

OCR A-LEVEL BIOLOGY B • H422

# BIOLOGY



**EXAM QUESTION PACK**

**2.1.1 CELLS AND MICROSCOPY**

**SCORE**

**/247**

**PERCENTAGE**

**%**

**STEMUP**

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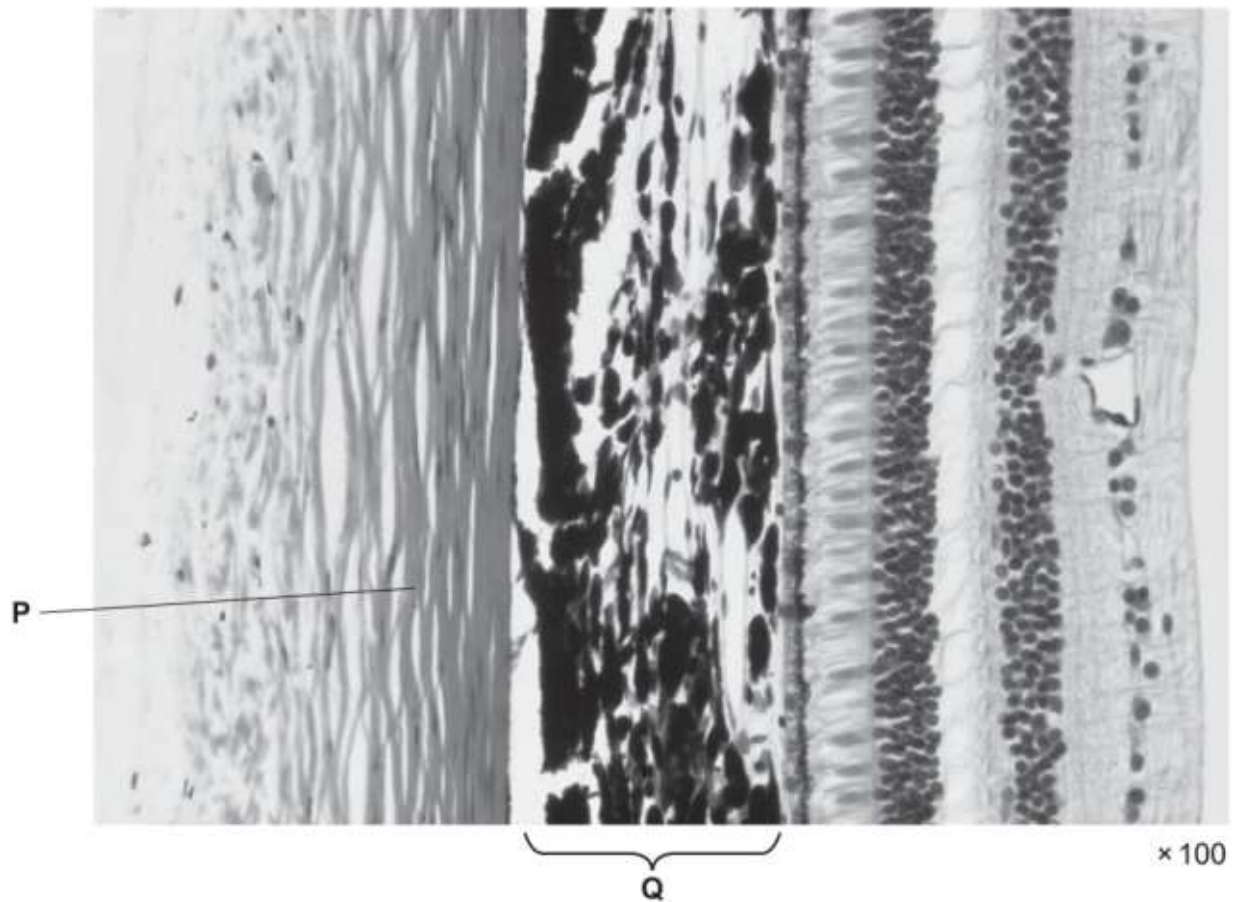
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1(a) The photomicrograph below shows a section through the wall of a mammalian eye.



The tissues of the eye shown in the photomicrograph were stained using eosin, which binds to cytoplasmic proteins staining them pink, and haematoxylin, which stains cell nuclei dark blue.

Describe the advantages of this method of staining tissues for viewing under a microscope.

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[2]

- (b) Four students were given copies of the photomicrograph and asked to measure the width of the retinal layer in the image using a mm ruler.

The students recorded their results in the table below.

| Width of the retinal layer (mm) |           |           |           |      |
|---------------------------------|-----------|-----------|-----------|------|
| Student 1                       | Student 2 | Student 3 | Student 4 | Mean |
| 64                              | 66        | 61        | 65        |      |

- (i) Find the mean of the data and use it to calculate the actual width of the retinal layer.

Width = .....  $\mu\text{m}$  [2]

- (ii) Calculate the uncertainty in the mean value for this data.

Use the equation:

$$\frac{R}{2\sqrt{N}}$$

$R$  = difference between maximum and minimum values

$N$  = number of measurements taken

Uncertainty = ..... [2]

(c) Bardet-Biedl syndrome (BBS) is a human genetic disorder. One of the main symptoms is child-onset loss of vision.

Abnormalities of cilia are known to be related to a wide range of disease symptoms including those commonly seen in BBS patients. It is now accepted that mutated *BBS* genes affect microtubules and the normal functioning of cilia.

In the early childhood of individuals with BBS, deterioration of cone cells in the retina occurs, leading to poor visual acuity and colour blindness.

(i) Using your knowledge of the internal structure of photoreceptor cells, suggest why mutated *BBS* genes lead to deterioration of cone cells and poor visual acuity.

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[2]

(ii) Explain how cone cells enable humans to distinguish colour.

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[3]

(iii) Obesity, syndactyly, diabetes and kidney failure are other symptoms associated with BBS.

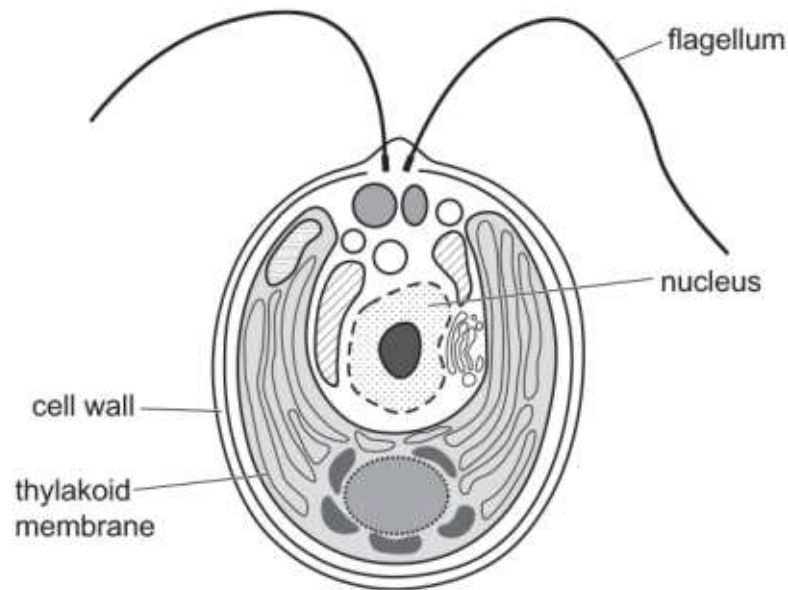
Suggest why BBS is described as a syndrome.

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----- [1]  
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(iv) State the mechanism that prevents syndactyly occurring in healthy individuals.

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----- [1]  
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- 2 The structure and part of the classification of *Chlamydomonas reinhardtii*, a single-celled organism, is shown below.



|                        |               |                   |                    |                                |
|------------------------|---------------|-------------------|--------------------|--------------------------------|
| Phylum:<br>Chlorophyta | Chlorophyceae | Chlamydomonadales | Chlamydomonadaceae | Genus:<br><i>Chlamydomonas</i> |
|------------------------|---------------|-------------------|--------------------|--------------------------------|

Which of the following statements is / are correct?

- 1: *C.reinhardtii* would be classified in the Kingdom, Bacteria.  
2: *C.reinhardtii* is a photosynthetic organism.  
3: Chlamydomonadaceae is the family taxon for *C.reinhardtii*.  
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]

- 3 Which of the eukaryotic cell membranes, A to D, is used to isolate enzymes that could cause cellular damage?

- A lysosome membrane  
B mitochondrial membrane  
C nuclear membrane  
D tonoplast

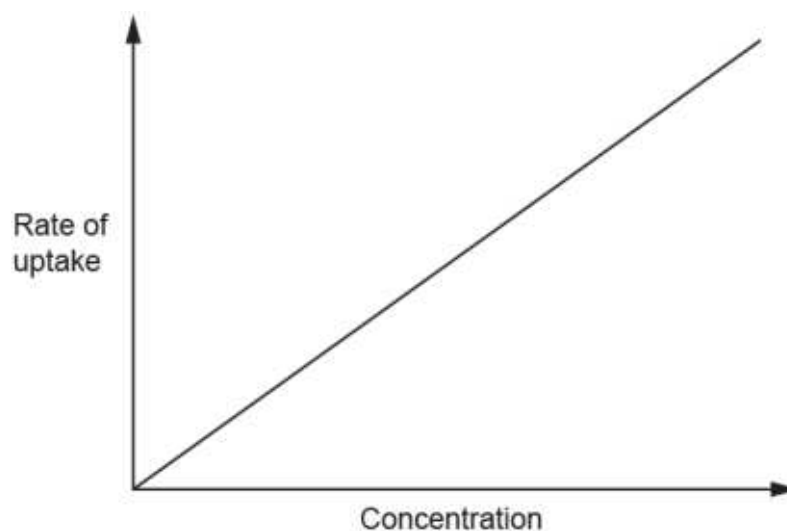
Your answer

☐

[1]

- 4 An investigation was carried out into the effect of concentration of a substance on its rate of uptake into cells.

The cells were placed in solutions of the substance at different concentrations and rate of uptake was measured.



Which of the options, **A** to **D**, is the mechanism being used by the cells to transport the substance across the cell membrane?

- A active transport
- B facilitated diffusion
- C osmosis
- D simple diffusion

Your answer

[1]

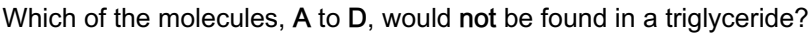
- 5 Which of the options, **A** to **D**, explains why viruses are not destroyed by antibiotics?

- A Viruses do not have DNA.
- B Viruses do not have nuclei.
- C Viruses do not have plasmids.
- D Viruses do not have cell walls.

Your answer

[1]

- A**



Your answer

[1]

7 Fig. 3.2 is a photomicrograph of the lower surface of a leaf showing stomata as viewed using a light microscope.

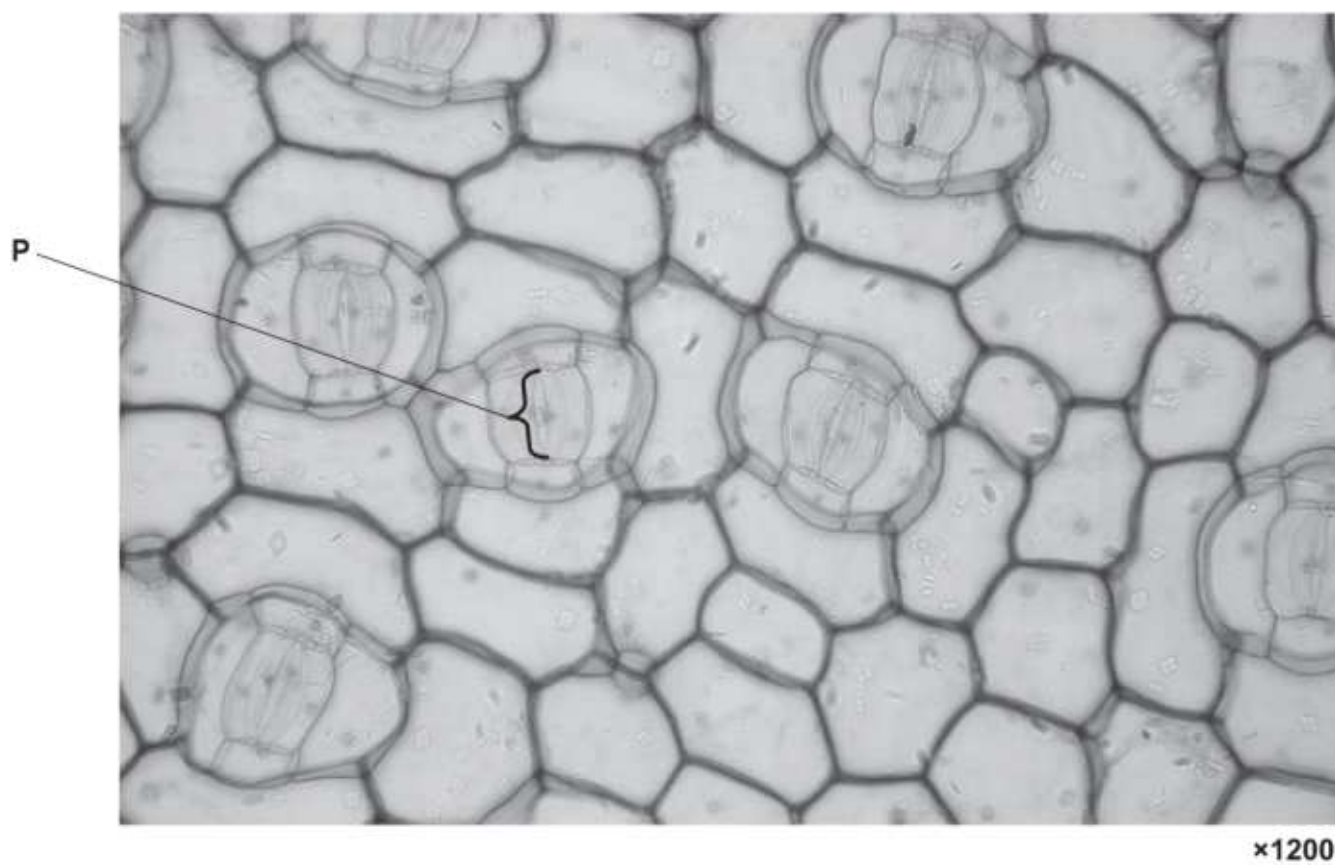


Fig. 3.2

Calculate the actual length of the stoma labelled P on Fig. 3.2.

Actual length = .....  $\mu\text{m}$  [2]

8(a)

Tuberculosis is a disease caused by the pathogen *Mycobacterium tuberculosis*.

*M. tuberculosis* is a prokaryotic cell which does not contain plasmids.

Describe **two** structural differences between an **erythrocyte** and a prokaryotic cell such as *M. tuberculosis*.

Difference 1

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Difference 2

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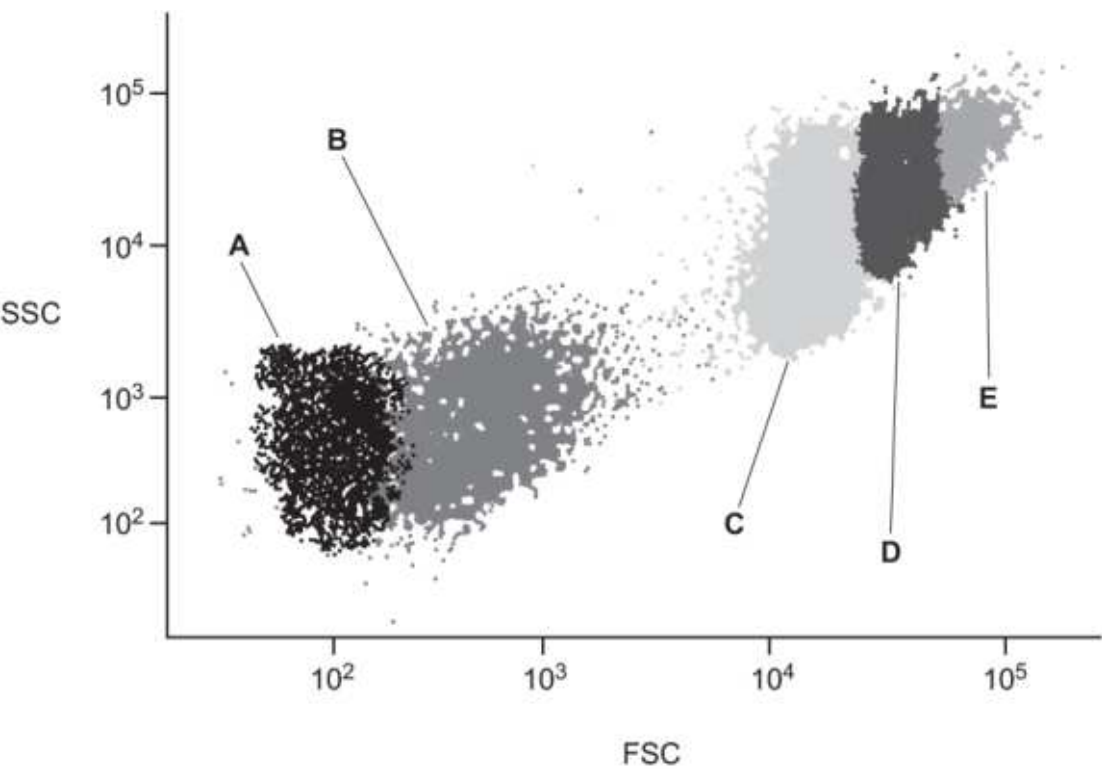
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[2]

(b) Flow cytometry is a technique used to detect and measure the physical characteristics of blood cells and platelets.

The graph shows the analysis of a blood sample from a patient suffering from septicaemia.

- FSC = Forward Scatter of light. The greater the FSC, the larger the cell.
- SSC = Side Scatter of light. The greater the SSC, the more granular the cell.
- Areas A–E contain many dots, each representing a single cell.



Using the graph, state the letter that corresponds to the type of cell, or cell fragment, found in the blood sample.

| Cell                   | Letter |
|------------------------|--------|
| Erythrocytes           |        |
| Lymphocytes            |        |
| Monocytes              | E      |
| <i>M. tuberculosis</i> |        |
| Platelets              |        |

[3]

9 Eosinophils are a type of white blood cell involved in producing allergic responses during an asthma attack.

A scientist wanted to calculate the diameter of the eosinophils from a blood sample using a microscope.

Describe how the scientist could use a microscope to work out the diameter of eosinophils **and** gain accurate and reproducible results.

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- 10 Please refer to the Insert H422-03 November 2020. Fig. 4.1 is a light micrograph of a transverse section through a mammalian spinal cord.

Fig. 4.2 shows a light micrograph and Fig. 4.3 shows a scanning electron micrograph of nerve cells in the human brain.

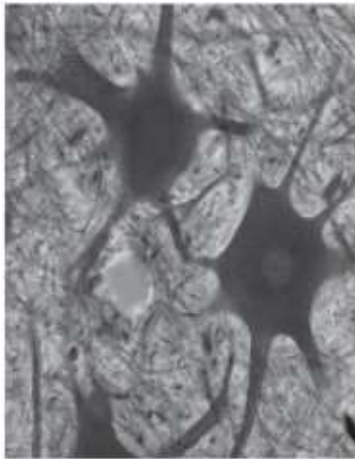


Fig. 4.2

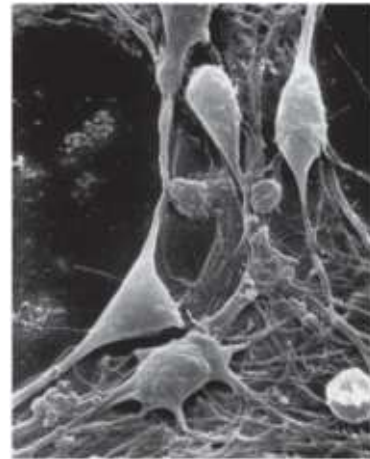


Fig. 4.3

The images in Fig. 4.2 and Fig. 4.3 were taken from the same tissue and were produced at the same magnification.

Explain why the image in Fig. 4.3 shows greater detail compared with the image in Fig. 4.2.

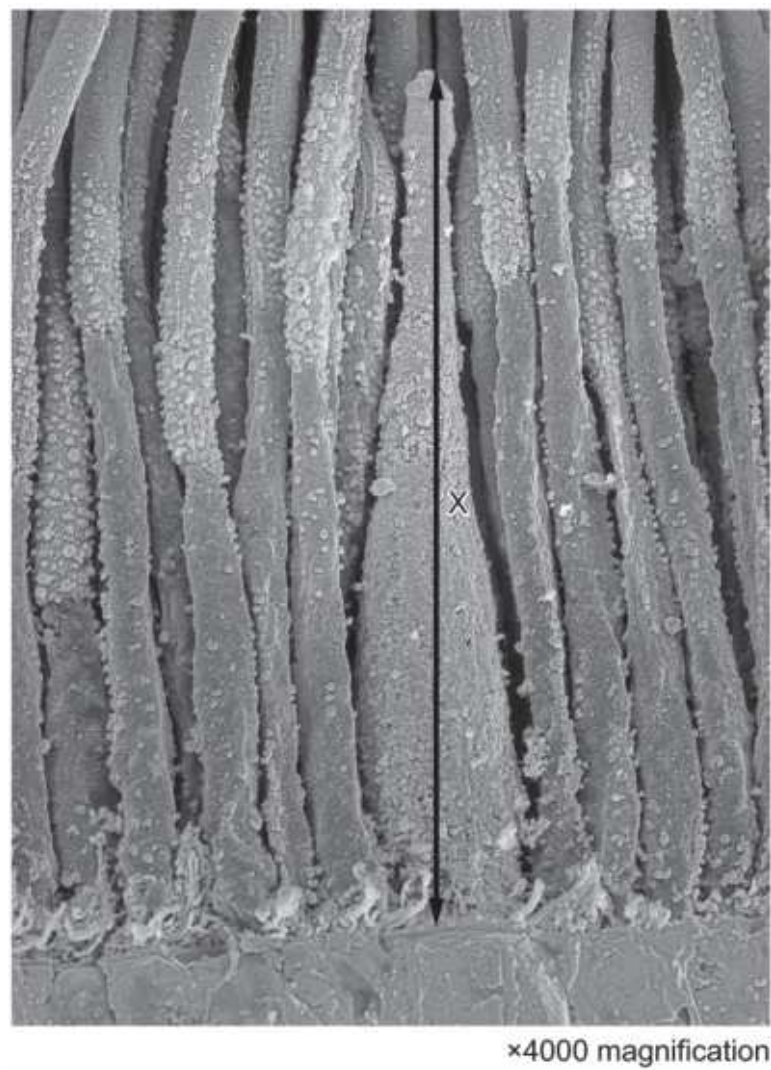


Fig. 3.1

- (i) Calculate the actual height of the cone cell using line X.

Give your answer to 3 significant figures.

height of cone cell = .....  $\mu\text{m}$  [2]

(ii) Name the photosensitive pigment found in cone cells.

[1]

(iii) Give **two disadvantages** of the technique used to prepare the image in Fig. 3.1.

[2]

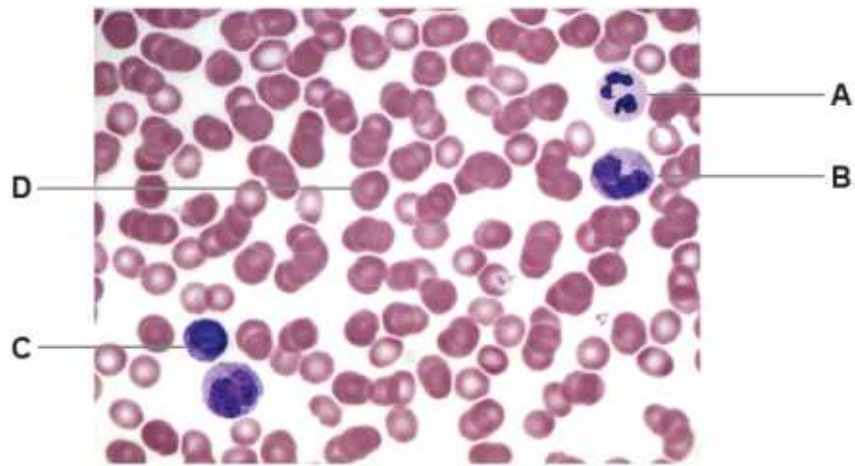


Fig. 4

(i) Identify the three different types of leucocytes labelled A, B and C on Fig. 4.

A .....  
B .....  
C .....

[3]

(ii) State one structural feature of the cell labelled D in Fig. 4 that is different to other eukaryotic cells.

..... [1]

- (b) A sample of blood was diluted by taking  $0.001\text{ cm}^3$  of blood and making up to a total volume of  $1.5\text{ cm}^3$ .

The number of erythrocytes in the diluted sample was counted using a haemocytometer of depth  $0.1\text{ mm}$ .

There were 15 cells in a  $0.2\text{ mm}$  square.

- (i) Suggest **one** thing you would do when diluting the blood sample to ensure that the number of erythrocytes is calculated accurately.

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----- [1]

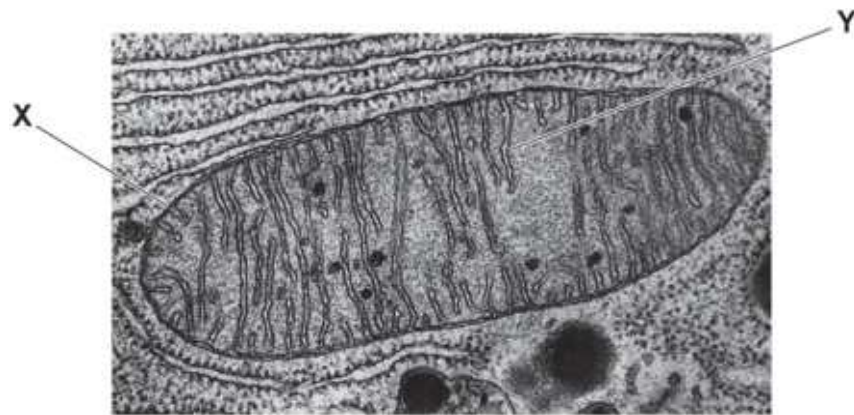
- (ii) Calculate the total concentration of erythrocytes in the undiluted blood sample.

Give your answer as cells  $\text{cm}^{-3}$  in standard form.

concentration = .....cells  $\text{cm}^{-3}$  [4]

13 Mitochondria are small eukaryotic organelles that generate ATP for cellular activity.

The image below is an electron micrograph of a mitochondrion. Two structures are labelled X and Y.



Identify structures X and Y in the micrograph and explain how they adapt the mitochondrion to its function.

structure X .....

structure Y .....

explanation .....

.....  
.....

[3]

14 Which of the cell organelles, A to D, is most likely to increase the mass of a newly-translated protein?

- A Golgi apparatus
- B lysosome
- C nucleus
- D smooth endoplasmic reticulum

Your answer

[1]

15 To which of the substances, **A** to **D**, is the plasma membrane of an axon **least** permeable?

- A ATP
- B glucose
- C  $K^+$
- D  $Na^+$

Your answer

[1]

16 Which of the molecules, **A** to **D**, reduces the permeability of the plasma membrane to most substances?

- A carbohydrate
- B cholesterol
- C glycoprotein
- D protein

Your answer

[1]

17 Osmosis can be investigated on a single-cell scale with microscopy by measuring cell size.

Fig. 33 shows the view down a microscope fitted with a stage micrometer.

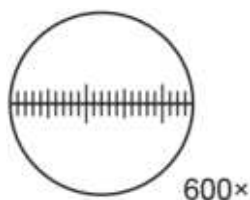


Fig. 33

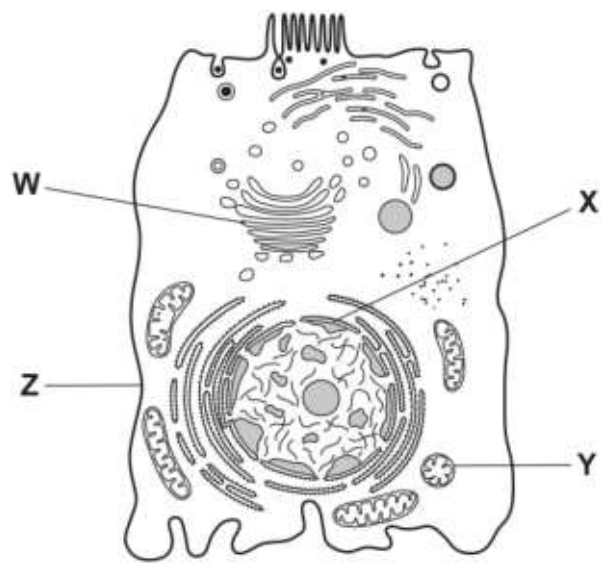
Calculate the **area** of the field of view of the microscope set up as shown in Fig. 33.

Give your answer to the nearest whole number.

area = .....  $\mu m^2$  [2]

18 The diagram below shows the ultrastructure of an animal cell.

Four structures are labelled W to Z.



Which of the rows in the table below correctly identifies the structures that can (✓) and can not (x) be visualised under a light microscope?

| Row | W | X | Y | Z |
|-----|---|---|---|---|
| A   | x | x | x | ✓ |
| B   | x | ✓ | x | ✓ |
| C   | ✓ | ✓ | ✓ | x |
| D   | ✓ | x | x | ✓ |

Your answer

[1]

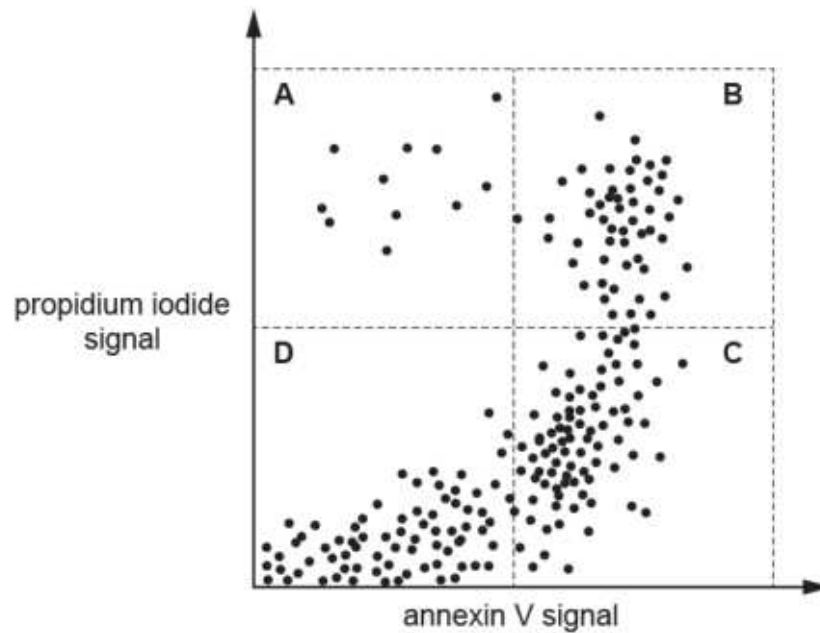
19 Cells undergoing apoptosis can be distinguished from living cells by staining with two reagents:

- annexin V, which binds to phosphatidylserine
- propidium iodide, which binds to DNA.

After staining, a flow cytometer is used to measure the fluorescent signal from each cell.

Neither reagent can diffuse across biological membranes.

The graph below shows the result of a flow cytometry experiment in a population of cells using annexin V and propidium iodide. Four regions are labelled A to D.



Which of the regions from the graph, A to D, identifies cells in late apoptosis?

Your answer

[1]

20 Which of the biological processes, **A** to **D**, is an example of facilitated diffusion?

- A** influx of sodium ions into a neurone during an action potential
- B** loading of sucrose into a companion cell
- C** movement of protons into the mitochondrial intermembrane space
- D** movement of acetylcholine across the synaptic cleft

Your answer

[1]

21 Which of the options, **A** to **D**, is the location of ATP synthase in a chloroplast?

- A** inner membrane
- B** stroma
- C** thylakoid lumen
- D** thylakoid membrane

Your answer

[1]

22 Which of the options, **A** to **D**, is a type of reaction involved in the breakdown of a phospholipid?

- A** condensation
- B** dehydrogenation
- C** hydrolysis
- D** phosphorylation

Your answer

[1]

23 Which of the options, **A** to **D**, is a property of the phosphate group in phospholipids?

- A** hydrophilic
- B** hydrophobic
- C** non-polar
- D** saturated

Your answer

[1]

24 The root shown in the photomicrograph in Fig. 4 in Insert H422-03 June 19 is from a plant classified in the group known as Eukaryota.

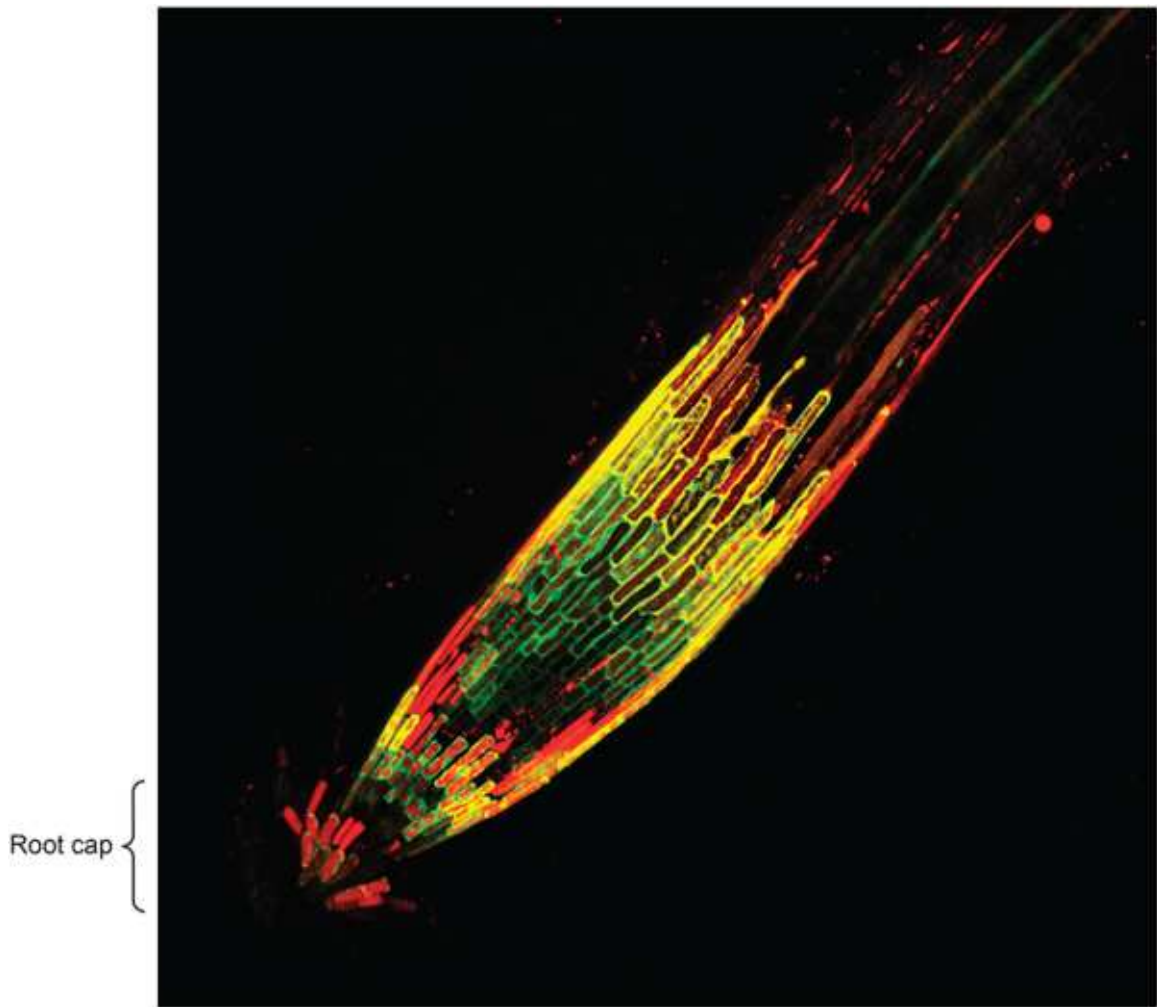


Fig. 4

(i) To which taxonomic rank does Eukaryota belong?

-----[1]

(ii) The group Eukaryota includes both animal and plant species. There are similarities and differences in the ultrastructure of cells found in animal and plant species.

Use a tick (✓) or a cross (✗) to complete the table below to compare the features of these cells.

| Feature         | Present in animal cells | Present in plant cells |
|-----------------|-------------------------|------------------------|
| Mitochondria    | ✓                       | ✓                      |
| Golgi apparatus |                         |                        |

|           |  |  |
|-----------|--|--|
| Tonoplast |  |  |
| Ribosomes |  |  |
| Cell wall |  |  |

[4]

QP H422/02, June 19.

the risk of developing multiple myeloma.

myeloma.

[4]

(b) Some genetic diseases, such as sickle cell anaemia, are caused by single mutations.

Explain how a single gene mutation causes sickle cell anaemia.

[3]

- (c) The goal of the researchers at the International Myeloma Foundation is to identify people who develop multiple myeloma after having monoclonal gammopathy of undetermined significance (MGUS).

Evaluate the advantages and disadvantages of this approach compared with pedigree analysis.

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[4]

(d) In MGUS, B cells produce an abnormal polypeptide called M protein.

Production of M protein involves the processes of transcription and translation.

Complete the table by putting a tick (✓) in the appropriate box to indicate whether the feature is involved in transcription, translation, both or neither.

| Feature                       | Transcription only | Translation only | Both | Neither |
|-------------------------------|--------------------|------------------|------|---------|
| C pairs with G                |                    |                  |      |         |
| A pairs with T                |                    |                  |      |         |
| Phosphodiester bonds are made |                    |                  |      |         |
| Peptide bonds are made        |                    |                  |      |         |

[4]

26 Scientists are producing a vaccine against a disease-causing bacterium.

The table below shows the locations and mutation rates of four proteins, A to D, in the bacterium.

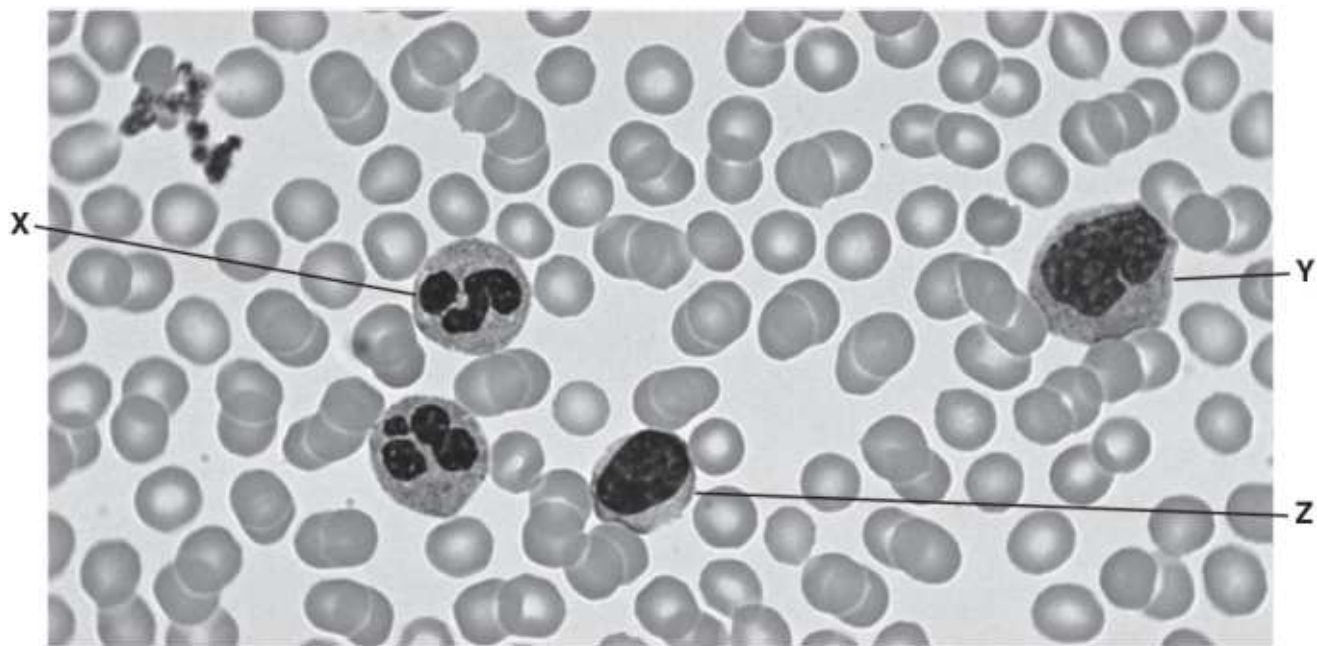
|   | Protein location | Mutation rate (per amino acid) |
|---|------------------|--------------------------------|
| A | cell membrane    | $2.1 \times 10^{-4}$           |
| B | cell wall        | $4.3 \times 10^{-4}$           |
| C | pilus            | $7.7 \times 10^{-4}$           |
| D | ribosome         | $1.8 \times 10^{-4}$           |

Which of the proteins, A to D, is most suitable as the basis of a vaccine against this bacterium?

Your answer

[1]

27 The image below is a photomicrograph of a human blood smear. Three cells are labelled X, Y and Z.



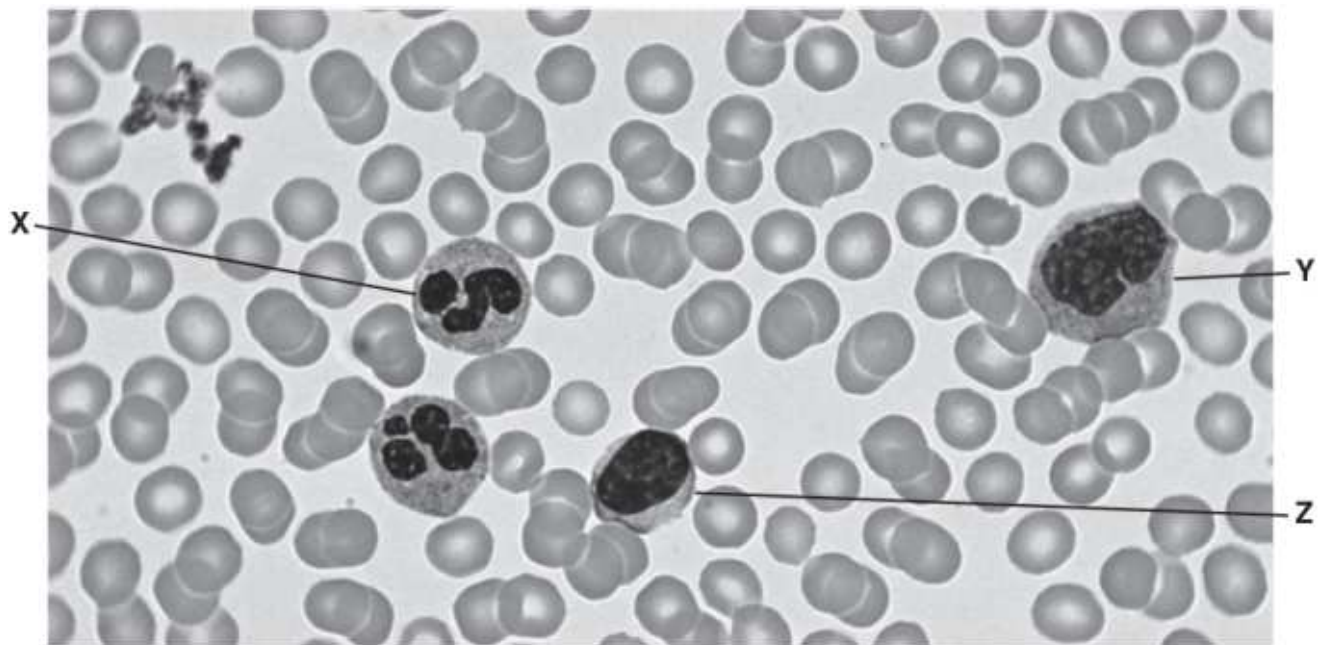
Which of the rows, A to D, in the table below correctly identifies cells X, Y and Z?

|   | Monocyte | Neutrophil | Lymphocyte |
|---|----------|------------|------------|
| A | X        | Y          | Z          |
| B | Z        | X          | Y          |
| C | Y        | X          | Z          |
| D | Y        | Z          | X          |

Your answer

[1]

28 The image below is a photomicrograph of a human blood smear. Three cells are labelled X, Y and Z.



The diameter of cell X in the image is 15.5 mm and its actual diameter is 12.4  $\mu\text{m}$ .

Which of the options, A to D, is the magnification of the image?

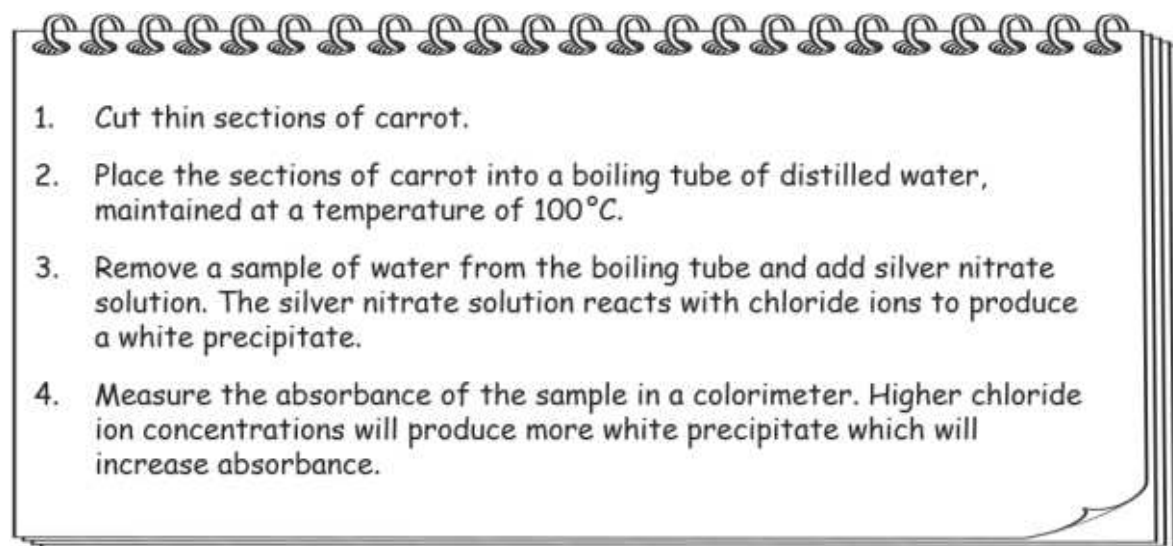
- A  $\times 125$
- B  $\times 800$
- C  $\times 1250$
- D  $\times 8000$

Your answer

[1]

29(a) A student investigated the effect of temperature on the rate of diffusion of chloride ions from carrot cells.

This is the student's method for the preliminary experiment.



(i) All equipment and sections of carrot were washed with distilled water before use.

Explain why.

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----- [1]

(ii) The absorbance value obtained in step 4 was used as a reference value for further tests. This absorbance value was considered to represent the highest chloride ion concentration that could be measured in the boiling tube solution.

Explain why.

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----- [1]

Using the sample produced from step 3 in the preliminary experiment, the student carried out a serial dilution that produced the results in Table 2.1.

| Concentration of chloride ions (a.u.) | Absorbance |
|---------------------------------------|------------|
| 1000.0                                | 0.080      |
| 100.0                                 | 0.040      |
| 10.0                                  | 0.020      |
| 1.0                                   | 0.018      |
| 0.1                                   | 0.005      |

Table 2.1

(b) Look at the trend in the results in Table 2.1.

Identify the anomalous result in this trend and give its expected absorbance value.

Anomalous result .....

Expected absorbance .....

[1]

- Describe **three** variables that the student would need to control when planning this investigation. Include reasons why each of your chosen variables must be controlled.

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[6]

(d) Fig. 2.1 shows the results of the student's experiment carried out at different temperatures.

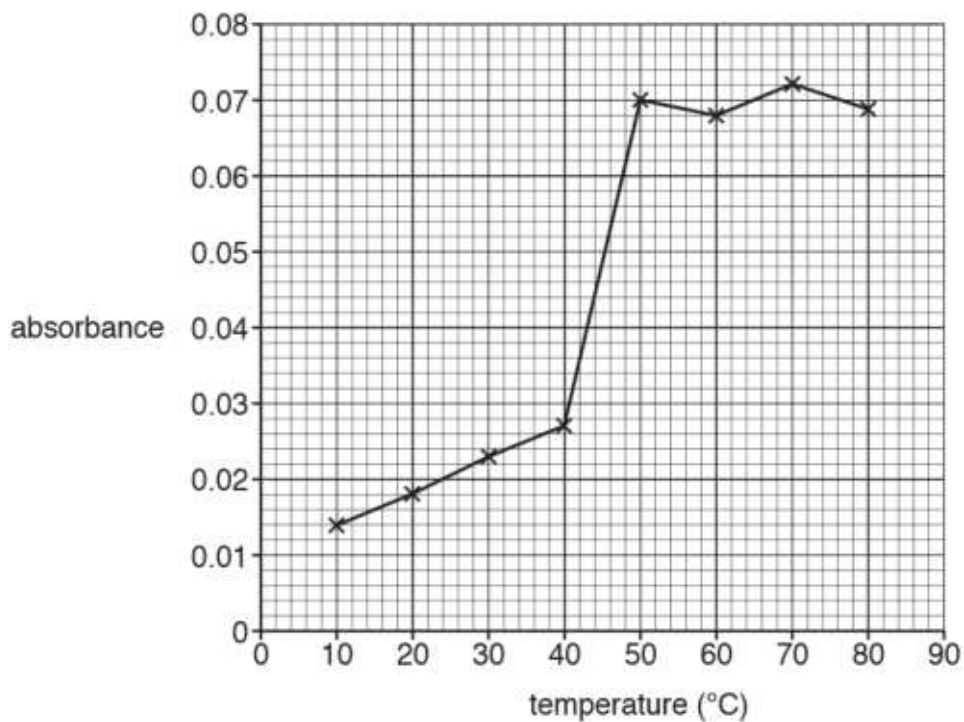


Fig. 2.1

(i) Use Fig. 2.1 to calculate the increase in absorbance between 10 °C and 40 °C.

Answer = ..... [1]

(ii) Suggest why the absorbance changed between 10 °C and 40 °C.

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----- [2]

Fig. 2.2 shows absorbance measured at different concentrations of chloride ions.

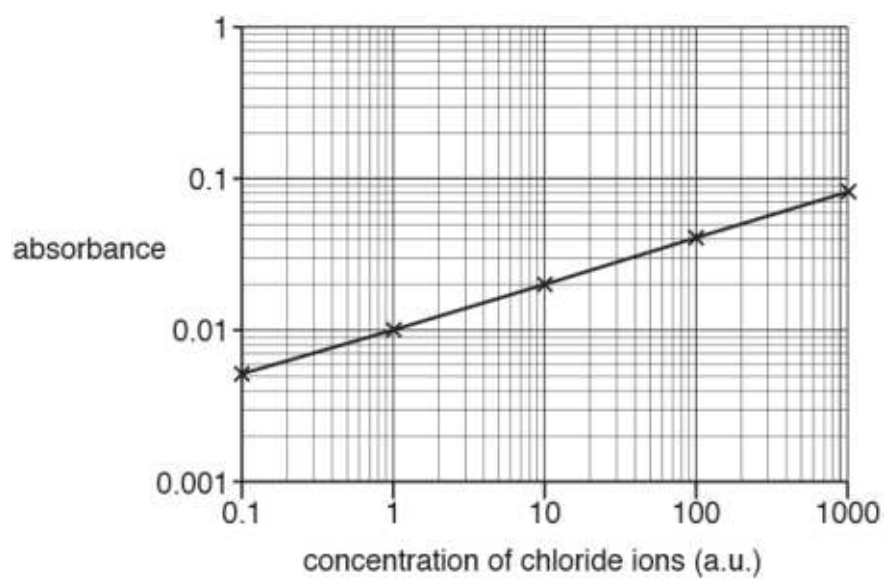


Fig. 2.2

- (iii) Using the graph in Fig. 2.1 and the graph in Fig. 2.2, estimate the chloride ion concentration at a temperature of 45 °C.

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----- [2]

30(a)

Fig. 7.1 shows the structures visible in a light micrograph of a generalised animal cell.

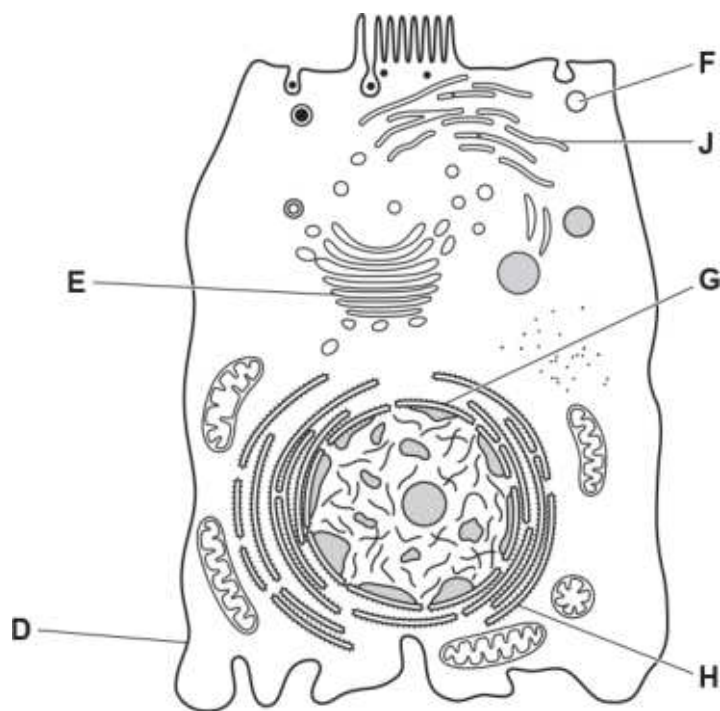


Fig. 7.1

(i) Identify the structures labelled D to H in Fig. 7.1.

D

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E

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F

-----

G

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H

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[5]

(ii) Describe **two** functions of structure **H** and **one** function of structure **J**.

H

H

J

[3]

(b) The route taken by proteins that are secreted from the cell has been worked out by many different experiments. One series of experiments involved the following steps:

- A virus was modified so that one of its proteins (VSVG) was tagged with green fluorescent protein (GFP).
- Cells were infected with the modified virus.
- The virus produced the tagged protein, VSVG-GFP, using the cells' organelles, but only when the temperature was reduced from 40 °C to 32 °C.
- This allowed the path through the cell taken by the VSVG-GFP to be followed by fluorescence microscopy from the time the temperature was reduced.

Fig. 7.2 shows the results of one experiment where the distribution of fluorescence within individual cells was followed for up to 600 minutes.

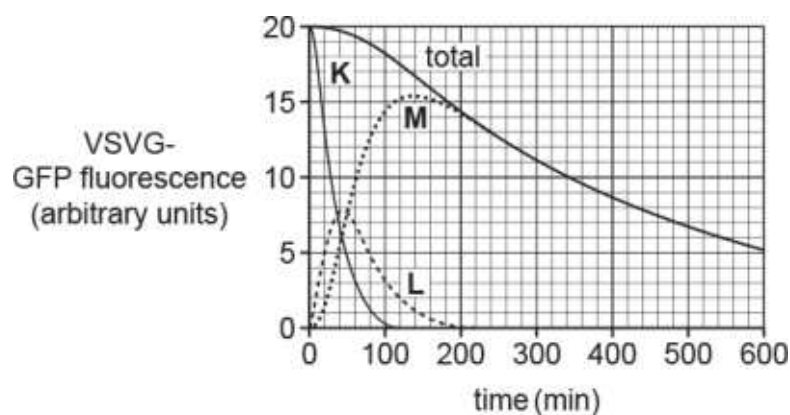


Fig. 7.2

- (i) Using Fig. 7.2 and your knowledge of the synthesis and secretion of proteins, identify the organelles corresponding to curves K, L and M on Fig. 7.2.

Give reasons for your answers.

K

reason

L

reason

M

reason

[6]

- (ii) Using Fig. 7.2, estimate the time taken for secretion of VSVG-GFP to reach a maximum.

[1]

(c) Vinblastine is a drug used in the treatment of cancer. It inhibits the assembly of microtubules.

Another experiment similar to that described in part (b) was carried out, but the cells were treated with vinblastine before the temperature was reduced from 40° C to 32° C.

When VSVG-GFP fluorescence was followed through the treated cells, only curve M disappeared.

Suggest why.

[2]

31 This question is based on the Advance Notice article **TURBOCHARGED PHOTOSYNTHESIS?**, which is an insert.

Use Fig. 1 on the insert to help you answer the following questions.

(i) State the precise location of the photosystems involved in the light-dependent reaction of photosynthesis.

-----[1]

(ii) Describe how the structures containing the photosystems are arranged differently in plant cells and cyanobacteria.

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-----  
-----[2]

(iii) State the precise location of Rubisco in:

unmodified plant cells

-----  
  
cyanobacteria  
-----[2]

(iv) Explain how cyanobacteria are able to almost eliminate oxygen (O<sub>2</sub>) fixation by Rubisco.

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-----[3]

Dialysis is a common treatment for kidney failure.

Fig. 37.1 shows a haemodialysis machine at the beginning of a dialysis session.

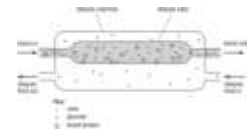


Fig. 37.1

(i) With reference to Fig. 37.1, describe how the composition of the blood changes over time.

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----- [2]

(ii) Explain the changes described in (i).

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----- [3]

A widely-publicised training programme claimed to improve aerobic fitness for various exercises after three months. To evaluate this claim, an investigation was conducted:

- 20 volunteers completed a series of test exercises at increasing intensities
- recovery time was recorded after each exercise
- the volunteers followed the training programme for three months
- after three months, the test exercises and measurements were repeated.

The results of the investigation are shown in Fig. 36.

The columns represent the mean recovery times before and after the training. The error bars represent the standard deviation above and below the mean.

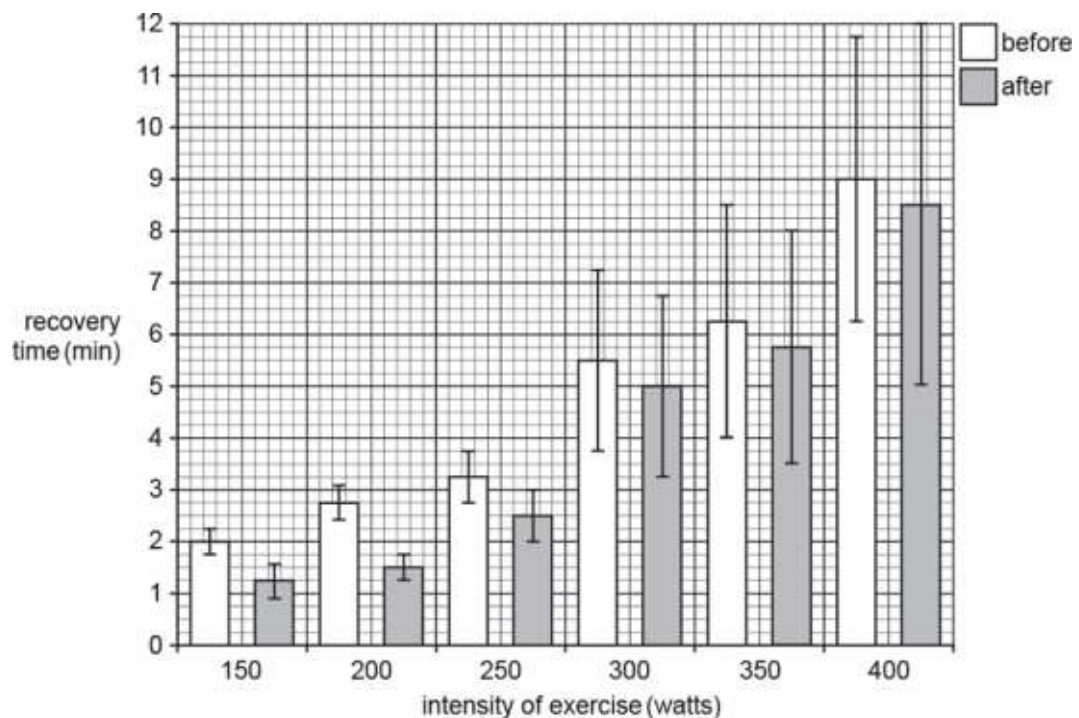


Fig. 36

(i) Name **one** statistical test that could be used to analyse the data in Fig. 36. Justify your choice.

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----- [2]

(ii) Comment on how well this training programme improved fitness.

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----- [2]

(iii) Promoters of the training programme claimed that it was good for training **weightlifters**. Comment on the **validity** of this statement.

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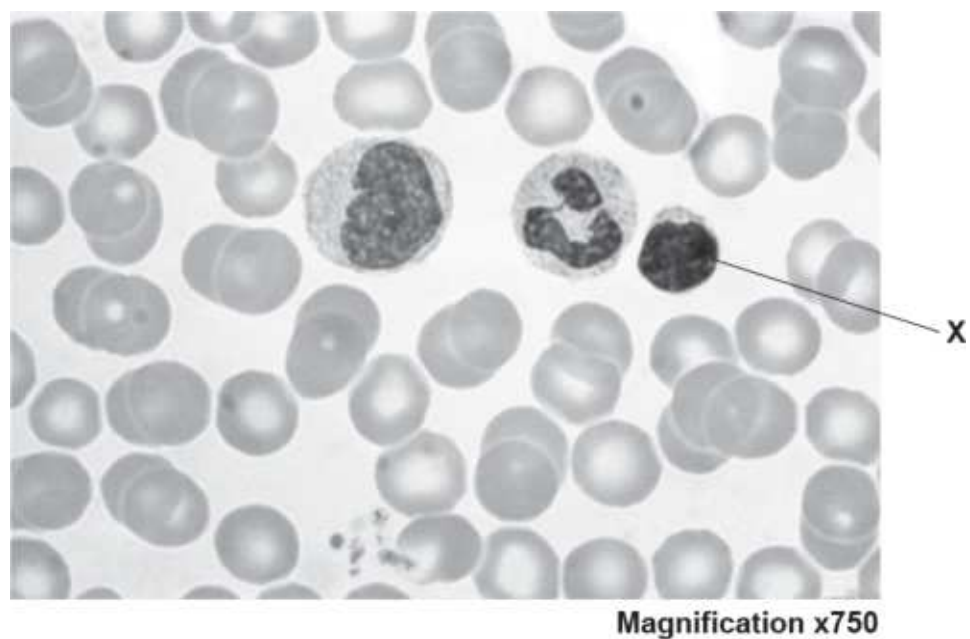
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----- [2]

34 A magnified section of a human blood smear is shown in the light micrograph below.

The diameter of cell X in this image is 11 mm.



Which of the options, A to D, is the actual diameter of cell X?

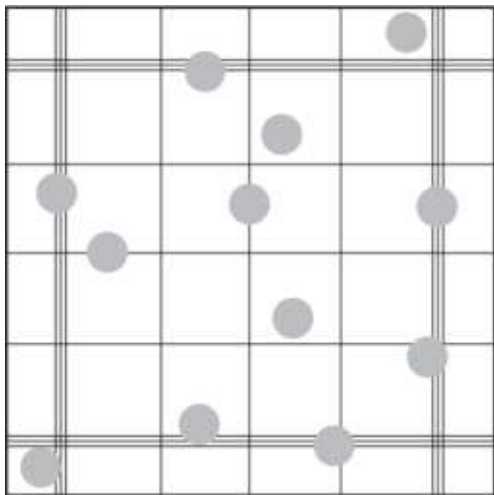
- A  $1.5 \times 10^{-5}$  m
- B  $1.5 \times 10^{-6}$  m
- C  $6.8 \times 10^{-5}$  m
- D  $6.8 \times 10^{-6}$  m

Your answer

[1]

35 The diagram below represents a microscopic view of a haemocytometer.

A triple-ruled square is further divided into 16 smaller squares.



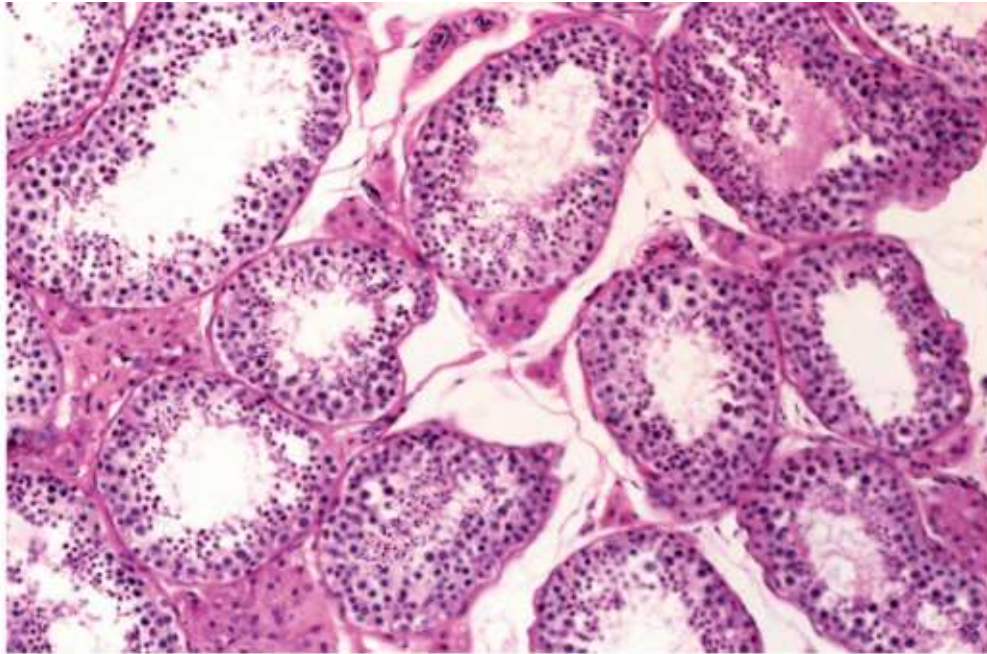
Which of the options, A to D, is the correct cell count for the triple-ruled square?

- A 4
- B 6
- C 8
- D 10

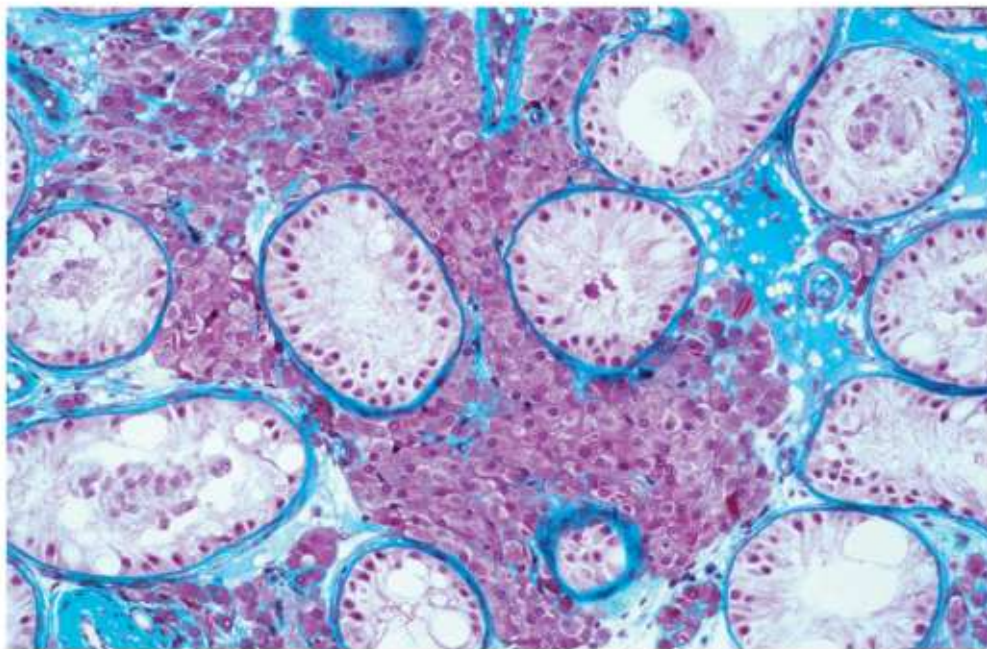
Your answer

[1]

- 36 The photomicrographs in Fig. 2.3 were prepared for viewing under a microscope using a differential staining technique.



**Seminiferous tubules from a male with a normal sperm count**



**Seminiferous tubules from a male where no spermatogenesis is occurring and no sperm are present**

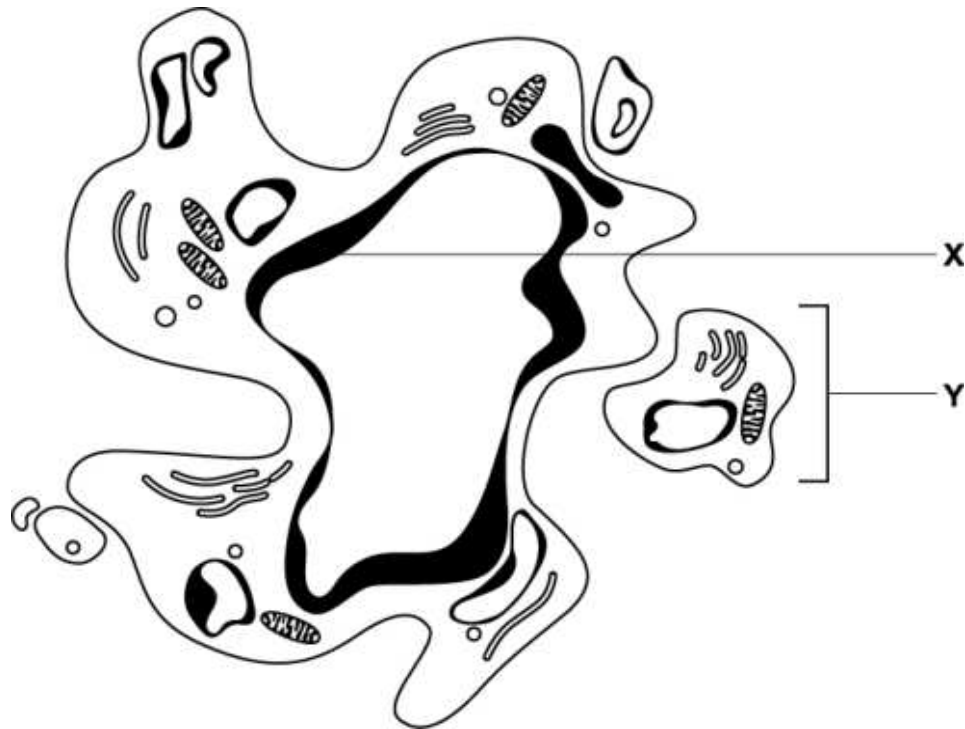
**Fig. 2.3**

Explain why this technique has been used.

[1]

37 The diagram below shows a cell in a late stage of apoptosis.

Two features are labelled X and Y.



Which of the following statements is/are correct?

- 1 X is a complex of DNA and protein.
- 2 Phosphatidylserine is present on the surface of Y.
- 3 The contents of Y are digested in a lysosome.

- 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]

38 In microscopy, images may be obtained at different depths within a specimen.

The images are then stacked together to provide a three-dimensional image.

Which of the options, **A** to **D**, is the type of microscope that obtains images in this way?

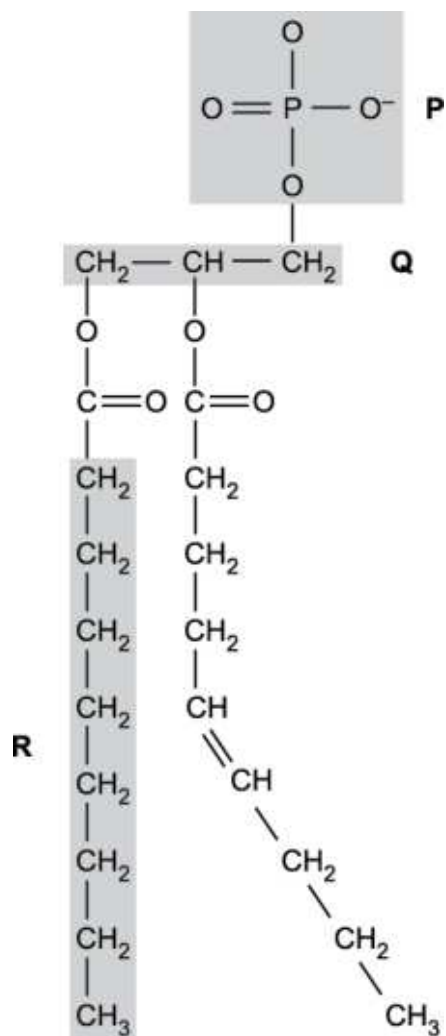
- A** confocal laser scanning microscope
- B** light microscope
- C** scanning electron microscope
- D** transmission electron microscope

Your answer

[1]

39 A phospholipid molecule is shown below.

Three features of the molecule are shown in grey and labelled **P** to **R**.



Which of the following statements is/are correct?

- 1 P is located on both surfaces of a phospholipid bilayer.
- 2 Q and R are joined by an ester bond.
- 3 R is an unsaturated fatty acid.

- 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]

40 A population of *Escherichia coli* was grown in the laboratory from a single cell.

In a laboratory, *E. coli* divides once every 15 minutes.

Which of the options, A to D, is the theoretical size of the *E. coli* population after 2 hours?

- A 8 cells
- B 16 cells
- C 225 cells
- D 256 cells

Your answer

[1]

41 Which of the rows, A to D, from the table below correctly identifies features that are present (✓) and absent (x) in a prokaryotic cell?

|   | Endoplasmic reticulum | Mitochondrion | Ribosome |
|---|-----------------------|---------------|----------|
| A | ✓                     | x             | x        |
| B | x                     | x             | ✓        |
| C | ✓                     | ✓             | x        |
| D | x                     | ✓             | ✓        |

Your answer

[1]

42 Oestrogen and progesterone are lipid-soluble hormones derived from cholesterol.

Which of the options, **A** to **D**, is the transport mechanism by which these hormones enter a cell?

- A** active transport
- B** endocytosis
- C** facilitated diffusion
- D** passive diffusion

Your answer

[1]

Catalase is found in peroxisomes in eukaryotic cells. Peroxisomes do not contain genetic material, but they replicate to form new peroxisomes. The enzymes in peroxisomes are synthesised on free ribosomes and transported into peroxisomes as polypeptide chains.

(i) Name one plant vascular tissue that will **not** contain peroxisomes. Justify your answer.

tissue \_\_\_\_\_

justification \_\_\_\_\_

\_\_\_\_\_

[1]

(ii) Compare the formation of peroxisomes, as described above, with the formation of lysosomes.

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

[2]

- 44 In the menstrual cycle, the activity of the reproductive organs is controlled by hormones. Some of these hormones, such as oestrogen, are steroid hormones. Others, such as follicle stimulating hormone (FSH) and luteinising hormone (LH), are glycoproteins.

Oestrogen, FSH and LH molecules carry out their function by binding to receptors.

- Oestrogen receptors are found in the cytoplasm of target cells.
- FSH and LH receptors are found on the cell surface membranes of target cells.

- (i) Suggest why receptors for FSH and LH are located on the cell surface membranes but the receptors for oestrogen are located in the cytoplasm.

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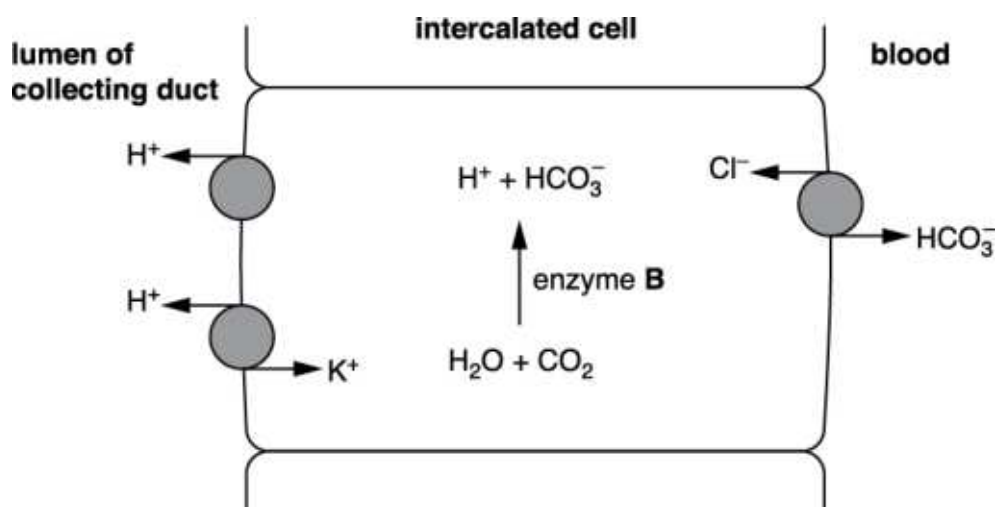
----- [2]

- (ii) Name the organ responsible for the secretion of FSH and LH.

----- [1]

- 45 Intercalated cells are specialised cells located in the walls of collecting ducts in the kidney. One function of intercalated cells is the regulation of the pH of blood plasma.

This figure is a diagram of an intercalated cell showing some of the mechanisms involved in the regulation of pH by the kidney.



- (i) Name the enzyme labelled **B** in the figure that catalyses the reaction shown.

-----[1]

- (ii) Using the information in the figure, suggest why intercalated cells contain large numbers of mitochondria.

-----[1]

- (iii) Identify **one other** organ system in the body that is responsible for controlling the pH of blood.

-----[1]

46 Anabolic steroids, such as testosterone, are steroid hormones. Steroid hormones have a chemical structure similar to that of cholesterol.

Anabolic steroids are transported in the blood plasma.

Suggest how anabolic steroid molecules in the blood plasma reach and enter the nucleus of a cell so that they can interact with the DNA.

[2]

Hormones control the production of mucus by cells of the cervix.

- Describe how the protein molecules that form mucins are modified and secreted from mucus-secreting cells.



[5]

(b) Prior to ovulation cervical mucus is thin in consistency as it has an increased ion content.

(i) Suggest how ions leave the cells of the cervix.

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----- [2]

(ii) Explain how an increased ion content results in mucus of a thinner consistency.

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----- [2]

(iii) Cervical mucus can affect the movement of sperm.

Suggest the advantage of cervical mucus becoming thinner in consistency after ovulation.

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----- [1]

- Antibiotics will be used to treat the horse, but the vet must first find out which species of bacterium is causing the pneumonia.
- A sample of fluid containing the bacteria is taken from the horse and sent to a laboratory for analysis in a small lidded bottle.

You should name any equipment needed and justify your choice of equipment.

[9]

- (b) The vet discovers that two different species of bacteria are present which may be causing the pneumonia.

Once suitably prepared and stained using the Gram staining technique, a sample of the bacteria are observed using the high power lens of a light microscope.

In one of the bacterial species, the cells are seen to be stained red / pink.

- (i) Why must a high power lens be used to view the bacteria?

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----- [1]

- (ii) What does the red / pink colour of the stained bacteria suggest about the structure of the cells?

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----- [1]

- (c) Fig. 2.1 is a photomicrograph of the bacterium, *Klebsiella pneumoniae*, the probable cause of the pneumonia.

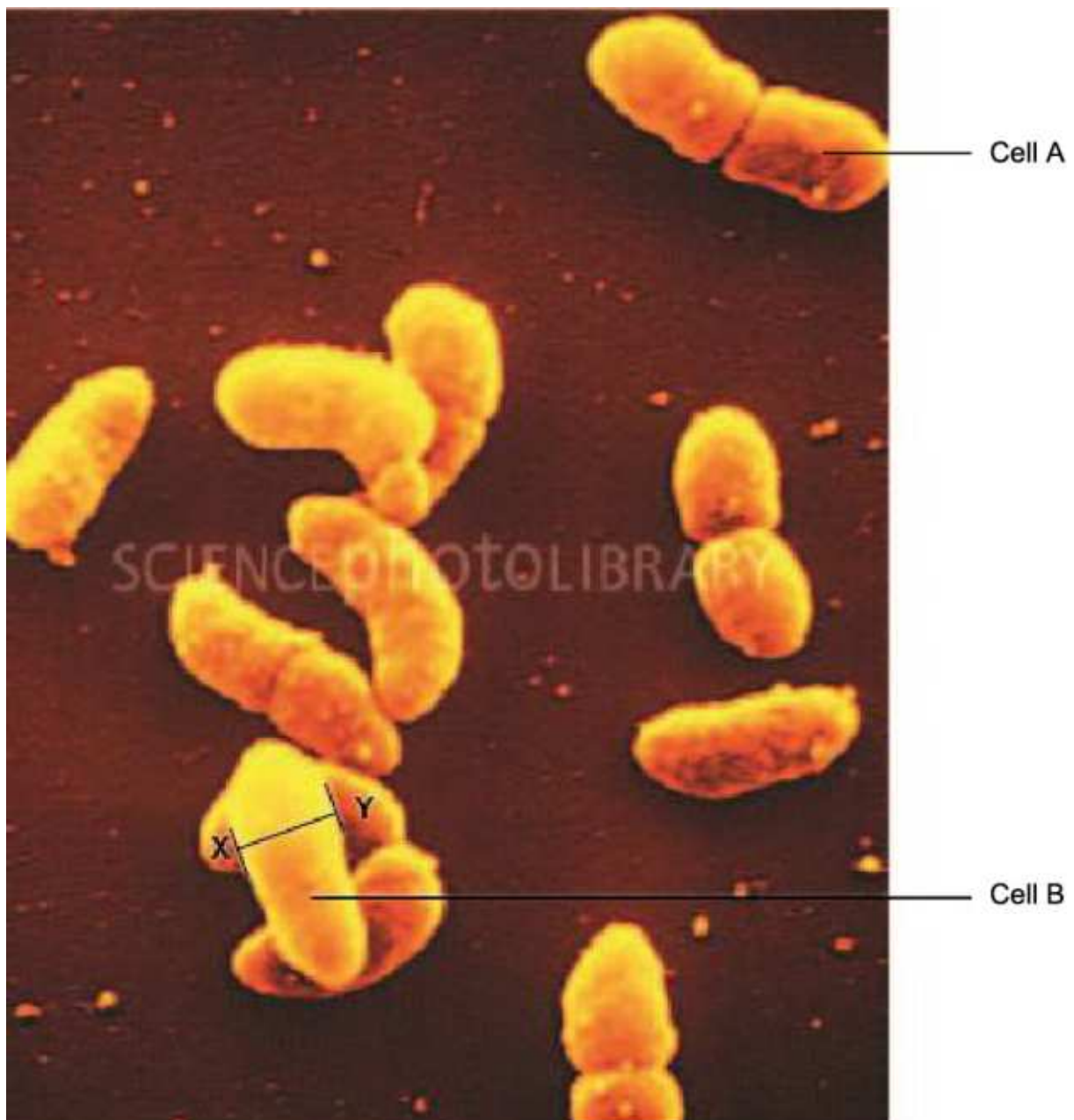


**Fig. 2.1**

- (i) The cell labelled A, in Fig. 2.1, is undergoing cell division by a process called binary fission.

Suggest why these bacterial cells do not divide by mitosis.

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[1]

- (ii) The cell labelled B, in Fig. 2.1, has a width of  $5\text{ }\mu\text{m}$  measured between X and Y.

Calculate the magnification of the photomicrograph.  
Show your working. Give your answer to **three** significant figures.

Answer X ..... [2]

Fig. 2.2 shows the results of a test carried out using the *Klebsiella pneumoniae* bacteria cultured from the horse. The bacterial culture was spread on an agar plate and discs containing antibiotics A to D were placed on the agar as shown. The plate was then incubated overnight.

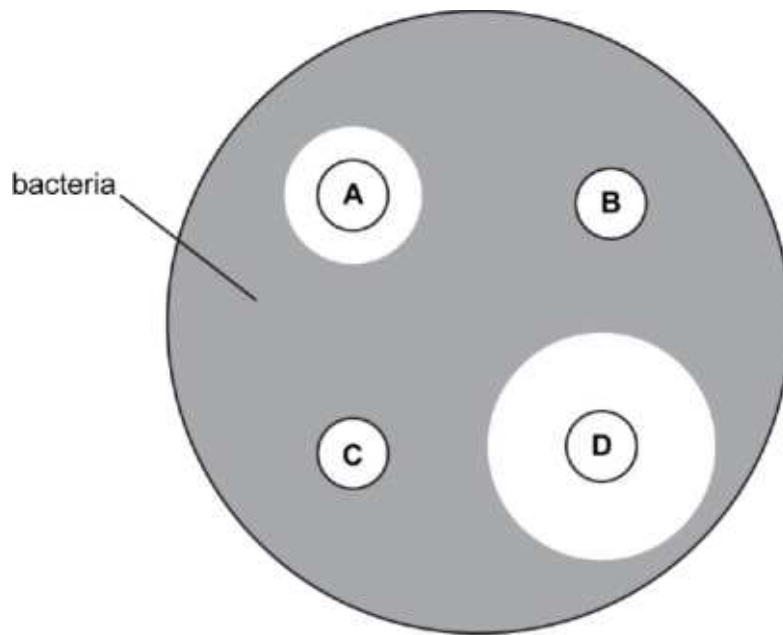


**Fig. 2.2**

Table 2.1 shows information about the 4 antibiotics used in the test.

| Antibiotic | Mode of Action                                                       | Notes                                                    |
|------------|----------------------------------------------------------------------|----------------------------------------------------------|
| A          | Inhibits the synthesis of protein by bacteria, leading to cell death | Family of over 20 antibiotics                            |
| B          | Inhibits bacterial cell wall synthesis                               | Most widely used antibiotics                             |
| C          | Inhibits bacterial cell wall synthesis                               | Resistance evolves rapidly                               |
| D          | Interferes with bacterial DNA replication and transcription          | Common 'drug of last resort' used with resistant strains |

**Table 2.1**

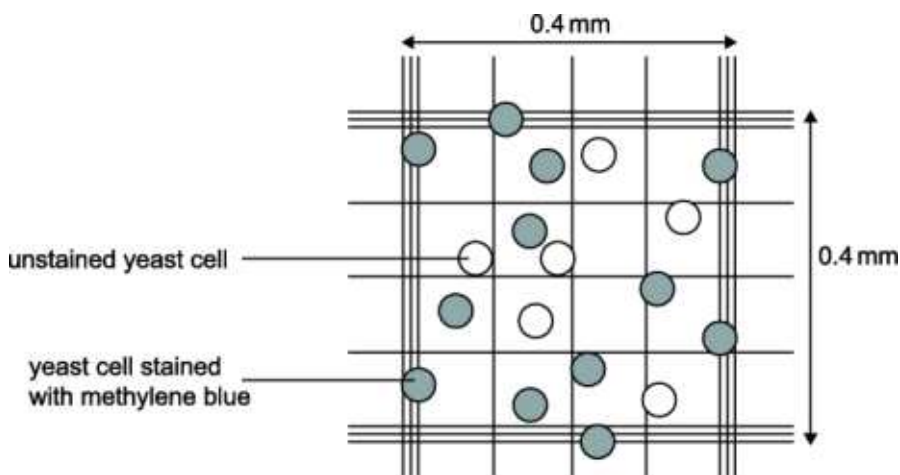
(d) The vet chooses to use antibiotic A. Using Fig 2.2 and Table 2.1, justify this decision.

[2]

49(a) A haemocytometer is used to estimate the population of live yeast in a sample of **undiluted** cider.

The stain methylene blue is added to the sample. Only live yeast cells will take up this stain.

Fig 1.1 shows the haemocytometer chamber containing the cider sample when viewed under a light microscope.



(i) The depth of the haemocytometer chamber, shown in Fig. 1.1, is 0.2 mm.

Calculate the number of live yeast cells in 1 cm<sup>3</sup> of the cider sample.

Show your working.

Answer ..... [3]

(ii) At the time it is bottled the optimum number of live yeast cells is between 250 000 to 500 000 cells per cm<sup>3</sup> of cider. This ensures the finished cider will contain just the right volume of CO<sub>2</sub>.

Using this information and your answer for part (i), would this cider be ready for bottling?

Justify your answer.

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-----[1]

(b) The farmer produces prize-winning cider which is bottled on the farm.

- To make the perfect cider, it must contain just the right volume of carbon dioxide (CO<sub>2</sub>) gas to make it fizzy.
- Live yeast remaining in the sealed bottles of cider produce this CO<sub>2</sub>.

Name the process by which live yeast cells make CO<sub>2</sub> in a sealed bottle.

-----[1]

(c) Flow cytometry is another technique that can be used for counting cells.

Compare the suitability of both techniques for counting the number of yeast cells in this population.

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-----[3]



**Fig. 4.2**

Using a light microscope and a suitably calibrated graticule it is possible to calculate the field of view for each eyepiece lens. Each of the smallest divisions on the graticule shown at this magnification is 0.1 mm.

- (i) For Fig. 4.2, calculate the diameter of the field of view.

diameter of field of view \_\_\_\_\_  $\mu\text{m}$  [2]

- (ii) For Fig. 4.2, estimate the number of cells shown in the field of view.

number of cells \_\_\_\_\_ [1]

- (iii) Using 3.14 as the value for  $\pi$ , calculate the density of the cells in the area shown in Fig. 4.2.

Show your working.

density of cells \_\_\_\_\_ [3]

- 51 Light-absorbing pigments are a feature of both photosynthetic prokaryotic and eukaryotic organisms. Both types of organism can utilise light energy to synthesise ATP.

Complete the following table comparing the features of **photosynthetic** prokaryotic and eukaryotic cells by inserting a tick (✓) in the appropriate column(s).

| Feature                                            | Photosynthetic prokaryotes | Photosynthetic eukaryotes |
|----------------------------------------------------|----------------------------|---------------------------|
| Light-absorbing pigments are found in chloroplasts |                            |                           |
| ATP synthase is present                            |                            |                           |
| Ribosomes are present                              |                            |                           |
| Circular DNA is present in cytoplasm               |                            |                           |
| Cellulose cell wall is present                     |                            |                           |

[3]

- 52 The sciatic nerve is one of the largest nerves in animals. It is a **mixed** nerve, which means that it contains different types of neurones.

Fig. 2.1 shows a transverse section through part of the sciatic nerve as seen with a light microscope.

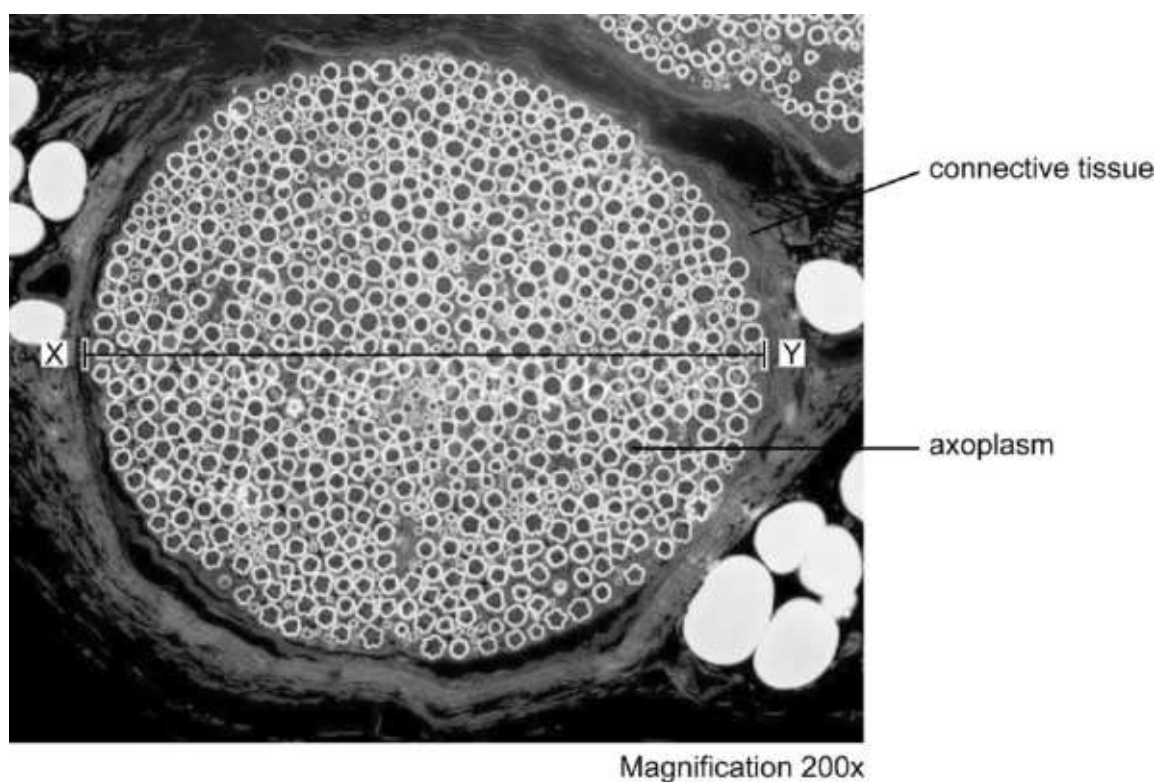


**Fig. 2.1**

- (i) Calculate the actual diameter of the sciatic nerve between X and Y as shown in Fig. 2.1.

Show your working. Give your answer to **two** significant figures.

Answer = \_\_\_\_\_ mm [2]

- (ii) Identify the white structure surrounding the axoplasm in Fig. 2.1.

----- [1]

53 In Extract 4 of the Advanced Notice article you were told that the immune response to tumour cells can be enhanced by improving the expression, processing, and presentation of TAAs (Tumour Associated Antigens).

(i) State the precise location of TAAs on tumour cells.

-----[1]

(ii) An anticancer vaccine would lead to the production of antibody molecules that recognise TAAs in the host.

Explain how the structure of the antibody molecule would enable it to recognise only TAAs.

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-----[2]

54 Like bacterial cells, palisade mesophyll cells have cell walls.

Complete **Table 4.1** to give **two** similarities and **two** differences between the structure of bacterial cells and palisade mesophyll cells **other than** the presence of a cell wall.

|              | Bacterial cells | Palisade mesophyll cells |
|--------------|-----------------|--------------------------|
| Differences  |                 |                          |
|              |                 |                          |
| Similarities |                 |                          |
|              |                 |                          |

Table 4.1

[4]

- 55 People travelling to high altitudes can develop altitude sickness because they produce more haemoglobin than normal, which results in thick, viscous blood.

Many people in Tibet live more than 4 000 m above sea level, but they do not develop altitude sickness.

Tibetan people have a variant of the EPAS1 gene that causes them to maintain relatively low haemoglobin levels in their blood.

- (i) Describe how the Tibetan variant of the EPAS1 gene has become common in Tibetan populations.

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[4]

- (ii) What type of adaptation is represented by the maintenance of low haemoglobin levels in Tibetan people?

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[1]

- (iii) State and explain **one** problem that a Tibetan person with the EPAS1 gene variant might experience.

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[2]

- (iv) Suggest a practical technique that could be used to compare the relative number of erythrocytes in a Tibetan population with that of another population **and** state what this technique would show.

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[2]

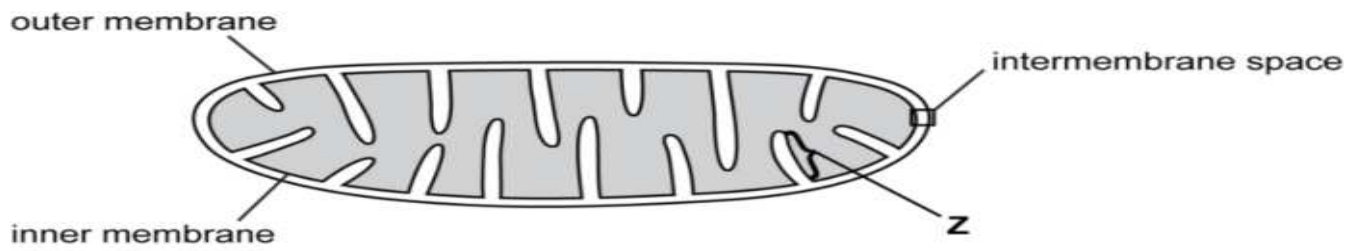


**Fig. 36.1**

- (i) Identify **Z** in Fig. 36.1 **and** outline its role in the function of the mitochondrion.

-----  
-----  
----- [2]

- (ii) State the importance of the intermembrane space for mitochondrial function.

-----  
----- [1]

- 57 Follicle-stimulating hormone (FSH), gonadotropin-releasing hormone (GnRH) and luteinising hormone (LH) have a role in the development and release of female gametes.

FSH is a globular protein. Fig. 35.1 shows another typical globular protein.

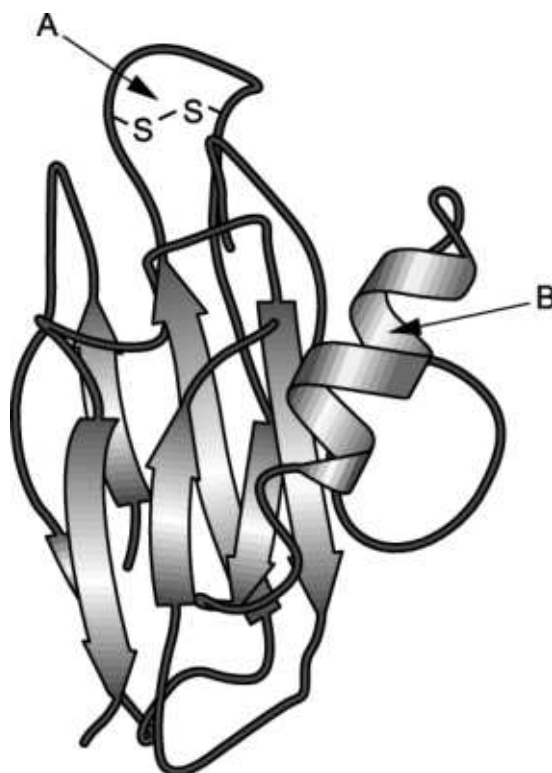


**Fig. 35.1**

- (i) Identify **and** describe the structural features labelled **A** and **B** in Fig. 35.1.

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[4]

- (ii) FSH is a glycoprotein.

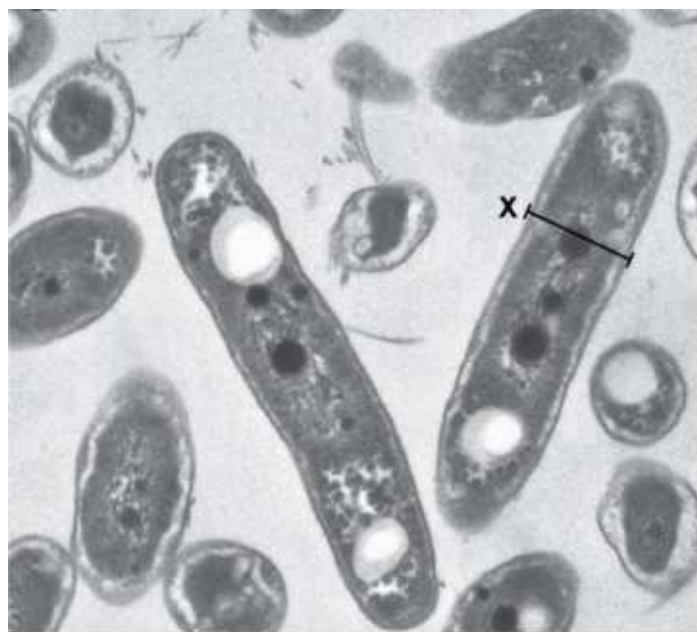
Describe how FSH is processed further and then secreted from a pituitary cell.

31

58 A population of nitrogen-fixing bacteria was isolated from a root nodule of the leguminous plant, *Pisum sativum*.

The bacteria were then cultured *in vitro* and viewed using an electron microscope.

The resulting photomicrograph is shown in Fig. 34.1.



Magnification 32 000x

Fig. 34.1

- (i) Name the **genus** of nitrogen-fixing bacteria seen in Fig. 34.1.

-----[1]

- (ii) Calculate the **actual** width of the bacterium labelled X. Show your working.

Answer = -----  $\mu\text{m}$  [2]

59 Which of the options, **A** to **D**, is a biological molecule that contains ester bonds?

- A amylase
- B cellulose
- C lipid
- D ribulose biphosphate

Your answer

[1]

The sequence of cellular events which happens in a normal erection is described below:

- stimulation of tissue causes the release of a cell signalling molecule (nitrogen monoxide) from nerve endings
- nitrogen monoxide diffuses into neighbouring cells and causes the production of an intracellular messenger molecule, cyclic **GMP**
- cyclic GMP causes smooth muscle in cells in blood vessel walls to relax
- cyclic GMP is then broken down by an enzyme **PDE-5**.

(i) Comment on the properties of nitrogen monoxide as a cell signalling molecule.

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----- [2]

(ii) The chemical sildenafil citrate (Viagra®) binds to the active site of the enzyme **PDE-5**.

Suggest how the action of Viagra® makes it an effective treatment for erectile dysfunction.

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----- [3]

The light dependent reactions of photosynthesis depend on pigments such as chlorophyll. The molecular structure of chlorophyll is shown in Fig. 34.1.

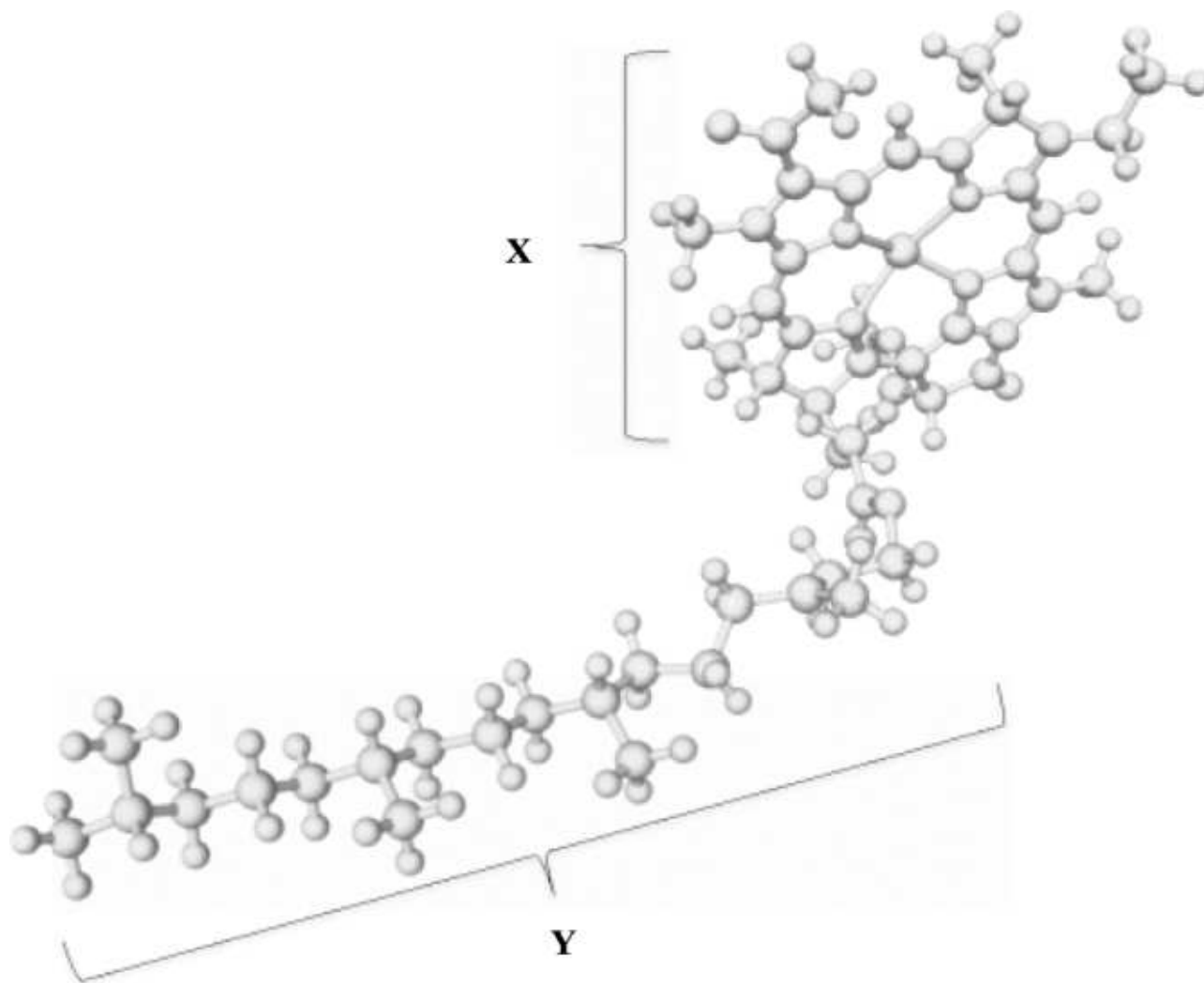


**Fig. 34.1**

Light energy is absorbed in the 'head' of the molecule labelled X. The part labelled Y is a long, hydrocarbon chain.

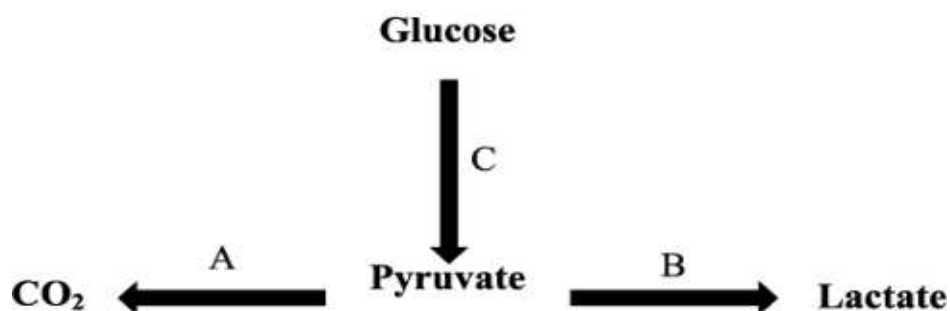
State the location of chlorophyll molecules in chloroplasts and suggest the arrangement of parts X and Y of the molecules.

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**Fig. 33.1**

- (i) The enzyme lactate dehydrogenase (LDH) catalyses pathway C. When the blood supply to any tissue is limited, LDH concentrations increase in cells.

Explain why LDH concentrations in cells increase when the blood supply to tissues is limited.

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----- [2]

- (ii) A heart attack occurs when blood vessels supplying the cardiac muscle become narrowed or blocked. This can lead to the death of cardiac muscle cells.

One indicator that a heart attack has occurred is a rise in concentrations of LDH in **blood plasma**.

Suggest why the death of cardiac muscle cells results in a rise in LDH concentrations in blood plasma.

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----- [2]

63 Penicillin is **not** effective against Gram negative bacteria and has no effect on plant and animal cells.

(i) Explain why penicillin has no effect on Gram negative bacteria.

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----- [2]

(ii) Explain why penicillin has no effect on plant or animal cells.

-----

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----- [1]

64 Sections of muscle tissue can be prepared and studied under a microscope.

A magnified section of muscle tissue is shown below in Fig. 17.1.

What is the approximate length of a sarcomere?

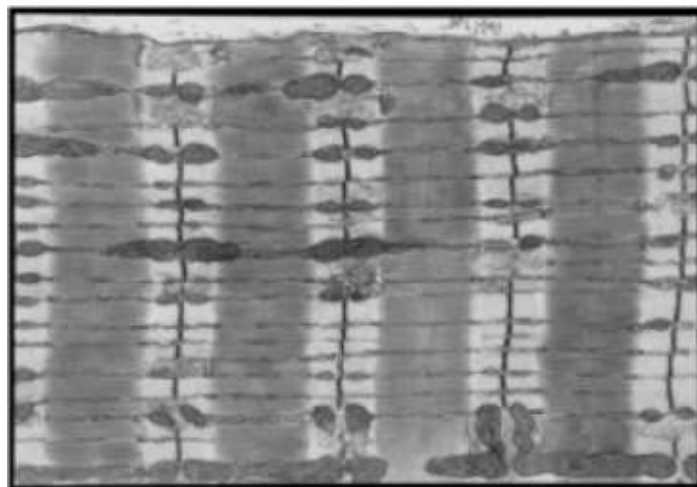


**Fig. 17.1**

Magnification =  $\times 16800$

- A  $1.5 \times 10^{-5}$  m
- B  $1.5 \times 10^{-6}$  m
- C  $1.25 \times 10^{-5}$  m
- D  $1.25 \times 10^{-6}$  m

Your answer

[1]

65 Fig. 12.1 shows a section through a dicotyledonous plant leaf.

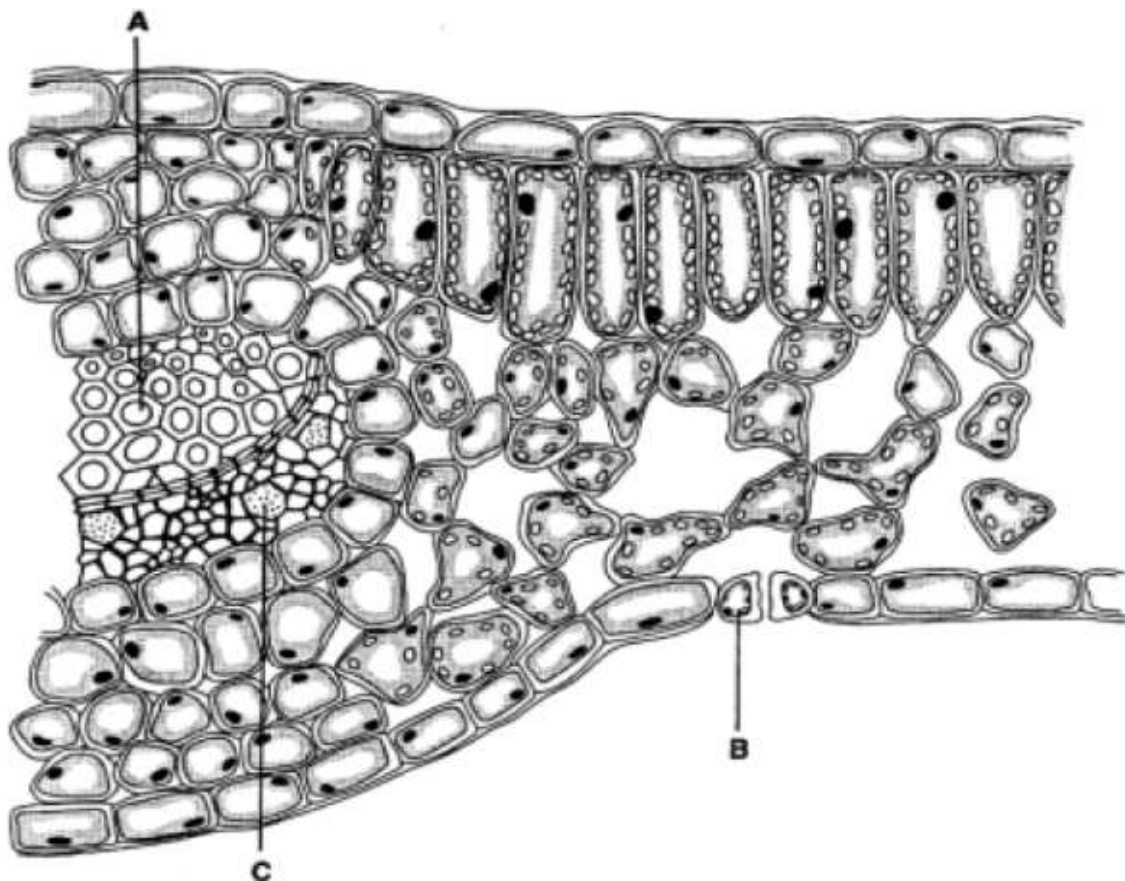


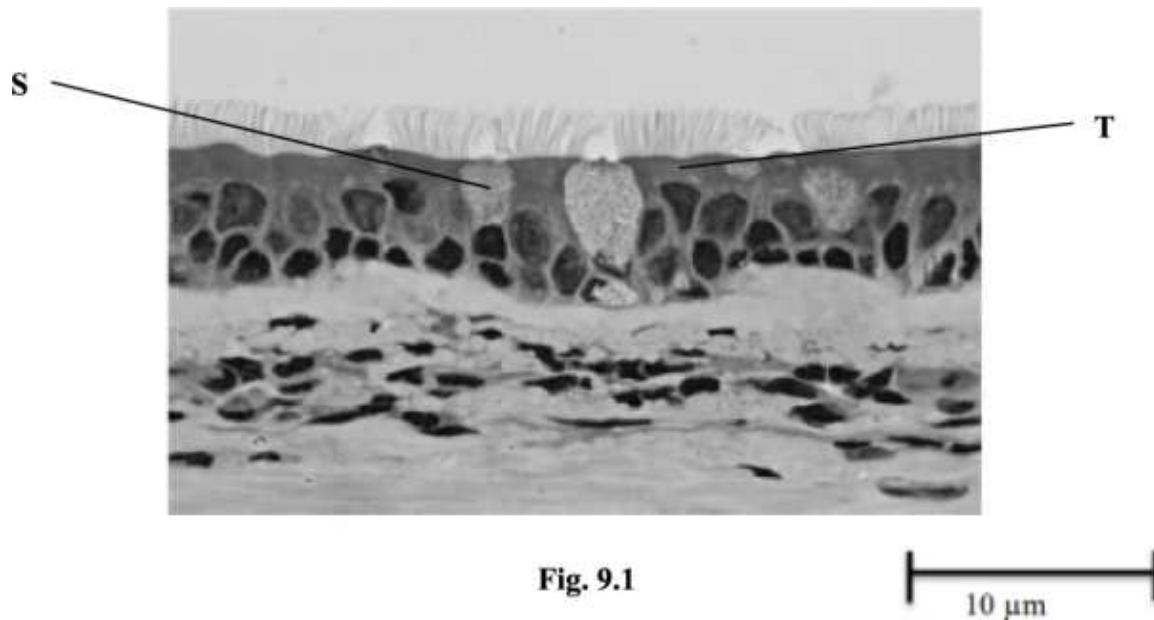
**Fig. 12.1**

Which of the cells labelled in Fig. 12.1 contain mitochondria?

- A A, B and C
- B A and C
- C B and C
- D B only

Your answer

[1]



Which of the following statements is / are true?

- Statement 1:** The magnification of this image is  $\times 300$ .  
**Statement 2:** The tissue shown is epithelial tissue.  
**Statement 3:** Cells S and T will be replaced from stem cells.

- A 1, 2 and 3  
B Only 1 and 2  
C Only 2 and 3  
D Only 1

Your answer

☐

[1]

END OF QUESTION PAPER

### Mark Scheme

| Question |   |     | Answer/Indicative content                                                                                                                                                                                                   | Marks        | Guidance                                                     |
|----------|---|-----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|--------------------------------------------------------------|
| 1        | a |     | differential (staining technique) ✓<br>different tissues / cell structures , stained different colours ✓<br><br>allows identification of cell nuclei ✓                                                                      | 2 max(AO2.7) | ALLOW gives an indication of tissue location within an organ |
|          | b | i   | 640 µm ✓✓                                                                                                                                                                                                                   | 2(AO2.8)     | ALLOW for 1 mark<br>64 (mm) ÷ 100<br>OR<br>0.64 (mm)         |
|          |   | ii  | (+/-) 1.25 ✓✓                                                                                                                                                                                                               | 2(AO3.2)     | ALLOW for 1 mark<br>(66-61) ÷ 2√4                            |
|          | c | i   | cilia connect inner and outer segments of (cone) cell ✓<br>(mutated BBS genes cause) production of non-functional proteins in , cilia / microtubules ✓<br>less / no , transport of proteins between segments ✓              | 2 max(AO2.1) |                                                              |
|          |   | ii  | different (cone) cells have different type of iodopsin ✓<br>(so iodopsin) absorbs either red or green or blue light ✓<br>(so) cone cells differ in sensitivity to different wavelengths of light ✓<br>trichromatic vision ✓ | 3 max(AO1.1) | ALLOW description                                            |
|          |   | iii | widespread effects in the body ✓<br>affects , several organs / systems, in the body ✓                                                                                                                                       | 1 max(AO2.5) |                                                              |
|          |   | iv  | apoptosis ✓                                                                                                                                                                                                                 | 1(AO1.1)     | ALLOW description                                            |
|          |   |     | <b>Total</b>                                                                                                                                                                                                                | <b>13</b>    |                                                              |
| 2        |   |     | C                                                                                                                                                                                                                           | 1(AO2.1)     |                                                              |
|          |   |     | <b>Total</b>                                                                                                                                                                                                                | <b>1</b>     |                                                              |
| 3        |   |     | A                                                                                                                                                                                                                           | 1(AO1.1)     |                                                              |
|          |   |     | <b>Total</b>                                                                                                                                                                                                                | <b>1</b>     |                                                              |

### Mark Scheme

| Question |   |  | Answer/Indicative content                                                                                                                                                                                                                                                                                                  | Marks           | Guidance                                                                                                                                                                                                          |
|----------|---|--|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 4        |   |  | D                                                                                                                                                                                                                                                                                                                          | 1(AO2.7)        |                                                                                                                                                                                                                   |
|          |   |  | Total                                                                                                                                                                                                                                                                                                                      | 1               |                                                                                                                                                                                                                   |
| 5        |   |  | D                                                                                                                                                                                                                                                                                                                          | 1(AO1.1)        |                                                                                                                                                                                                                   |
|          |   |  | Total                                                                                                                                                                                                                                                                                                                      | 1               |                                                                                                                                                                                                                   |
| 6        |   |  | C                                                                                                                                                                                                                                                                                                                          | 1(AO1.1)        |                                                                                                                                                                                                                   |
|          |   |  | Total                                                                                                                                                                                                                                                                                                                      | 1               |                                                                                                                                                                                                                   |
| 7        |   |  | <p><b>FIRST CHECK THE ANSWER ON ANSWER LINE</b><br/> <b>If answer = 10 (µm) ✓✓</b></p> <p>12mm ÷ 1200<br/> <b>OR</b><br/> 1.2cm ÷ 1200 ✓</p>                                                                                                                                                                               | 2(AO2.4)        |                                                                                                                                                                                                                   |
|          |   |  | Total                                                                                                                                                                                                                                                                                                                      | 2               |                                                                                                                                                                                                                   |
| 8        | a |  | <p>Erythrocytes has <u>no</u> DNA / chromosomes, <u>and</u> prokaryotes have circular DNA molecules ✓</p> <p>no cell wall <u>and</u> peptidoglycan cell wall ✓</p> <p>have haemoglobin <u>and</u> no haemoglobin ✓</p> <p>no mesosomes <u>and</u> have mesosomes ✓</p> <p>no slime layer <u>and</u> have slime layer ✓</p> | max<br>2(AO1.1) | <p><b>DO NOT ALLOW</b> a description of one cell without comparative statements<br/> <b>DO NOT ALLOW</b> eukaryote features that would not apply to erythrocytes</p> <p><b>ACCEPT</b> capsule for slime layer</p> |
|          | b |  | C D (E) A B ✓✓✓                                                                                                                                                                                                                                                                                                            | 3(AO2.1)        | <p>If answer incorrect award up to 2 marks for:<br/> C FIRST B LAST ✓</p> <p>D AFTER C ✓</p> <p>A AFTER D ✓</p>                                                                                                   |
|          |   |  | Total                                                                                                                                                                                                                                                                                                                      | 5               |                                                                                                                                                                                                                   |

# Mark Scheme

| Question | Answer/Indicative content                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Marks                           | Guidance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 9        | <p><i>Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.</i></p> <p><b>In summary:</b></p> <p><i>Read through the whole answer. (Be prepared to recognise and credit unexpected approaches where they show relevance.)</i></p> <p><i>Using a 'best-fit' approach based on the science content of the answer, first decide which of the level descriptors, <b>Level 1</b>, <b>Level 2</b> or <b>Level 3</b>, best describes the overall quality of the answer.</i></p> <p><i>Then, award the higher or lower mark within the level, according to the <b>Communication Statement</b> (shown in italics):</i></p> <ul style="list-style-type: none"> <li><i>award the higher mark where the Communication Statement has been met.</i></li> <li><i>award the lower mark where aspects of the Communication Statement have been missed.</i></li> </ul> <ul style="list-style-type: none"> <li><b>The science content determines the level.</b></li> <li><b>The Communication Statement determines the mark within a level.</b></li> </ul> <p><b>Level 3 (5–6 marks)</b></p> <p>Provides a detailed description of how to <b>calibrate</b> an eye piece graticule with a stage micrometer before <b>using</b> it, measuring the cell and details of how to make the results more <b>accurate</b> and <b>reproducible</b>.</p> <p><i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i></p> <p><b>Level 2 (3–4 marks)</b></p> <p>Provides a description of how to <b>use</b> an eye piece graticule and how to make the results more <b>accurate</b> and <b>reproducible</b>.</p> <p><i>There is a line of reasoning presented with some structure. The information presented is in the most-part relevant and supported by some evidence.</i></p> | <p>max 6<br/>(AO1.2, AO2.8)</p> | <p>Indicative points may include:</p> <p><b>Calibration</b></p> <ul style="list-style-type: none"> <li>align the eyepiece graticule with the stage micrometer</li> <li>count how many EPU = 1 division of micrometer scale (100µm or 0.1mm)</li> <li>calculate length of one EPU</li> <li>must be recalibrated if magnification changed</li> </ul> <p><b>Using the eye piece graticule</b></p> <p>line up the eye piece graticule with the cell<br/>count how many EPU = 1 cell<br/>calculate number of EPU x size of one EPU</p> <p><b>Accuracy</b></p> <p>use at the highest magnification (x400)<br/>use a stain or adjust lighting (to make edge of cell easy to identify)<br/>measure more than one diameter per cell and take a mean<br/>repeat with (more than 3 cells) to identify anomalous results</p> <p><b>Reproducibility</b></p> <p>Same method should be carried out by another scientist using different equipment to check that the same result is obtained</p> |

### Mark Scheme

| Question |  |     | Answer/Indicative content                                                                                                                                                                                                                                                                                                                                                                                  | Marks           | Guidance                                                                                                                                                                                                                                                                                                                            |
|----------|--|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|          |  |     | <p><b>Level 1 (1–2 marks)</b><br/>Provides a brief description of how to <b>use</b> an eye piece graticule and how to make the results either more <b>accurate</b> or <b>reproducible</b>.<br/><i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</i></p> <p><b>0 marks</b><br/><i>No response or no response worthy of credit.</i></p> |                 |                                                                                                                                                                                                                                                                                                                                     |
|          |  |     | <b>Total</b>                                                                                                                                                                                                                                                                                                                                                                                               | <b>6</b>        |                                                                                                                                                                                                                                                                                                                                     |
| 10       |  |     | (Fig 4.3 is an electron micrograph and has) <u>higher / greater, resolution</u> ✓                                                                                                                                                                                                                                                                                                                          | 1 AO 1.2        | <b>IGNORE</b> 'better' resolution                                                                                                                                                                                                                                                                                                   |
|          |  |     | <b>Total</b>                                                                                                                                                                                                                                                                                                                                                                                               | <b>1</b>        |                                                                                                                                                                                                                                                                                                                                     |
| 11       |  | i   | <p>Line measured as 112mm = 28.0 (µm) and 114mm = 28.5 (µm)</p> <p>28.0 to 28.5 (µm) ✓✓</p>                                                                                                                                                                                                                                                                                                                | 2 AO 2.8        | <p><i>Only allow values within the range (using image size 112 to 114)</i></p> <p><b>ALLOW</b> one mark as ECF for incorrect measurement provided there is evidence of rearranging formula <b>AND</b> showing working <b>AND</b> answer given to 3 sf i.e.</p> <p>= <u>incorrect measured value</u> = ECF value to 3sf<br/>4000</p> |
|          |  | ii  | iodopsin ✓                                                                                                                                                                                                                                                                                                                                                                                                 | 1 AO1.1         |                                                                                                                                                                                                                                                                                                                                     |
|          |  | iii | <p><b>MARK FIRST TWO RESPONSES</b></p> <p>procedure is more technical / requires more advanced practical skills / AW ✓<br/>further detail of skill required e.g. complex staining process needed to prepare specimens ✓<br/>artefacts may occur ✓</p>                                                                                                                                                      | 2 max<br>AO 2.7 | <p><b>IGNORE</b> Specimens must be placed in a vacuum and so must be dehydrated / dead as image 3.1 is a <u>section</u> of tissue</p> <p><b>IGNORE</b> reference to black and white images as this is not related to the preparation of the image</p> <p><b>IGNORE</b> references to cost</p>                                       |
|          |  |     | <b>Total</b>                                                                                                                                                                                                                                                                                                                                                                                               | <b>5</b>        |                                                                                                                                                                                                                                                                                                                                     |

### Mark Scheme

| Question |   |    | Answer/Indicative content                                                                                                                                                                                                                                                                                                                                                                                                                    | Marks                 | Guidance                                              |
|----------|---|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|-------------------------------------------------------|
| 12       | a | i  | A = neutrophil ✓<br>B = monocyte ✓<br>C = lymphocyte                                                                                                                                                                                                                                                                                                                                                                                         | 3 AO 2.3              | ALLOW granulocyte<br>ALLOW agranulocyte or macrophage |
|          |   | ii | does not have a nucleus / nucleolus / nuclear envelope / is anuclear ✓                                                                                                                                                                                                                                                                                                                                                                       | 1 AO 2.3              | ALLOW biconcave disc shape                            |
|          | b | i  | any one from:<br>ensure thorough mixing ✓<br>use , isotonic / AW , diluent / solvent ✓                                                                                                                                                                                                                                                                                                                                                       | 1 AO 3.3              |                                                       |
|          |   | ii | <b>FIRST CHECK ON ANSWER LINE if answer = <math>5.6(3) \times 10^9</math> award 4 marks</b><br><br>volume = $0.2 \times 0.2 \times 0.1 = 0.004 \text{ mm}^3$ ✓<br><br>cell density = $15 / 0.004 = 3750 \text{ mm}^{-3} = 3.75 \times 10^6 \text{ cm}^{-3}$ ✓<br><br>dilution factor = $1.5 / 0.001 = 1\,500$ ✓<br><br>cell density = $1\,500 \times 3.75 \times 10^6 \text{ cm}^{-3} = 5.6(3) \times 10^9 \text{ (cells cm}^{-3}\text{)}$ ✓ | 4 AO 2.4              | ECF for evidence of 15 divided by candidate's volume  |
|          |   |    | <b>Total</b>                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>9</b>              |                                                       |
| 13       |   |    | <i>structure X</i> : outer membrane<br><b>AND</b><br><i>structure Y</i> : inner membrane / crista ✓<br><br><i>explanation (any 2 from)</i> :<br>Y / inner membrane, large surface area for, (respiratory) enzymes / oxidative phosphorylation ✓<br>double membrane allows accumulation of, $\text{H}^+$ (ions) / protons ✓<br>generation of, $\text{H}^+$ (ion) / proton / pH, gradient ✓                                                    | max 3<br>AO1.1<br>2.3 | ALLOW cristae                                         |
|          |   |    | <b>Total</b>                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>3</b>              |                                                       |
| 14       |   |    | A                                                                                                                                                                                                                                                                                                                                                                                                                                            | 1 AO2.5               |                                                       |
|          |   |    | <b>Total</b>                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>1</b>              |                                                       |

### Mark Scheme

| Question |  |  | Answer/Indicative content                                                                                                                                                | Marks   | Guidance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|----------|--|--|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 15       |  |  | A                                                                                                                                                                        | 1 AO1.1 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|          |  |  | Total                                                                                                                                                                    | 1       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 16       |  |  | D                                                                                                                                                                        | 1 AO1.1 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|          |  |  | Total                                                                                                                                                                    | 1       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 17       |  |  | <p>1256/7✓✓</p> <p>diameter = 24mm / 2 = 12mm = 12000µm<br/> 12000 / 600 = 20µm<br/> <math>3.14 \times 20^2 = 1256</math><br/> <math>3.142 \times 20^2 = 1257</math></p> | 2 AO2.2 | <p>ALLOW unrounded (1256.637) for 1 mark</p> <p><b>Examiner's Comments</b></p> <p>Some candidates did not calculate the actual diameter, and hence the radius, of the field of view although many did state the equation (<math>A=I/M</math>). Some calculated the actual radius but were not able to convert these to micrometres. Others did not know the formula for calculating the surface area of a circle.</p> <div style="text-align: center;">  <p>OCR support</p> </div> <p>Maths for Biology website offers support to candidates in use of units and formulae that learners need to recall<br/> <a href="https://www.ocr.org.uk/subjects/biology/maths-for-biology/arithmetic-and-numerical-computation/">https://www.ocr.org.uk/subjects/biology/maths-for-biology/arithmetic-and-numerical-computation/</a></p> |
|          |  |  | Total                                                                                                                                                                    | 2       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 18       |  |  | A                                                                                                                                                                        | 1 AO2.1 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|          |  |  | Total                                                                                                                                                                    | 1       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |

### Mark Scheme

| Question |  |  | Answer/Indicative content | Marks    | Guidance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|----------|--|--|---------------------------|----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 19       |  |  | B                         | 1 AO2.8  | <p><b><u>Examiner's Comments</u></b></p> <p>This proved to be the most challenging question of the multiple choice items. Both DNA and phosphatidylserine are normally found within cells and because neither reagent can normally diffuse across the membrane they would not be stained and picked up in flow cytometry. In late apoptosis the cell fragments, so that annexin can access phosphatidylserine and propidium iodide will be able to stain the DNA. Thus, there would be high signals from both reagents as demonstrated by section B. Most candidates either opted for A or C.2</p> |
|          |  |  | <b>Total</b>              | <b>1</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 20       |  |  | A                         | 1 AO1.2  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|          |  |  | <b>Total</b>              | <b>1</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 21       |  |  | D                         | 1 AO1.1  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|          |  |  | <b>Total</b>              | <b>1</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 22       |  |  | C                         | 1 AO1.1  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|          |  |  | <b>Total</b>              | <b>1</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 23       |  |  | A                         | 1 AO1.1  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|          |  |  | <b>Total</b>              | <b>1</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |

### Mark Scheme

| Question        |                         |                        | Answer/Indicative content                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Marks      | Guidance                |                        |              |   |   |                 |   |   |           |   |   |           |   |   |           |   |   |            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-----------------|-------------------------|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|-------------------------|------------------------|--------------|---|---|-----------------|---|---|-----------|---|---|-----------|---|---|-----------|---|---|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 24              |                         | i                      | domain ✓                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 1 (AO 1.1) |                         |                        |              |   |   |                 |   |   |           |   |   |           |   |   |           |   |   |            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|                 |                         | ii                     | <p>Award one mark for each correct row – ticks <u>and</u> crosses must be present (as per the stem of the question)</p> <table><tr><th>Feature</th><th>Present in animal cells</th><th>Present in plant cells</th></tr><tr><td>Mitochondria</td><td>✓</td><td>✓</td></tr><tr><td>Golgi apparatus</td><td>✓</td><td>✓</td></tr><tr><td>Tonoplast</td><td>X</td><td>✓</td></tr><tr><td>Ribosomes</td><td>✓</td><td>✓</td></tr><tr><td>Cell wall</td><td>X</td><td>✓</td></tr></table> | Feature    | Present in animal cells | Present in plant cells | Mitochondria | ✓ | ✓ | Golgi apparatus | ✓ | ✓ | Tonoplast | X | ✓ | Ribosomes | ✓ | ✓ | Cell wall | X | ✓ | 4 (AO 1.1) | <p><b>DO NOT ALLOW</b> hybrid ticks and crosses</p> <p><u><b>Examiner's Comments</b></u></p> <p>The use of correct examination technique was important in this question. The instructions ask the candidates to <u>complete</u> table using ticks or crosses. In a number of cases candidates only used ticks and did not place a symbol in each cell. To that end they have not completed the table and as such did not gain credit (usually) for the Golgi apparatus and cell wall row. Although many candidates scored well in this question, a few seemed to think there were no Golgi apparatus and/or ribosomes in plant cells.</p> |
| Feature         | Present in animal cells | Present in plant cells |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |            |                         |                        |              |   |   |                 |   |   |           |   |   |           |   |   |           |   |   |            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Mitochondria    | ✓                       | ✓                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |            |                         |                        |              |   |   |                 |   |   |           |   |   |           |   |   |           |   |   |            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Golgi apparatus | ✓                       | ✓                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |            |                         |                        |              |   |   |                 |   |   |           |   |   |           |   |   |           |   |   |            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Tonoplast       | X                       | ✓                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |            |                         |                        |              |   |   |                 |   |   |           |   |   |           |   |   |           |   |   |            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Ribosomes       | ✓                       | ✓                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |            |                         |                        |              |   |   |                 |   |   |           |   |   |           |   |   |           |   |   |            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Cell wall       | X                       | ✓                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |            |                         |                        |              |   |   |                 |   |   |           |   |   |           |   |   |           |   |   |            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|                 |                         |                        | Total                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 0          |                         |                        |              |   |   |                 |   |   |           |   |   |           |   |   |           |   |   |            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |

## Mark Scheme

| Question |   |  | Answer/Indicative content                                                                                                                                                                                                                                           | Marks          | Guidance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|----------|---|--|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 25       | a |  | <p>Label cells with fluorescent marker ✓</p> <p>(fluorescence attached to) antibodies ✓</p> <p>(antibodies bind to) <u>antigens</u> on (white blood) cells ✓</p> <p>(alternative) fluorescent DNA probe ✓</p> <p>counts / sorts, cells (with genetic variant) ✓</p> | 4 max<br>AO2.3 | <p><b>IGNORE</b> red blood cells</p> <p><b>IGNORE</b> fluorescent marker binds to antigens</p> <p><b>ALLOW</b> section of DNA for 'DNA probe'</p> <p><b><u>Examiner's Comments</u></b></p> <p>Candidates clearly recognised this technique and most candidates discussed the counting of cells and the use of fluorescence. To achieve full marks, candidates had to follow a sequential logic of the labelling technique. Some candidates did refer to DNA probes as they made the connection between searching for genetic variants and the direct use of these probes.</p> |

# Mark Scheme

| Question |   | Answer/Indicative content                                                                                                                                                                                                                                                                                                                               | Marks          | Guidance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|----------|---|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|          | b | <p>base / nucleotide, substitution ✓</p> <p>mRNA codon changes<br/>OR<br/>different amino acid (attached) ✓</p> <p>changes haemoglobin, (tertiary) structure / (3D) shape ✓</p> <p>(abnormal) haemoglobin, clumps / crystallises</p> <p>(clumping) at low O<sub>2</sub> concentration ✓</p> <p>(only present in) homozygous recessive individuals ✓</p> | 3 max<br>AO1.1 | <p>ALLOW named bases</p> <p>ALLOW glutamic acid changed to valine<br/>ALLOW different primary structure</p> <p>IGNORE mutations in haemoglobin protein</p> <p>IGNORE red blood cells clump together</p> <p>ALLOW H<sup>S</sup> H<sup>S</sup> for 'homozygous recessive'</p> <p><b><u>Examiner's Comments</u></b></p> <p>Many candidates clearly knew the amino acid substitution causing sickle cell anaemia but often struggled to describe the type of mutation. Many candidates recognised it as a substitution but did not state base/nucleotide thus not differentiating it from the mark for amino acid substitution. Candidates then struggled to relate this change to an alteration in haemoglobin, referring straight to the altered erythrocyte shape. A few candidates discussed the gene mutation with the erythrocyte directly, confusing a cell with the protein inside.</p> <div> </div> <p><b>OCR support</b></p> <p>OCR delivery guide on Population genetics and epigenetics (5.1.2) can offer support:</p> <p><a href="https://www.ocr.org.uk/qualifications/as-a-level-gce-biology-b-advancing-biology-h022-h422-from-2015/delivery-guide/module-bb05-module-5-genetics-control-and-homeostasis/delivery-guide-bbdg028-population-genetics-and-epigenetics-512">https://www.ocr.org.uk/qualifications/as-a-level-gce-biology-b-advancing-biology-h022-h422-from-2015/delivery-guide/module-bb05-module-5-genetics-control-and-homeostasis/delivery-guide-bbdg028-population-genetics-and-epigenetics-512</a></p> |

# Mark Scheme

| Question                      |                    |                  | Answer/Indicative content                                                                                                                                                                                                                                                                                                                                                                                                                      | Marks          | Guidance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                  |      |         |                |  |  |   |  |                |   |  |  |  |                               |   |  |  |  |                        |  |   |  |  |         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|-------------------------------|--------------------|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|------|---------|----------------|--|--|---|--|----------------|---|--|--|--|-------------------------------|---|--|--|--|------------------------|--|---|--|--|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                               | c                  |                  | <p><i>advantages of the IMF approach:</i></p> <p>(may) give a more accurate diagnosis ✓</p> <p>treat / intervene, earlier ✓</p> <p>identify people (at risk) who do not have family history</p> <p><b>OR</b></p> <p>removes worry for people that do have a family history ✓</p> <p><i>disadvantages of IMF approach:</i></p> <p>results of the MGUS screening may give false positives ✓</p> <p>more expensive (than pedigree analysis) ✓</p> | 4 max<br>AO3.2 | <p><b>ALLOW</b> ora throughout</p> <p><b>ALLOW</b> prevents / cures, myeloma</p> <p><u><b>Examiner's Comments</b></u></p> <p>Candidates knew the relevance of pedigree analysis and answered this question from this perspective. It was clear the pre-release material had been read as the most common mark point was the expense of this technique from this section of the pre-release; '<i>Researchers at the IMF store thousands of blood .....These expensive tests allow the identification of genetic variants that might be linked to the risk of developing multiple myeloma.</i>' Many candidates also recognised the relevance of the 'identification' aspect of this quote and stated this approach was more accurate. All mark points were seen as some candidates not only used the pre-release material to gain information but realised the limitations of a pedigree analysis to those who have a family history and would not detect those who did not have this history.</p> |                  |      |         |                |  |  |   |  |                |   |  |  |  |                               |   |  |  |  |                        |  |   |  |  |         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|                               | d                  |                  | <table><tr><th>Feature</th><th>Transcription only</th><th>Translation only</th><th>Both</th><th>Neither</th></tr><tr><td>C pairs with G</td><td></td><td></td><td>✓</td><td></td></tr><tr><td>A pairs with T</td><td>✓</td><td></td><td></td><td></td></tr><tr><td>Phosphodiester bonds are made</td><td>✓</td><td></td><td></td><td></td></tr><tr><td>Peptide bonds are made</td><td></td><td>✓</td><td></td><td></td></tr></table>           | Feature        | Transcription only                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Translation only | Both | Neither | C pairs with G |  |  | ✓ |  | A pairs with T | ✓ |  |  |  | Phosphodiester bonds are made | ✓ |  |  |  | Peptide bonds are made |  | ✓ |  |  | 4 AO2.1 | <p><b>Mark the first answer. If an additional answer is given that is incorrect, then = 0 marks</b></p> <p><b>ALLOW</b> crosses or any other unequivocal symbol as alternative to ticks.</p> <p><u><b>Examiner's Comments</b></u></p> <p>Few candidates achieved full marks, with many candidates scoring at least 2 marks. Most candidates did not realise that the T base would not be present during translation and that the only covalent bonds made during translation are peptide bonds.</p> |
| Feature                       | Transcription only | Translation only | Both                                                                                                                                                                                                                                                                                                                                                                                                                                           | Neither        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                  |      |         |                |  |  |   |  |                |   |  |  |  |                               |   |  |  |  |                        |  |   |  |  |         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| C pairs with G                |                    |                  | ✓                                                                                                                                                                                                                                                                                                                                                                                                                                              |                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                  |      |         |                |  |  |   |  |                |   |  |  |  |                               |   |  |  |  |                        |  |   |  |  |         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| A pairs with T                | ✓                  |                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                |                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                  |      |         |                |  |  |   |  |                |   |  |  |  |                               |   |  |  |  |                        |  |   |  |  |         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Phosphodiester bonds are made | ✓                  |                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                |                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                  |      |         |                |  |  |   |  |                |   |  |  |  |                               |   |  |  |  |                        |  |   |  |  |         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Peptide bonds are made        |                    | ✓                |                                                                                                                                                                                                                                                                                                                                                                                                                                                |                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                  |      |         |                |  |  |   |  |                |   |  |  |  |                               |   |  |  |  |                        |  |   |  |  |         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|                               |                    |                  | <b>Total</b>                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>0</b>       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                  |      |         |                |  |  |   |  |                |   |  |  |  |                               |   |  |  |  |                        |  |   |  |  |         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

### Mark Scheme

| Question |  |  | Answer/Indicative content | Marks | Guidance                                                                                                                                                                                                                                                                                                         |
|----------|--|--|---------------------------|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 26       |  |  | B                         | 1     | <p><b><u>Examiner's Comments</u></b></p> <p>Candidates realised that a vaccine would be more useful against a protein with a low mutation rate. However, very few appreciated that the vaccine would only work if the protein were on the outside of the bacterial cell. The correct answer was therefore B.</p> |
|          |  |  | Total                     | 1     |                                                                                                                                                                                                                                                                                                                  |
| 27       |  |  | C                         | 1     |                                                                                                                                                                                                                                                                                                                  |
|          |  |  | Total                     | 1     |                                                                                                                                                                                                                                                                                                                  |
| 28       |  |  | C                         | 1     |                                                                                                                                                                                                                                                                                                                  |
|          |  |  | Total                     | 1     |                                                                                                                                                                                                                                                                                                                  |

### Mark Scheme

| Question |   |    | Answer/Indicative content                                                                                                                                                                                                                                                   | Marks | Guidance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|----------|---|----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 29       | a | i  | <p>to remove <u>chloride</u> ions<br/> <b>OR</b><br/> to remove other chemicals, that could react with silver nitrate ✓</p> <p>contamination would reduce, <u>validity</u> of results<br/> <b>OR</b><br/> removes contamination to, increase, validity of the results ✓</p> | 1 max | <p><b>IGNORE</b> generic comments about contamination</p> <p><u>Examiner's Comments</u></p> <p>This question required candidates to consider impact of chloride ions released onto the outside of the carrot sections when they were cut and if they were not removed by washing. Able candidates related this potential source of error and identified it could affect the validity of the results. Other candidates were vague in their answers and referred to removing dirt and other chemicals.</p> |
|          |   | ii | <p>(at 100 °C) all (carrot) cell membranes will have broken down ✓</p> <p>all chloride ions (from vacuole/cell) will have, been released/ diffused out ✓</p>                                                                                                                | 1 max | <p><b>ALLOW</b> maximum precipitate formed</p> <p><u>Examiner's Comments</u></p> <p>This question required candidates to consider the importance of reference values when using a colorimeter. Some candidates were distracted from the focus of the question and referred to the boiling point of water and commented on the evaporation of the water. Able candidates referred to the maximum disruption to the cell surface membrane and tonoplast and the release of all the chloride ions.</p>      |
|          | b |    | <p>(anomaly identified as) <u>0.018</u></p> <p><b>AND</b></p> <p>(expected correct value as) <u>0.010</u> ✓</p>                                                                                                                                                             | 1     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |

# Mark Scheme

| Question |   |  | Answer/Indicative content                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Marks | Guidance                                                                                                                                                                                                                                        |
|----------|---|--|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|          | c |  | <p><b>Mark first 3 variables only</b></p> <p><i>Variable</i><br/> <u>volume</u> of distilled water in the boiling tube ✓</p> <p><i>Explanation</i><br/> <u>larger</u> volume <u>reduce</u>, the concentration of chloride ions / precipitate formed / absorbance <b>ORA</b> ✓</p> <p><i>Variable</i><br/> <u>volume</u> of distilled water removed in the sample ✓</p> <p><i>Explanation</i><br/> <u>larger</u> volume will <u>increase</u>, number of chloride ions / precipitate formed / absorbance <b>ORA</b> ✓</p> <p><i>Variable</i><br/> time boiling tube remains in water bath ✓</p> <p><i>Explanation</i><br/> time in water bath should allow for desired temperature to be reached <b>OR</b><br/> if time is too short, fewer chloride ions will have diffused across the membrane(s) / <b>ORA</b> ✓</p> <p><i>Variable</i><br/> size / volume / number / surface area, of carrot sections ✓</p> <p><i>Explanation</i><br/> <u>larger surface area</u> (to volume ratio) will <u>increase</u> diffusion (rate) / <b>ORA</b> ✓</p> <p><i>Variable</i><br/> concentration/ volume/ number of drops, of silver nitrate ✓</p> <p><i>Explanation</i><br/> larger concentration/ volume/ number will increase, the absorbance / precipitate formed <b>ORA</b> ✓</p> | 6 max | <p><b>IGNORE</b> references to temperature as this is the independent variable in the investigation</p> <p><b>DO NOT ALLOW</b> amount</p> <p><b>DO NOT ALLOW</b> amount</p> <p><b>DO NOT ALLOW</b> amount</p> <p><b>DO NOT ALLOW</b> amount</p> |

### Mark Scheme

| Question |   |   | Answer/Indicative content                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Marks | Guidance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|----------|---|---|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|          |   |   | <p><i>Variable</i><br/>same filter used in colorimeter ✓</p> <p><i>Explanation</i><br/>the filter affects the wavelengths that reach, the sample / the detector ✓</p> <p><i>Variable</i><br/>same reference solution used in colorimeter ✓</p> <p><i>Explanation</i><br/>prevents zeroing errors ✓</p> <p><i>Variable</i><br/>sections of carrot / tissue, taken from same carrot ✓</p> <p><i>Explanation</i><br/>different carrots will, have/store, different chloride ion concentrations ✓</p> |       | <p><u>Examiner's Comments</u></p> <p>This question covered two key practical skills: the ability to identify key variables and the ability to justify why these variables should be controlled. Candidates should also be aware that the question asks for three variables and as such only the first 3 responses were marked. Some candidates duplicated their answers by, in effect, listing the same variable more than once e.g. size of carrot section and surface area of the carrot section. Candidates who did not perform well in this question did not quantify the impact of the uncontrolled variable, for example stating "volume of distilled water removed in the sample will affect the number of chloride ions" rather than "a larger volume will increase the number of the chloride ions".</p> |
|          | d | i | 0.013 ✓                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 1     | <p>at 10 °C, absorbance is 0.014</p> <p>at 40 °C absorbance is 0.027</p> <p><u>Examiner's Comments</u></p> <p>Several candidates did not read the question carefully and rather than calculating the actual increase in absorbance assumed the question was asking for a percentage increase and to that end did not gain credit.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |

### Mark Scheme

| Question |  |     | Answer/Indicative content                                                                                                                                                                                                                                                                                     | Marks     | Guidance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|----------|--|-----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|          |  | ii  | <p>higher temperature(s) results in, more disruption to the membrane ✓</p> <p>(rate of) diffusion increases with, an increase in temperature / increased <u>kinetic</u> energy (of chloride ions) ✓</p> <p>hence more chloride ions diffuse out, so more precipitate is formed, so absorbance increases ✓</p> | 2 max     | <p><b>DO NOT ALLOW</b> any ref to active transport as chloride ion movement at low temperatures is simple diffusion</p> <p><b>ALLOW</b> higher temperature, increases permeability of the plasma membrane</p>                                                                                                                                                                                                                                                                                                                                                             |
|          |  | iii | <p>200 ✓</p> <p>AU ✓</p>                                                                                                                                                                                                                                                                                      | 2         | <p><i>As the question asks for an estimate of the chloride ion concentration the value of 0.05 absorbance is used from Fig. 2.1</i></p> <p><b><u>Examiner's Comments</u></b></p> <p>It appeared that some candidates were unfamiliar with the use of log scales and log graph paper. Centres should ensure that all the mathematical requirements of the specification are covered and could be assessed in any of the three examination papers. Those candidates that could estimate the chloride ion concentration did not always give units (a.u) from the x-axis.</p> |
|          |  |     | <b>Total</b>                                                                                                                                                                                                                                                                                                  | <b>14</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |

### Mark Scheme

| Question |   |    | Answer/Indicative content                                                                                                                                                                                                                            | Marks | Guidance                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|----------|---|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 30       | a | i  | <p>D = <u>plasma</u> / cell surface, membrane ✓</p> <p>E = Golgi (body / apparatus) ✓</p> <p>F = (secretory) vesicle ✓</p> <p>G = nuclear, envelope / membrane ✓</p> <p>H = <u>rough</u> endoplasmic reticulum / <u>RER</u> / ribosome ✓</p>         | 5     | <p>ALLOW lysosome</p> <p>ALLOW nucleus</p> <p><b>Examiner's Comments</b><br/>(a)(i) was well answered. A few candidates stated cell membrane only and a few candidates stated G as the rough endoplasmic reticulum as well as H.</p>                                                                                                                                                                                                                                    |
|          |   | ii | <p>H = site of protein synthesis ✓</p> <p>H = (allows for) folding of (glyco) proteins / secondary structure formation / tertiary structure formation ✓</p> <p>J = synthesis / storage / transport, of, lipids / phospholipids / carbohydrates ✓</p> | 3     | <p>ALLOW description of protein synthesis</p> <p>ALLOW removal of leader sequences, packaging into vesicles</p> <p><b>Examiner's Comments</b><br/>Although the majority of candidates realised that H was the site of protein synthesis in (a)(ii) they struggled to think of a second relevance and confused this with the function of the Golgi Body. Most candidates recognised and stated the function of J although a few discussed this in terms of proteins.</p> |

### Mark Scheme

| Question |   |    | Answer/Indicative content                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Marks     | Guidance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|----------|---|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|          | b | i  | <p>K = (R)ER / ribosome ✓</p> <p>(VSVG-GFP) fluorescence is, highest / present at 0 min, at site of synthesis ✓</p> <p>OR</p> <p>(VSVG-GFP) fluorescence declines rapidly as proteins move, through / from, K ✓</p> <p>L = Golgi ✓</p> <p>(VSVG-GFP) fluorescence increases as K decreases so protein moved to L which is next in sequence</p> <p>OR</p> <p>(VSVG-GFP) fluorescence lasts longer so protein being modified ✓</p> <p>M = plasma / cell <u>surface</u> membrane ✓</p> <p>(VSVG-GFP) fluorescence, equals total curve / declines at the same level as total, so M is where protein is secreted ✓</p> | 6         | <p>IGNORE ref to vesicles</p> <p><b>Examiner's Comments</b><br/>Candidates struggled with (b)(i). Many candidates correctly stated K and L but did not relate this to the level of fluorescence. Candidates that started with K as the nucleus failed to appreciate that the fluorescence would only manifest itself when the protein is produced even though the stem of the question clearly referred to the protein tagged with fluorescence.</p>                                                                                                                                                                                                                                                                                   |
|          |   | ii | answer in the range 135 – 145 (minutes) ✓                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 1         | <p><b>Examiner's Comments</b><br/>Candidates seemed to randomly pick numbers for their answers to (b)(ii) with only the minority giving a correct answer.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|          | c |    | <p>movement of (secretory) vesicles requires microtubules ✓</p> <p>(so) no movement of vesicles (containing VSG-GFP) to, plasma / cell surface, membrane ✓</p> <p>movement, to / through the, Golgi must be, via a different mechanism / not involving microtubules ✓</p>                                                                                                                                                                                                                                                                                                                                         | 2         | <p><b>Examiner's Comments</b><br/>For (c), many candidates appreciated that vesicles require microtubules to move but could not follow through with the relevance of M disappearing. A few candidates discussed microtubules moving proteins directly. Some candidates felt that Golgi body would not be formed or vesicles would not be formed as microtubules were required for their production. It may be helpful to stress the structural features of certain organelles so it is clear what they are composed of and thus what would or would not be required for their production. Some candidates discussed spindle fibre formation, or lack of it, as this is obviously the context in which they associate microtubules.</p> |
|          |   |    | <b>Total</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>17</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |

### Mark Scheme

| Question |  |     | Answer/Indicative content                                                                                                                        | Marks | Guidance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|----------|--|-----|--------------------------------------------------------------------------------------------------------------------------------------------------|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31       |  | i   | (in) thylakoid / grana / lamellae. ✓                                                                                                             | 1     | <b>Examiner's Comments</b><br>a)(i) was well answered: 95% of candidates gave the necessary level of detail required for this answer; a few candidates stated chloroplasts.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|          |  | ii  | (plant thylakoids in) chloroplast(s) / stacks / grana <b>ora</b> ✓<br><br>(cyanobacteria thylakoids ) near, cell surface membrane / cell wall. ✓ | 2     | <b>IGNORE</b> ref to thylakoids attached (to cell surface membrane).<br><b>Examiner's Comments</b><br>The majority of candidates structured their answers well with clear references to plant cells and (cyano)bacteria. Most candidates correctly described the thylakoids in plant cells as stacked with only a minority of those adding that they are in chloroplasts which suggests many did not appreciate that thylakoids were held in an organelle in plant cells when compared to the cyanobacteria. Candidates then struggled to describe where the thylakoids were located in cyanobacteria. Many stated they were attached to or on the cell surface membrane and some described them as outside the cell. Candidates should be reminded to read their answers to make sure they make sense. |
|          |  | iii | stroma (in chloroplast) ✓<br><br>carboxysomes (in cytoplasm) ✓                                                                                   | 2     | <b>Examiner's Comments</b><br>(a)(iii) was generally well answered with a few candidates stating cytoplasm only for mp2 and some confusing stroma with matrix of mitochondria.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |

# Mark Scheme

| Question |  |    | Answer/Indicative content                                                                                                                                                                                                                                                                                                                               | Marks    | Guidance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|----------|--|----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|          |  | iv | <p>increased CO<sub>2</sub>, around Rubisco / in carboxysomes ✓</p> <p>(therefore) CO<sub>2</sub>, binds to / AW, Rubisco not O<sub>2</sub> ✓</p> <p>(Membrane-bound) pumps for HCO<sub>3</sub><sup>-</sup> (entry into cell) ✓</p> <p>carbonic anhydrase for CO<sub>2</sub> (entry into carboxysome) / conversion of HCO<sub>3</sub><sup>-</sup> ✓</p> | 3 max    | <p><b>ACCEPT</b> <i>idea</i> of CO<sub>2</sub> outcompetes O<sub>2</sub></p> <p><b>Examiner's Comments</b><br/> (a)(iv) was also generally well answered and candidates clearly used and understood the literature provided to complement this question.<br/> Many candidates wrote about the ancient form of RuBisCO which was not worthy of marks as the question asks for an explanation and this was a direct quote from the literature.<br/> Some candidates described the HCO<sub>3</sub><sup>-</sup> being pumped into the carboxysome which clearly does not have pumps in the diagram provided.<br/> A few candidates described oxygen as being prevented from entering the cell and / or the carboxysome. Generally candidates tended to imply that no oxygen was surrounding RuBisCO.<br/> The presence of the pumps obviously led to this misconception. Candidates should be reminded that gases can simply diffuse at a certain rate through all membranes but pumps will increase the rate of movement for other gases as well as allowing passage of charged ions. As a consequence of this, very few candidates mentioned that carbon dioxide would be able to out-compete oxygen for RuBisCO.</p> |
|          |  |    | <b>Total</b>                                                                                                                                                                                                                                                                                                                                            | <b>8</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

### Mark Scheme

| Question |  |   | Answer/Indicative content                                                                                                                                                                                     | Marks | Guidance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|----------|--|---|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 32       |  | i | <p>any 2 from:</p> <p>decrease in urea concentration (in blood) ✓</p> <p>glucose concentration (of blood) remains unchanged ✓</p> <p>protein, composition / concentration, (of blood) remains unchanged ✓</p> | max 2 | <p><b>IGNORE</b> reference to glucose increasing or decreasing</p> <p><b>Examiner's Comments</b></p> <p>(a)(i) and (ii) both referred to Fig and serve to emphasise how important it is for candidates to read command words. The question was not asking about what happens in the kidney so any references to glucose diffusing out to the tubule and being selectively reabsorbed or proteins being too large to pass through the basement membrane did not gain credit. This was a question about movement of molecules across a partially permeable membrane in the context of dialysis and successful candidates studied the figure and used it to describe and explain the movement of molecules. Those candidates who suggested that glucose would diffuse into the tubing probably made the error based on number of molecules rather than concentration.</p> |

### Mark Scheme

| Question |  |    | Answer/Indicative content                                                                                                                                                                                                                                                                                                                                                                  | Marks    | Guidance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|----------|--|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|          |  | ii | <p>passage of molecules through partially permeable membrane via (passive) <u>diffusion</u> ✓</p> <p>urea (diffuses) from a high concentration to a low concentration / down concentration gradient ✓</p> <p>glucose (stays the same) because of, equilibration of molecules either side of membrane / no net diffusion ✓</p> <p>protein too large to pass through membrane / tubing ✓</p> | max 3    | <p><b>ALLOW</b> 'semi-permeable membrane'</p> <p><b>DO NOT ALLOW</b> ECF from 37 (a)(i)</p> <p><b>Examiner's Comments</b><br/>(a)(i) and (ii) both referred to <b>Fig</b> and serve to emphasise how important it is for candidates to read command words. The question was not asking about what happens in the kidney so any references to glucose diffusing out to the tubule and being selectively reabsorbed or proteins being too large to pass through the basement membrane did not gain credit. This was a question about movement of molecules across a partially permeable membrane in the context of dialysis and successful candidates studied the figure and used it to describe and explain the movement of molecules. Those candidates who suggested that glucose would diffuse into the tubing probably made the error based on number of molecules rather than concentration.</p> |
|          |  |    | <b>Total</b>                                                                                                                                                                                                                                                                                                                                                                               | <b>5</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

### Mark Scheme

| Question |  |     | Answer/Indicative content                                                                                                                                                                                                                    | Marks    | Guidance                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|----------|--|-----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 33       |  | i   | (Student's) t-test ✓<br>paired / measurements from same people (before and after) ✓                                                                                                                                                          | 2        | <b>Examiner's Comments</b><br>It was encouraging to see that over 60% of candidates were awarded at least one mark when asked about the type of statistical test that could be used to analyse the data in (b)(i). A significant number of candidates justified their choice, clearly explaining how measurements were taken from the same people before and after exercise.                                                                          |
|          |  | ii  | improvement in recovery time (at all intensities / wattages of exercise) ✓<br>improvement falls as intensity / wattage rises ✓<br>uncertainty in making conclusion because standard deviations / error bars (for before-and-after) overlap ✓ | 2        | <b>ORA</b><br><b>Examiner's Comments</b><br>(b)(ii) was another example where candidates showed that they could describe data clearly. They were also able to identify that large error bars illustrated the data was variable but often failed to develop the idea of lack of significance when error bars overlapped.                                                                                                                               |
|          |  | iii | higher intensity / wattage exercises such as weightlifting show less improvement in recovery time ✓<br>weightlifting is not an aerobic exercise ✓<br>weightlifting occurs over a short duration / in short bursts ✓                          | 2        | <b>ORA</b><br><b>ALLOW</b> if not awarded in (b)(ii) uncertainty in making conclusion (about weightlifting) because standard deviations / error bars (for before-and-after) overlap<br><b>Examiner's Comments</b><br>(b)(iii) required candidates to understand that weightlifting is not an aerobic exercise and occurs in short bursts so this training programme, which candidates were told focused on aerobic fitness, would not be appropriate. |
|          |  |     | <b>Total</b>                                                                                                                                                                                                                                 | <b>6</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 34       |  |     | A ✓                                                                                                                                                                                                                                          | 1        | <b>Examiner's Comments</b><br>Most candidates could accurately calculate the diameter of the cell and select the correct answer written in standard form.                                                                                                                                                                                                                                                                                             |
|          |  |     | <b>Total</b>                                                                                                                                                                                                                                 | <b>1</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

### Mark Scheme

| Question |  |  | Answer/Indicative content                                                                                                     | Marks    | Guidance                                                                                                                                                            |
|----------|--|--|-------------------------------------------------------------------------------------------------------------------------------|----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 35       |  |  | B ✓                                                                                                                           | 1        | <b>Examiner's Comments</b><br>Most candidates were familiar with the north / west rule for counting cells in a haemocytometer and answered this question correctly. |
|          |  |  | <b>Total</b>                                                                                                                  | <b>1</b> |                                                                                                                                                                     |
| 36       |  |  | to stain different tissues/cell types different colours ✓<br><br>allows viewer to differentiate between, tissues/cell types ✓ | max 1    | <b>ALLOW</b> means untrained viewer can tell cells/tissues apart OWTTE                                                                                              |
|          |  |  | <b>Total</b>                                                                                                                  | <b>1</b> |                                                                                                                                                                     |
| 37       |  |  | A ✓                                                                                                                           | 1        |                                                                                                                                                                     |
|          |  |  | <b>Total</b>                                                                                                                  | <b>1</b> |                                                                                                                                                                     |
| 38       |  |  | A ✓                                                                                                                           | 1        |                                                                                                                                                                     |
|          |  |  | <b>Total</b>                                                                                                                  | <b>1</b> |                                                                                                                                                                     |
| 39       |  |  | B ✓                                                                                                                           | 1        |                                                                                                                                                                     |
|          |  |  | <b>Total</b>                                                                                                                  | <b>1</b> |                                                                                                                                                                     |
| 40       |  |  | D ✓                                                                                                                           | 1        |                                                                                                                                                                     |
|          |  |  | <b>Total</b>                                                                                                                  | <b>1</b> |                                                                                                                                                                     |
| 41       |  |  | B ✓                                                                                                                           | 1        |                                                                                                                                                                     |
|          |  |  | <b>Total</b>                                                                                                                  | <b>1</b> |                                                                                                                                                                     |
| 42       |  |  | D ✓                                                                                                                           | 1        |                                                                                                                                                                     |
|          |  |  | <b>Total</b>                                                                                                                  | <b>1</b> |                                                                                                                                                                     |

### Mark Scheme

| Question |  |    | Answer/Indicative content                                                                                                                                                       | Marks    | Guidance                                                                                   |
|----------|--|----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------------------------------------------------------------------------------------|
| 43       |  | i  | <i>tissue</i><br><br>(mature) xylem (no mark)<br><br><i>justification</i><br><br><i>idea that xylem</i> vessels, are hollow / have no cytoplasm / have no organelles ✓          | 1        | DO NOT ALLOW xylem without further explanation<br><br>IGNORE reference to xylem being dead |
|          |  | ii | lysosomal enzymes produced on, RER / rough endoplasmic reticulum ✓<br><br><i>idea that</i> lysosomal enzymes are enclosed in vesicles ✓<br><br>lysosomes bud off Golgi (body) ✓ | max 2    |                                                                                            |
|          |  |    | <b>Total</b>                                                                                                                                                                    | <b>3</b> |                                                                                            |

# Mark Scheme

| Question |  |    | Answer/Indicative content                                                                                                                                                                                                                                                           | Marks | Guidance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|----------|--|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 44       |  | i  | <p>1 FSH and / or LH cannot, cross / AW, membrane</p> <p>OR</p> <p>oestrogen can cross the, membrane / phospholipid bilayer;</p> <p>2 (because) oestrogen is lipid soluble</p> <p>OR</p> <p>FSH and / or LH are not lipid soluble;</p> <p>3 membrane / bilayer, is hydrophobic;</p> | 2     | <p><b>CREDIT</b> 'glycoproteins' for FSH and LH and 'steroids' for oestrogen throughout</p> <p>1.<b>DO NOT CREDIT</b> reference to molecular size</p> <p>2. <b>CREDIT</b> idea that molecule is lipid - like or hydrophobic</p> <p><b>ACCEPT</b> non-polar / hydrophobic (for lipid soluble) and polar / hydrophilic (for not lipid soluble)</p> <p>3. <b>ACCEPT</b> reference to hydrophobic core (of membrane)</p> <p><b>Examiner's Comments</b></p> <p>Part (i) called for a straightforward link between ability to cross the cell membrane and lipid solubility and most candidates seemed aware of this link. Marks were quite often lost for incorrectly relating the ability to cross the membrane to molecular size, or considering FSH and LH in terms of binding to a receptor on the cell surface membrane, hence repeating the stem of the question.</p> |
|          |  | ii | (anterior) pituitary gland;                                                                                                                                                                                                                                                         | 1     | <p><b>Mark the first answer.</b> If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer = <b>0 marks</b></p> <p><b>Examiner's Comments</b></p> <p>Most candidates were aware that the organ was the anterior pituitary gland in (ii) ,the main source of error being the brain.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |

### Mark Scheme

| Question |  |     | Answer/Indicative content                                                            | Marks    | Guidance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|----------|--|-----|--------------------------------------------------------------------------------------|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|          |  |     | <b>Total</b>                                                                         | <b>3</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 45       |  | i   | carbonic anhydrase;                                                                  | 1        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|          |  | ii  | (mitochondria) for synthesis of / AW, ATP, for active transport / transport of ions; | 1        | <p><b>CREDIT</b> hydrogen ions / <math>H^+</math> / protons / chloride ions / <math>Cl^-</math> / hydrogen carbonate ions / <math>HCO_3^-</math></p> <p><b>IGNORE</b> mitochondria providing energy</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|          |  | iii | gas exchange (system);                                                               | 1        | <p><b>Mark the first answer</b></p> <p><b>IGNORE</b> 'lungs' or 'brain' or a region of the brain since these are not organ systems</p> <p><b>CREDIT</b> 'respiratory' system<br/> <b>CREDIT</b> nervous system</p> <p><b>Examiner's Comments</b></p> <p>Biochemistry is often a weakness with Human Biology candidates and very few were able to identify carbonic anhydrase in (i). In (ii) although many correct statements were made regarding active transport and ATP, candidates failed to link this to the role of mitochondria is synthesising ATP while in (iii) many candidates did not spot that it was an organ system that was required rather than an organ and answers such as 'lung' or 'medulla oblongata' could therefore not be credited.</p> |
|          |  |     | <b>Total</b>                                                                         | <b>3</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |

### Mark Scheme

| Question |  |  | Answer/Indicative content                                                                                                                                                                   | Marks    | Guidance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|----------|--|--|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 46       |  |  | <p>(anabolic) steroids are, lipid soluble / non-polar;</p> <p>(steroids) diffuse through phospholipid bilayer;</p> <p>cell surface / plasma, membrane and nuclear membrane;</p> <p>AVP;</p> | Max 2    | <p><b>IGNORE</b> lipid based</p> <p><b>DO NOT CREDIT</b> facilitated diffusion</p> <p><b>IGNORE</b> envelope</p> <p>ref. to intracellular transport of steroids</p> <p><b>Examiner's Comments</b></p> <p>This looked at factors that contribute to improved athletic performance based on the taking of anabolic steroids. Initially the mechanism of their entry into the nucleus was considered. The percentage increase in an athlete's performance who had taken anabolic steroids was calculated from graphical data. Two ways in which anabolic steroids could improve athletic performance were taken into account followed by an evaluation of athletic performance before and after out of competition drug testing was introduced in the late 1980s.</p> <p>The question tested both AO1, AO2 and AO3.</p> <p>Many candidates knew that steroids are lipid soluble or non-polar and that they entered through the phospholipid bilayer in (a), but some lost the second marking point for not specifying that it was by diffusion. They sometimes lost the first mark for referring to membrane instead of phospholipid bilayer. Only very few candidates stated that steroids cross both the plasma membrane and the nuclear membrane nor the AVP.</p> |
|          |  |  | <b>Total</b>                                                                                                                                                                                | <b>2</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |

# Mark Scheme

| Question |   |  | Answer/Indicative content                                                                                                                                                                                                                                | Marks                 | Guidance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|----------|---|--|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 47       | a |  | <p>attachment of <b>carbohydrate</b> (to protein) in <b>Golgi</b>;</p> <p>(mucin packaged) into <b>vesicle(s)</b>;</p> <p>vesicle, moves toward and fuses with, <b>cell surface / plasma membrane</b>;</p> <p>(mucin) released by <b>exocytosis</b>;</p> | <p>Max 4</p> <p>1</p> | <p><b>CREDIT</b>sugar</p> <p><b>IGNORE</b> binding</p> <p><b>QWC</b> awarded for correct use of three emboldened terms <b>Golgi vesicle(s) cell surface / plasma, membrane exocytosis</b></p> <p><b>Examiner's Comments</b></p> <p>This was about the factors needed for successful fertilisation, requiring explanations of factors which facilitated the passage of sperm for fertilisation and of clomiphene in enhancing the chances of a successful pregnancy. This involved an initial consideration of the intracellular modification of proteins to form mucins, followed by the mechanism by which ions moved into the cervical mucus, how this resulted in mucus becoming less viscous and why this allowed sperm to travel more easily for fertilisation. The action of clomiphene on the reproductive hormones oestrogen and FSH was analysed. The question tested both AO1 and AO2. The majority of candidates were well versed in involvement of the Golgi body, the packaging of mucins into vesicles and their release by exocytosis, gaining the QWC mark for making these points. Many Candidates however did not include the attachment of the carbohydrate to the protein in the Golgi body. A lot of candidates dedicated a large part of their answer to a long and unnecessary description of protein synthesis, which gained them no marks, with the modification part included briefly at the end of their answer. The mark for the vesicles travelling to and fusing with the plasma membrane was also rarely given and often lost for missing the travelling part.</p> |

# Mark Scheme

| Question |   |   | Answer/Indicative content                                                                           | Marks | Guidance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|----------|---|---|-----------------------------------------------------------------------------------------------------|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|          | b | i | <p>facilitated diffusion</p> <p>OR</p> <p>active transport;</p> <p>correct detail of mechanism;</p> | Max 2 | <p>e.g. (facilitated diffusion) through channel proteins / down concentration gradient<br/>(active transport) through carrier proteins / against concentration gradient</p> <p><b>Examiner's Comments</b></p> <p>This was about the factors needed for successful fertilisation, requiring explanations of factors which facilitated the passage of sperm for fertilisation and of clomiphene in enhancing the chances of a successful pregnancy. This involved an initial consideration of the intracellular modification of proteins to form mucins, followed by the mechanism by which ions moved into the cervical mucus, how this resulted in mucus becoming less viscous and why this allowed sperm to travel more easily for fertilisation. The action of clomiphene on the reproductive hormones oestrogen and FSH was analysed. The question tested both AO1 and AO2. Most candidates gained one, if not both marks in (i) for describing how ions could leave cells, either by facilitated diffusion or active transport and of the relevant accompanying mechanism. A number of candidates did lose a mark for being too vague about channel or carrier proteins being involved, often stating both for one process. Most candidates could explain the lowering of water potential and movement of water by osmosis in (ii). Although the majority of candidates correctly described that the thinning of the mucus enabled sperm to swim more easily in (iii), many did not link this to increasing the chances of fertilisation thereby failing to score the mark for this question.</p> |

### Mark Scheme

| Question |  |     | Answer/Indicative content                                                                                                          | Marks     | Guidance                                                                              |
|----------|--|-----|------------------------------------------------------------------------------------------------------------------------------------|-----------|---------------------------------------------------------------------------------------|
|          |  | ii  | (high concentration of ions) reduces water potential;<br><br>water moves out of cells, by osmosis / down water potential gradient; | 2         | CREDIT ORA for inside cells<br><br>CREDIT ORA for mucus                               |
|          |  | iii | <i>idea of</i> easier for sperm to swim so increased chance of fertilisation;                                                      | 1         | e.g. allows an easier passage for sperm to reach the fallopian tube for fertilisation |
|          |  |     | <b>Total</b>                                                                                                                       | <b>10</b> |                                                                                       |

# Mark Scheme

| Question |   | Answer/Indicative content                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Marks | Guidance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|----------|---|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 48       | a | <p><i>* Please refer to the marking instruction point 10 for guidance on how to mark this question.</i></p> <p><i>In summary:</i><br/> Read through the whole answer. (Be prepared to recognise and credit unexpected approaches where they show relevance.)<br/> Using a 'best-fit' approach based on the science content of the answer, first decide which of the level descriptors, <b>Level 1</b>, <b>Level 2</b> or <b>Level 3</b>, best describes the overall quality of the answer.<br/> Then, award the higher or lower mark within the level, according to the <b>Communication Statement</b> (shown in <i>italics</i>):</p> <ul style="list-style-type: none"> <li>• award the higher mark where the Communication Statement has been met.</li> <li>• award the middle mark where aspects of the Communication Statement have been missed</li> <li>• award the lower mark where the Communication Statement has not been met.</li> </ul> <ul style="list-style-type: none"> <li>• <i>The science content determines the level.</i></li> <li>• <i>The Communication Statement determines the mark within a level.</i></li> </ul> <p><b>Level 3 (7–9 marks)</b><br/> Details of apparatus and a method to produce bacterial colonies are provided. A thorough risk assessment is written which includes most of the high risk hazards and suitable control methods. The importance of aseptic technique is evident and most examples are given.</p> <p><i>There is a well-developed line of reasoning which is clear and logically structured and uses scientific terminology at an appropriate level. All the information presented is relevant and forms a</i></p> | 9     | <p>Indicative scientific points may include:</p> <p>Equipment correctly identified with a reason</p> <ul style="list-style-type: none"> <li>• container / named container (e.g. Petri dish, flask, bottle, flat) because sterile / easily sterilised / lidded</li> <li>• culture medium because provides food / nutrients / water <b>IGNORE</b> moist</li> <li>• incubator because gives controlled optimum temperature</li> <li>• inoculating loop because allows for, accurate transfer / transfer of a small number / one colony, of bacteria</li> <li>• spreader because enables bacteria to be dispersed across / through medium</li> <li>• nutrient agar plates / broth because supplies the nutrients for bacterial growth</li> </ul> <p><b>ALLOW</b> references to different nutrient agars</p> <p><b>Aseptic technique</b></p> <ul style="list-style-type: none"> <li>• flaming of flask / bottle neck</li> <li>• flaming of inoculation loop / spreader</li> <li>• keeping lids on culture dishes / flasks (when not in use)</li> <li>• keeping Petri dishes upside down</li> <li>• work next to Bunsen flame to carry away contaminating bacteria in convection current / rising hot air <b>OR</b> to stop bacteria in air from falling onto / contaminating plates</li> </ul> <p><b>Method</b></p> <ul style="list-style-type: none"> <li>• detail of removal of fluid from bottle and transfer to nutrient plate / broth</li> <li>• detail of streak plating after initial culture</li> <li>• incubation of sample / kept at constant optimum temperature</li> <li>• detail of selecting bacteria with differing colony morphology to separate bacterial species</li> </ul> |

### Mark Scheme

| Question |   |    | Answer/Indicative content                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Marks | Guidance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|----------|---|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|          |   |    | <p><i>continuous narrative.</i></p> <p><b>Level 2 (4–6 marks)</b><br/>The apparatus and a method to produce bacterial colonies are provided although some details may be missing. There is an outline risk assessment including some control measures. Aseptic technique is evident and some examples are given.</p> <p><i>There is a line of reasoning presented with some structure and use of appropriate scientific language. The information presented is mostly relevant.</i></p> <p><b>Level 1 (1–3 marks)</b><br/>The apparatus and an outline method are suggested which will allow for bacterial culture. A risk assessment is present but incomplete. Information about aseptic technique is limited.</p> <p><i>There is a logical structure to the answer. The explanation, though basic, is clear.</i></p> <p><b>0 marks</b><br/>No response or no response worthy of credit.</p> |       | <p><b>Hazards identified with an appropriate control measure</b></p> <ul style="list-style-type: none"> <li>• (zoonotic) bacteria (on surfaces / from fluid touched by hands – wear gloves</li> <li>• (zoonotic) bacteria (on surfaces / from fluid transferred to clothes – wear a lab coat / remove lab coat before exiting lab</li> <li>• flammable liquids / ethanol used (e.g. in irrigating during Gram staining / flaming) – ensure bottles / flasks kept away from ignition sources / Bunsen burner / flame</li> <li>• 100% ethanol used risks intoxication – use at arm's length / use in a well-ventilated space</li> </ul> |
|          | b | i  | bacteria very small / too small to be seen with low power lens                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 1     | <p><b>ALLOW</b> because the bacteria are only 5 <math>\mu\text{m}</math> wide / shape of individual bacterium cannot be seen with LP</p> <p><b>IGNORE</b> bacteria are small / bacteria can't be seen with a low power, lens / microscope</p>                                                                                                                                                                                                                                                                                                                                                                                         |
|          |   | ii | cells have thin(ner) (peptidoglycan) cell walls                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 1     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|          | c | i  | Bacteria do not have a nucleus / nuclear membrane                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 1     | <b>ALLOW</b> bacteria only have a single / one chromosome (plus plasmids)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|          |   | ii | $\times 3000$ (1) (1)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 2     | <b>ALLOW</b> one mark for correct working [15 mm $\times$ 1000] / 5 $\mu\text{m}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

### Mark Scheme

| Question |   |  | Answer/Indicative content                                                                                                                                                                                                                                                                                                                                                                         | Marks     | Guidance                                                                                                                                                                                       |
|----------|---|--|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|          | d |  | D is largest clear zone (diameter) indicates more bacteria killed is not selected because this antibiotic is used as a last resort / with resistant strains (so) A is selected as next largest clear zone (diameter) / next largest number of bacteria killed, and inhibits protein synthesis / prevents bacteria, dividing / reproducing, without risk of selecting antibiotic resistant strains | 2         | Candidates may describe A being tried and, if found not to work, vet has another antibiotic to choose.<br><b>ALLOW</b> if correct ref is also given to mode of action (second mark point only) |
|          |   |  | <b>Total</b>                                                                                                                                                                                                                                                                                                                                                                                      | <b>16</b> |                                                                                                                                                                                                |

### Mark Scheme

| Question |   |    | Answer/Indicative content                          | Marks | Guidance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|----------|---|----|----------------------------------------------------|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 49       | a | i  | 281 250 (cell count) (1) (1) (1)                   | 3     | <p>Allow marks for working as follows:</p> <p>1 mark for correctly calculating the volume of the chamber<br/> <math>0.4 \text{ (mm)} \times 0.4 \text{ (mm)} \times 0.2 \text{ (mm)} = 0.032 \text{ mm}^3</math></p> <p>1 mark for correctly calculating the proportion of the sample in <math>1\text{cm}^3</math><br/> <math>1 \text{ (cm}^3\text{)} / 0.032 \text{ (mm}^3\text{)} = 1000 / 0.032 \text{ (mm}^3\text{)} = 31250</math></p> <p>1 mark for correctly calculating the number of cells in <math>1\text{cm}^3</math> based on the cell count visible<br/> <math>31\,250 \times 9 \text{ cells} = 281\,250 \text{ (yeast cells)}</math></p> |
|          |   | ii | yes because 281 250 is between 250 000 and 500 000 | 1     | <p><b>IGNORE</b> yes alone</p> <p><b>ALLOW</b> yes because (the cell count) is within / lies in the stated range</p> <p><b>ALLOW</b> ECF from (i)</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|          | b |    | anaerobic respiration                              | 1     | <p><b>ALLOW</b> fermentation</p> <p>Some candidates may recognise that a small volume of dissolved oxygen will be introduced during the bottling process and that the yeast will use this oxygen to start with and then change to anaerobic respiration.</p>                                                                                                                                                                                                                                                                                                                                                                                           |

### Mark Scheme

| Question |   |  | Answer/Indicative content                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Marks    | Guidance                                                                                                                                                                                                                                                                                                                                   |
|----------|---|--|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|          | c |  | <p><i>marks only awarded for <b>comparative statements</b></i></p> <ul style="list-style-type: none"> <li>• haemocytometer is simpler / cheaper equipment <b>ORA</b> (1)</li> <li>• haemocytometer requires less training for operative <b>ORA</b> (1)</li> <li>• repeats easier to carry out to find mean / average with haemocytometer <b>ORA</b> (1)</li> <li>• haemocytometer takes a shorter time to prepare sample for counting <b>ORA</b> (1)</li> <li>• haemocytometer any mistakes in counting magnified many times <b>ORA</b> (1)</li> <li>• haemocytometer each count must be completed manually / no way to speed up counting and flow cytometer once prepared is automated process (1)</li> <li>• haemocytometer can differentiate between living and dead cells once stained and flow cytometer cannot differentiate between living and dead cells / cell count would be too high because dead cells counted (1)</li> </ul> | 3        | <p><b>IGNORE</b> references to hazards / safety as both methylene blue and fluorescent stains have similar hazards and risk assessments</p> <p><b>ALLOW</b> gives a large standard error (or S.E.M.)</p> <p><b>2 ALLOW</b> flow cytometer counts dead cells / doesn't only count living cells unlike haemocytometer when cells stained</p> |
|          |   |  | <b>Total</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <b>8</b> |                                                                                                                                                                                                                                                                                                                                            |

### Mark Scheme

| Question                                           |                            |                           | Answer/Indicative content                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Marks   | Guidance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                           |                                                    |  |   |                         |   |   |                       |   |   |                                      |   |  |                                |  |   |   |                                                                                   |
|----------------------------------------------------|----------------------------|---------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|----------------------------------------------------|--|---|-------------------------|---|---|-----------------------|---|---|--------------------------------------|---|--|--------------------------------|--|---|---|-----------------------------------------------------------------------------------|
| 50                                                 |                            | i                         | 6 divisions = 0.6 mm<br>0.6 × 1000 = 600 μm (1)(1)                                                                                                                                                                                                                                                                                                                                                                                                                                    | 2       | ALLOW one mark for correct working                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                           |                                                    |  |   |                         |   |   |                       |   |   |                                      |   |  |                                |  |   |   |                                                                                   |
|                                                    |                            | ii                        | ALLOW value between 10 – 12 cells (1)                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 1       | DO NOT ALLOW if whole number not given                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                           |                                                    |  |   |                         |   |   |                       |   |   |                                      |   |  |                                |  |   |   |                                                                                   |
|                                                    |                            | iii                       | Area of field of view = π × r <sup>2</sup><br><br>Correctly calculated density (1)(1)(1)                                                                                                                                                                                                                                                                                                                                                                                              | 3       | ALLOW ecf from (i) and (ii) throughout<br><br>Allow marks for working as follows:<br>one mark for calculating the area of field of view – 3.14 × (300 × 300) = 282 600 μm <sup>2</sup><br>one mark for correctly calculating the radius – 600 / 2<br><br>The possible answers for density based on 10 / 11 / 12 cells depending on the answer to (ii):<br><br>• 3.5 × 10 <sup>-5</sup> cells μm <sup>-2</sup> (based on 10 cells)<br>• 3.9 × 10 <sup>-5</sup> cells μm <sup>-2</sup> (based on 11 cells)<br>• 4.2 × 10 <sup>-5</sup> cells μm <sup>-2</sup> (based on 12 cells). |                           |                                                    |  |   |                         |   |   |                       |   |   |                                      |   |  |                                |  |   |   |                                                                                   |
|                                                    |                            |                           | Total                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 6       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                           |                                                    |  |   |                         |   |   |                       |   |   |                                      |   |  |                                |  |   |   |                                                                                   |
| 51                                                 |                            |                           | <table><tr><th>Feature</th><th>Photosynthetic prokaryotes</th><th>Photosynthetic eukaryotes</th></tr><tr><td>Light absorbing pigments are found in chloroplasts</td><td></td><td>✓</td></tr><tr><td>ATP synthase is present</td><td>✓</td><td>✓</td></tr><tr><td>Ribosomes are present</td><td>✓</td><td>✓</td></tr><tr><td>Circular DNA is present in cytoplasm</td><td>✓</td><td></td></tr><tr><td>Cellulose cell wall is present</td><td></td><td>✓</td></tr></table><br>(1)(1)(1) | Feature | Photosynthetic prokaryotes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Photosynthetic eukaryotes | Light absorbing pigments are found in chloroplasts |  | ✓ | ATP synthase is present | ✓ | ✓ | Ribosomes are present | ✓ | ✓ | Circular DNA is present in cytoplasm | ✓ |  | Cellulose cell wall is present |  | ✓ | 3 | All rows correct = 3 marks<br>4 rows correct = 2 marks<br>3 rows correct = 1 mark |
| Feature                                            | Photosynthetic prokaryotes | Photosynthetic eukaryotes |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                           |                                                    |  |   |                         |   |   |                       |   |   |                                      |   |  |                                |  |   |   |                                                                                   |
| Light absorbing pigments are found in chloroplasts |                            | ✓                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                           |                                                    |  |   |                         |   |   |                       |   |   |                                      |   |  |                                |  |   |   |                                                                                   |
| ATP synthase is present                            | ✓                          | ✓                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                           |                                                    |  |   |                         |   |   |                       |   |   |                                      |   |  |                                |  |   |   |                                                                                   |
| Ribosomes are present                              | ✓                          | ✓                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                           |                                                    |  |   |                         |   |   |                       |   |   |                                      |   |  |                                |  |   |   |                                                                                   |
| Circular DNA is present in cytoplasm               | ✓                          |                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                           |                                                    |  |   |                         |   |   |                       |   |   |                                      |   |  |                                |  |   |   |                                                                                   |
| Cellulose cell wall is present                     |                            | ✓                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                           |                                                    |  |   |                         |   |   |                       |   |   |                                      |   |  |                                |  |   |   |                                                                                   |
|                                                    |                            |                           | Total                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 3       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                           |                                                    |  |   |                         |   |   |                       |   |   |                                      |   |  |                                |  |   |   |                                                                                   |

### Mark Scheme

| Question     |                                  |                              | Answer/Indicative content                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Marks | Guidance                                                                                        |                          |             |                   |                  |                              |                           |                 |              |              |                    |                                  |                              |      |         |              |                     |  |           |  |                                 |  |   |                                                                                                                                                                             |
|--------------|----------------------------------|------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|-------------------------------------------------------------------------------------------------|--------------------------|-------------|-------------------|------------------|------------------------------|---------------------------|-----------------|--------------|--------------|--------------------|----------------------------------|------------------------------|------|---------|--------------|---------------------|--|-----------|--|---------------------------------|--|---|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 52           |                                  | i                            | 0.45 mm (1)(1)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 2     | If answer is incorrect look for:<br><br>90 ÷ 200<br>OR<br>9 ÷ 200<br>OR<br>0.045 for max 1 mark |                          |             |                   |                  |                              |                           |                 |              |              |                    |                                  |                              |      |         |              |                     |  |           |  |                                 |  |   |                                                                                                                                                                             |
|              |                                  | ii                           | myelin sheath                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 1     |                                                                                                 |                          |             |                   |                  |                              |                           |                 |              |              |                    |                                  |                              |      |         |              |                     |  |           |  |                                 |  |   |                                                                                                                                                                             |
|              |                                  |                              | Total                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 3     |                                                                                                 |                          |             |                   |                  |                              |                           |                 |              |              |                    |                                  |                              |      |         |              |                     |  |           |  |                                 |  |   |                                                                                                                                                                             |
| 53           |                                  | i                            | (outer surface of) cell surface membrane                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 1     |                                                                                                 |                          |             |                   |                  |                              |                           |                 |              |              |                    |                                  |                              |      |         |              |                     |  |           |  |                                 |  |   |                                                                                                                                                                             |
|              |                                  | ii                           | <i>idea of variable region being complementary to antigen (1)</i><br><i>idea that different antigens would have a different (3D) shape (1)</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 2     |                                                                                                 |                          |             |                   |                  |                              |                           |                 |              |              |                    |                                  |                              |      |         |              |                     |  |           |  |                                 |  |   |                                                                                                                                                                             |
|              |                                  |                              | Total                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 3     |                                                                                                 |                          |             |                   |                  |                              |                           |                 |              |              |                    |                                  |                              |      |         |              |                     |  |           |  |                                 |  |   |                                                                                                                                                                             |
| 54           |                                  |                              | <table><tr><td></td><td>Bacterial cells</td><td>Palisade mesophyll cells</td></tr><tr><td rowspan="6">Differences</td><td>Smaller ribosomes</td><td>Larger ribosomes</td></tr><tr><td>No membrane-bound organelles</td><td>Membrane-bound organelles</td></tr><tr><td>No chloroplasts</td><td>Chloroplasts</td></tr><tr><td>Circular DNA</td><td>DNA in chromosomes</td></tr><tr><td>Cell wall contains peptidoglycan</td><td>Cell wall contains cellulose</td></tr><tr><td>Pili</td><td>No pili</td></tr><tr><td rowspan="3">Similarities</td><td colspan="2">Cytoplasm / cytosol</td></tr><tr><td colspan="2">Ribosomes</td></tr><tr><td colspan="2">Plasma / cell surface, membrane</td></tr></table> |       | Bacterial cells                                                                                 | Palisade mesophyll cells | Differences | Smaller ribosomes | Larger ribosomes | No membrane-bound organelles | Membrane-bound organelles | No chloroplasts | Chloroplasts | Circular DNA | DNA in chromosomes | Cell wall contains peptidoglycan | Cell wall contains cellulose | Pili | No pili | Similarities | Cytoplasm / cytosol |  | Ribosomes |  | Plasma / cell surface, membrane |  | 4 | 2 marks maximum for differences<br>2 marks maximum for similarities<br>1 mark maximum per row<br><br>ALLOW 70S ribosomes (bacterial) and 80S ribosomes (palisade mesophyll) |
|              | Bacterial cells                  | Palisade mesophyll cells     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |       |                                                                                                 |                          |             |                   |                  |                              |                           |                 |              |              |                    |                                  |                              |      |         |              |                     |  |           |  |                                 |  |   |                                                                                                                                                                             |
| Differences  | Smaller ribosomes                | Larger ribosomes             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |       |                                                                                                 |                          |             |                   |                  |                              |                           |                 |              |              |                    |                                  |                              |      |         |              |                     |  |           |  |                                 |  |   |                                                                                                                                                                             |
|              | No membrane-bound organelles     | Membrane-bound organelles    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |       |                                                                                                 |                          |             |                   |                  |                              |                           |                 |              |              |                    |                                  |                              |      |         |              |                     |  |           |  |                                 |  |   |                                                                                                                                                                             |
|              | No chloroplasts                  | Chloroplasts                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |       |                                                                                                 |                          |             |                   |                  |                              |                           |                 |              |              |                    |                                  |                              |      |         |              |                     |  |           |  |                                 |  |   |                                                                                                                                                                             |
|              | Circular DNA                     | DNA in chromosomes           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |       |                                                                                                 |                          |             |                   |                  |                              |                           |                 |              |              |                    |                                  |                              |      |         |              |                     |  |           |  |                                 |  |   |                                                                                                                                                                             |
|              | Cell wall contains peptidoglycan | Cell wall contains cellulose |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |       |                                                                                                 |                          |             |                   |                  |                              |                           |                 |              |              |                    |                                  |                              |      |         |              |                     |  |           |  |                                 |  |   |                                                                                                                                                                             |
|              | Pili                             | No pili                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |       |                                                                                                 |                          |             |                   |                  |                              |                           |                 |              |              |                    |                                  |                              |      |         |              |                     |  |           |  |                                 |  |   |                                                                                                                                                                             |
| Similarities | Cytoplasm / cytosol              |                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |       |                                                                                                 |                          |             |                   |                  |                              |                           |                 |              |              |                    |                                  |                              |      |         |              |                     |  |           |  |                                 |  |   |                                                                                                                                                                             |
|              | Ribosomes                        |                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |       |                                                                                                 |                          |             |                   |                  |                              |                           |                 |              |              |                    |                                  |                              |      |         |              |                     |  |           |  |                                 |  |   |                                                                                                                                                                             |
|              | Plasma / cell surface, membrane  |                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |       |                                                                                                 |                          |             |                   |                  |                              |                           |                 |              |              |                    |                                  |                              |      |         |              |                     |  |           |  |                                 |  |   |                                                                                                                                                                             |
|              |                                  |                              | Total                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 4     |                                                                                                 |                          |             |                   |                  |                              |                           |                 |              |              |                    |                                  |                              |      |         |              |                     |  |           |  |                                 |  |   |                                                                                                                                                                             |

### Mark Scheme

| Question |  |     | Answer/Indicative content                                                                                                                                                                                                                                                                                                   | Marks    | Guidance                                                                                |
|----------|--|-----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-----------------------------------------------------------------------------------------|
| 55       |  | i   | selection pressure, (is) high altitude / risk of altitude sickness<br><i>idea of</i> individuals with, mutated gene / allele / Tibetan variant, will survive better at high altitude / have selective advantage<br><i>idea that</i> allele frequency for Tibetan EPAS1 increases over many generations<br>natural selection | 4        |                                                                                         |
|          |  | ii  | physiological                                                                                                                                                                                                                                                                                                               | 1        | <b>ALLOW</b> biochemical                                                                |
|          |  | iii | <b>Any 2 from:</b><br><i>idea of</i> less oxygen able to be transported in their blood<br>(the potential for) less / reduced / AW, respiration<br>partial pressure / concentration, of oxygen is lower at high altitude                                                                                                     | 2        |                                                                                         |
|          |  | iv  | (erythrocyte cell count using) haemocytometer<br>measures / AW, concentration of (red blood) cells<br><br><b>OR</b><br><br>flow cytometry<br>measures / AW, volume / morphology / concentration, of (red blood) cells                                                                                                       | 2        | <b>ALLOW</b> numbers of / types of protein in / amount of protein in, (red blood) cells |
|          |  |     | <b>Total</b>                                                                                                                                                                                                                                                                                                                | <b>9</b> |                                                                                         |
| 56       |  | i   | Z:<br>crista(e) (1)<br><br>large surface area, for oxidative phosphorylation / ATP production (1)                                                                                                                                                                                                                           | 2        |                                                                                         |
|          |  | ii  | establish, H <sup>+</sup> / proton gradient, across inner membrane                                                                                                                                                                                                                                                          | 1        |                                                                                         |
|          |  |     | <b>Total</b>                                                                                                                                                                                                                                                                                                                | <b>3</b> |                                                                                         |

### Mark Scheme

| Question |  |    | Answer/Indicative content                                                                                                                                                                                                                                                                                                                                                | Marks    | Guidance                                                                                                                                      |
|----------|--|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-----------------------------------------------------------------------------------------------------------------------------------------------|
| 57       |  | i  | <p><b>A:</b><br/> <b>any 2 from:</b><br/>           (di)sulfide, bonds / bridges (1)<br/>           covalent bonds (1)<br/>           between cysteine amino acids / S-S atoms / S-H groups (1)</p> <p><b>B:</b><br/>           alpha helix (1)<br/>           hydrogen bonding / interactions, between –NH (group) of one amino acid and –CO (group) of another (1)</p> | 4        | disulfide bonds are covalent = 2 marks<br><b>DO NOT ALLOW</b> disulfate<br><b>IGNORE</b> ref to carbohydrate chains                           |
|          |  | ii | <p><b>any 3 from:</b><br/>           transported to Golgi (apparatus / body / complex) (1)<br/>           glycosylated / sugar / carbohydrate added using glycosylase / enzymes (1)<br/>           packaged into / formation of (secretory) vesicles (1)<br/>           fusion of vesicles with, plasma / cell surface, membrane (1)</p>                                 | 3        |                                                                                                                                               |
|          |  |    | <b>Total</b>                                                                                                                                                                                                                                                                                                                                                             | <b>7</b> |                                                                                                                                               |
| 58       |  | i  | <i>Rhizobium</i> (1)                                                                                                                                                                                                                                                                                                                                                     | 1        | <b>ALLOW</b> <i>Sino</i> / <i>Meso</i> / <i>Brady</i> / <i>Azorhizobium</i><br><b>ALLOW</b> not italicised<br><b>DO NOT ALLOW</b> lowercase r |
|          |  | ii | image size ÷ magnification<br><b>OR</b><br>15,000 ÷ 32,000 (1)<br>0.47 / 0.5 (1)                                                                                                                                                                                                                                                                                         | 2        | <b>ALLOW</b> 2 marks for correct answer without working<br><br><b>ALLOW</b> 0.469                                                             |
|          |  |    | <b>Total</b>                                                                                                                                                                                                                                                                                                                                                             | <b>3</b> |                                                                                                                                               |
| 59       |  |    | C                                                                                                                                                                                                                                                                                                                                                                        | 1        |                                                                                                                                               |
|          |  |    | <b>Total</b>                                                                                                                                                                                                                                                                                                                                                             | <b>1</b> |                                                                                                                                               |

### Mark Scheme

| Question |  |    | Answer/Indicative content                                                                                                                                                                                                                                                                | Marks    | Guidance                                                                                                                                                                  |
|----------|--|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 60       |  | i  | <b>Any 2 from:</b><br><i>idea that</i> nitrogen monoxide must be, lipid soluble / hydrophobic<br>(explanation) it diffuses / AW, through the cell surface membrane<br>binds to, receptor / AW, inside the cell<br><i>idea that</i> second messenger is cyclic GMP rather than cyclic AMP | 2        |                                                                                                                                                                           |
|          |  | ii | <b>Any 3 from:</b><br>Viagra acts as a competitive inhibitor (of PDE-5)<br><br><i>idea that</i> cyclic GMP, is not broken down / lasts longer (in cells)<br><i>idea that</i> blood vessels dilate, more / for longer<br><i>idea that</i> erection maintained for longer                  | 3        | <b>ALLOW</b> 'Viagra forms an enzyme inhibitor complex' OR description 'prevents the formation of ESC'                                                                    |
|          |  |    | <b>Total</b>                                                                                                                                                                                                                                                                             | <b>5</b> |                                                                                                                                                                           |
| 61       |  |    | (chlorophyll molecules) in thylakoid membrane<br>Y / hydrocarbon chain, in the (phospholipid) bilayer of thylakoid membranes<br>X / head, at the surface of the thylakoid membrane                                                                                                       | 3        | Thylakoid membrane must be stated in at least one of the mark points but can be implied in the second<br><br><b>ALLOW</b> a description e.g. in the phosphate head region |
|          |  |    | <b>Total</b>                                                                                                                                                                                                                                                                             | <b>3</b> |                                                                                                                                                                           |
| 62       |  | i  | (limited blood supply) reduced oxygen available<br><br>ref to, increased / more, anaerobic respiration                                                                                                                                                                                   | 2        | <b>IGNORE</b> reference to glucose<br><br><b>DO NOT ALLOW</b> anaerobic respiration alone – need the idea of more anaerobic respiration                                   |
|          |  | ii | <i>idea that</i> (muscle) cell surface / plasma, membrane is, damaged / AW<br><i>idea that</i> LDH, diffuses, out of cytoplasm / into blood plasma                                                                                                                                       | 2        |                                                                                                                                                                           |
|          |  |    | <b>Total</b>                                                                                                                                                                                                                                                                             | <b>4</b> |                                                                                                                                                                           |

### Mark Scheme

| Question |  |    | Answer/Indicative content                                                                                                                                                                                                   | Marks    | Guidance                 |
|----------|--|----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------------------|
| 63       |  | i  | Any 2 from:<br>(Gram negative bacteria have) outer, membrane / lipopolysaccharide layer<br><i>idea that</i> this is impermeable to penicillin<br><br><i>idea that</i> penicillin cannot reach, murein / peptidoglycan layer | 2        |                          |
|          |  | ii | animal cells do not have a cell wall<br><b>AND</b><br>cell wall in plants is, cellulose / not peptidoglycan                                                                                                                 | 1        | Both needed for one mark |
|          |  |    | <b>Total</b>                                                                                                                                                                                                                | <b>3</b> |                          |
| 64       |  |    | D                                                                                                                                                                                                                           | 1        |                          |
|          |  |    | <b>Total</b>                                                                                                                                                                                                                | <b>1</b> |                          |
| 65       |  |    | C                                                                                                                                                                                                                           | 1        |                          |
|          |  |    | <b>Total</b>                                                                                                                                                                                                                | <b>1</b> |                          |
| 66       |  |    | C                                                                                                                                                                                                                           | 1        |                          |
|          |  |    | <b>Total</b>                                                                                                                                                                                                                | <b>1</b> |                          |