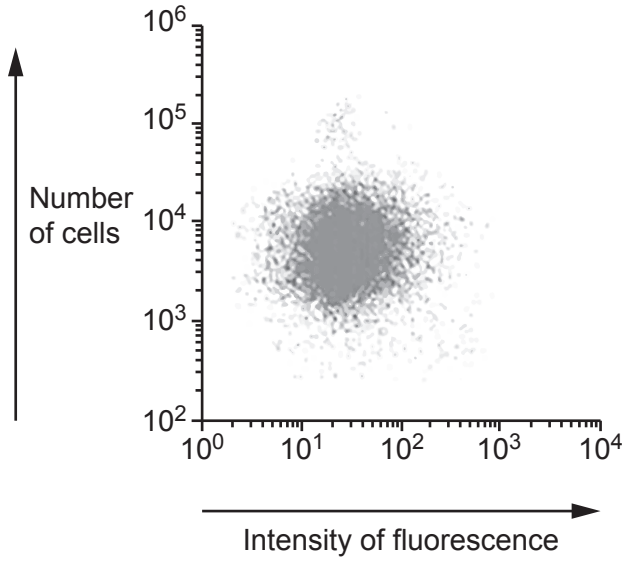
- host cells were added to a culture of cells expressing HIV antigens
- host cells were treated with a non-competitive inhibitor of dynamin for one hour prior to being added to cells expressing HIV antigens.

The cultures were then left for 24 hours. The HIV antigens had been tagged with a fluorescent marker for flow cytometry.

This is data from the study obtained using flow cytometry.



Host cells cultured with cells expressing HIV antigen



Host cells treated with inhibitor prior to being cultured

(iii) Explain why a logarithmic scale is appropriate for presenting the data obtained in this study.

The numbers of cells cover a very large range (from 10^2 to 10^6), so a log scale allows all the data to be shown clearly on one graph. **[1]**

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(iv) Discuss how the data support the suggestion that dynamin is involved in the entry of HIV into host cells.

The intensity of fluorescence is less in the culture with the inhibitor than in the host cells without it.

This shows that fewer cells have been infected with HIV (fewer cells express the fluorescent HIV antigens).

The non-competitive inhibitor decreases the activity of dynamin, so HIV entry by endocytosis is reduced.

For example, the fluorescence is concentrated between about 15 and 150 in the host cells, but only between about 10 and 100 with the inhibitor. **[3]**

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25 A group of students are investigating the growth of algal species in a freshwater pond.

This is the method they use to prepare a sample of pond water for counting individual algae.

1. Place 199 cm^3 of pond water in a measuring cylinder containing 1 cm^3 of settling agent.
2. Mix the contents of the measuring cylinder thoroughly and leave for 24 hours.
3. After 24 hours, carefully remove 180 cm^3 of the algal solution without disturbing the remaining 20 cm^3 at the bottom of the measuring cylinder.
4. Mix this 20 cm^3 sample thoroughly and place a drop on a haemocytometer slide and view using a microscope.

(a)

(i) Suggest **one** reason why steps 1 and 2 are included in the method.

To concentrate the algae into a smaller volume (the bottom 20 cm^3), so there are enough to count.

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

(ii) Suggest **one** reason why it is necessary to mix the sample again thoroughly in step 4.

To ensure an even distribution of the algae, so the drop placed on the slide is representative of the sample.

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

(iii) Outline further steps in the method that would enable the students to estimate the number of individual algae present in the sample.

Count the number of individuals of each species (algal type) in one triple-lined square, using the north-west rule for those on the boundary lines.

Count in more than one square and calculate a mean.

Calculate the number of individuals in the known volume of the observed square (area × depth) and scale to 1 cm^3.

Multiply by the dilution factor (allow for the settling agent and for concentrating 200 cm^3 into 20 cm^3).

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

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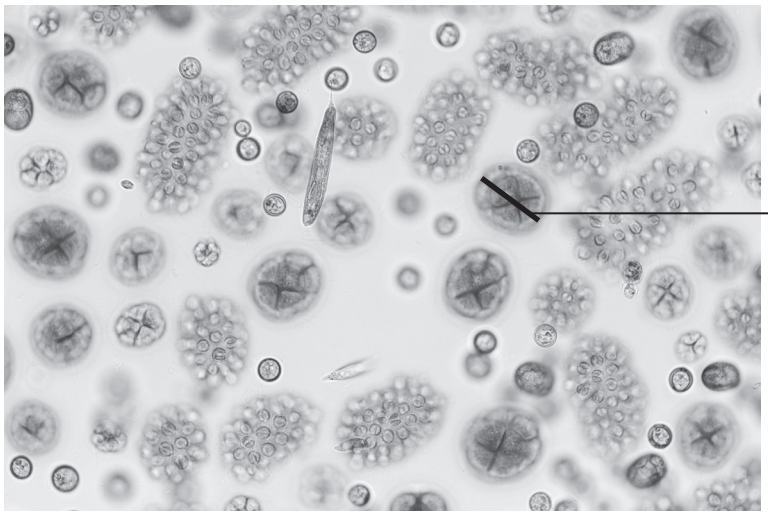
(b) One of the students placed a drop of the sample from step 4 on a normal microscope slide and observed the algal species using a light microscope with a magnification of ×200.

The image shows the view seen by the student.



×200

(i) Using the image, explain a disadvantage of using a haemocytometer to estimate the number of algal cells in a pond water sample.

Some species are made up of more than one cell (form colonies), like individual P, so it is difficult to count individual cells and they may be under- or over-counted. **[1]**

(ii) The diameter of individual **P** of the algal species, *Pandorina morum*, is shown on the image.

Calculate the actual diameter of this individual.

Diameter on image = 9 mm = 9000 μm

actual diameter = 9000 ÷ 200 = 45 μm

Diameter = 45 μm **[2]**

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(iii) Wet biomass (biovolume) of *P. morum* in the sample can be calculated using the equation:

Biovolume = number of individuals per cm^3 × mean volume of individuals

The number of *P. morum* in the sample was estimated to be 3.0×10^3 per cm^3.

Assuming the diameter calculated in **(b)(ii)** is also the mean diameter and the individuals are spherical, calculate the biovolume for *P. morum*.

Use the equation: volume of a sphere = $\frac{4}{3}\pi r^3$

radius = 45 ÷ 2 = 22.5 μm

volume = 4/3 × π × 22.5^3 = 4.77×10^4 μm^3

1 cm^3 = 10^{12} μm^3, so volume = 4.77×10^{-8} cm^3

biovolume = $3.0 \times 10^3 \times 4.77 \times 10^{-8} = 1.4 \times 10^{-4}$ cm^3

Biovolume = ...1.4×10^{-4}..... cm^3 **[3]**

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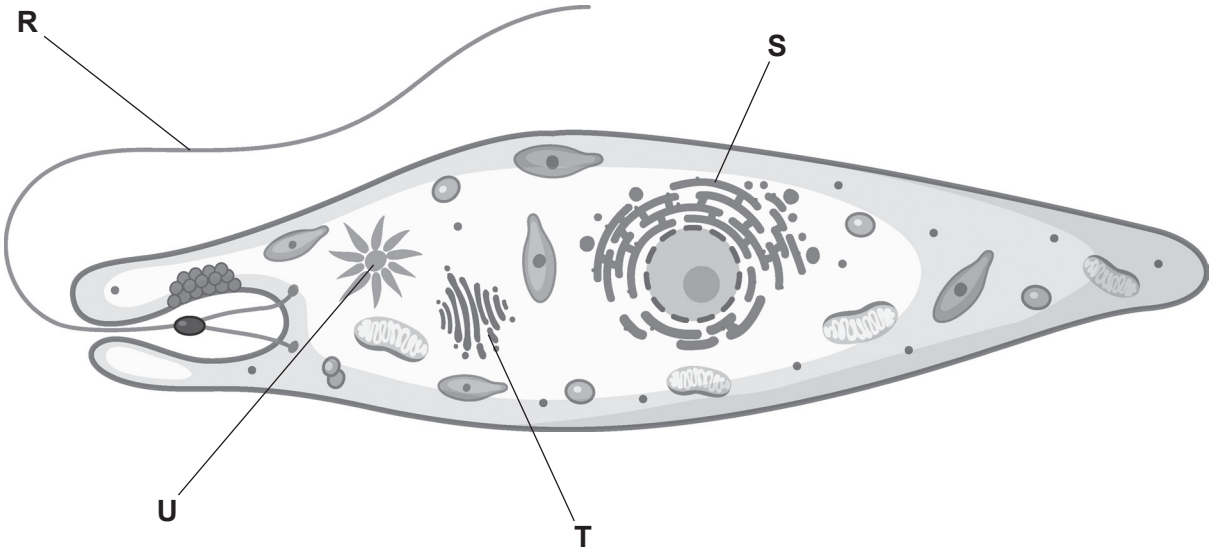
(c) The diagram shows the ultrastructure of an algal cell from the *Euglena* species.



Give the letters identifying one organelle that would be present **and** one that would **not** be present in a palisade mesophyll cell.

Present .....S.....

Not present .....R.....

[2]

END OF QUESTION PAPER

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EXTRA ANSWER SPACE

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

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