1. Erythrocytes contain few organelles. They do **not** have mitochondria or Golgi apparatus.

   Which process can be carried out by an erythrocyte?

   A   cell division
   B   aerobic respiration
   C   anaerobic respiration
   D   protein synthesis

   Your answer ☐

   [1]

2. The passage below outlines one method that can be used to prepare and view onion cells under a microscope. Two terms are missing.

   Add a few drops of water to a microscope slide. Use forceps to remove the _____ layer of cells from the onion tissue. Place the layer on the microscope slide and use a pipette to add a stain. Place a cover slip over the stained layer. Place the slide on the microscope stage. Adjust the magnification by rotating the microscope nosepiece to select a suitable _____ lens.

   Which are the missing terms?

   A   epidermal and eyepiece
   B   epidermal and objective
   C   endodermal and eyepiece
   D   endodermal and objective

   Your answer ☐

   [1]

3. A group of students were comparing electron micrographs of three different types of cell:

X a macrophage

Y a palisade mesophyll cell

Z the bacterium *Escherichia coli*

They recorded their observations in a table.

Which row, in **Table 12.1** below, shows the correct observations?

	Has a cellulose cell wall	Has a Golgi apparatus	Has a plasma membrane	Has ribosomes
A	Y and Z	X, Y and Z	X, Y and Z	X, Y and Z
B	Y and Z	X and Y	X and Y	X, Y and Z
C	Y	X	X, Y and Z	X and Y
D	Y	X and Y	X, Y and Z	X, Y and Z

Table 12.1

Your answer ☐

[1]

4. The diagram in **Fig. 13.1** shows part of the plasma membrane.
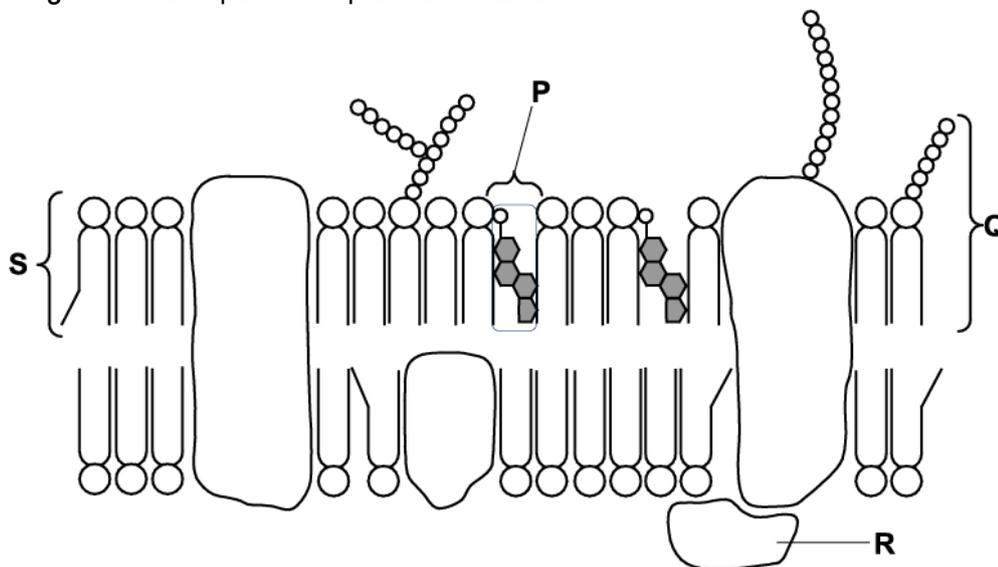

Fig. 13.1

Which components affect the fluidity of the plasma membrane?

    A   P, Q, R and S

    B   P and S

    C   P

    D   P,Q and S

Your answer ☐

[1]

5. The diameter of the field of view seen by a light microscope changes with the magnification.
The relationship between magnification and diameter is,

$$\frac{Magnification\ a}{Magnification\ b} = \frac{Diameter\ b}{Diameter\ a}$$

If the diameter of the field of view at **x40** is 400 µm, the **area** of the field of view at **x400** will be:

A 40 µm^2

B 5027 µm^2

C 1257 µm^2

D 126 µm^2

Your answer ☐

[1]

6.   Flow cytometry can be used to determine the DNA content of cells during the cell cycle.

- A fluorescent dye is used, which binds to DNA.
- The greater the intensity of the fluorescence, the greater the mass of DNA present.

Fig. 7.1 shows a flow cytometer print-out from a population of dividing cells.
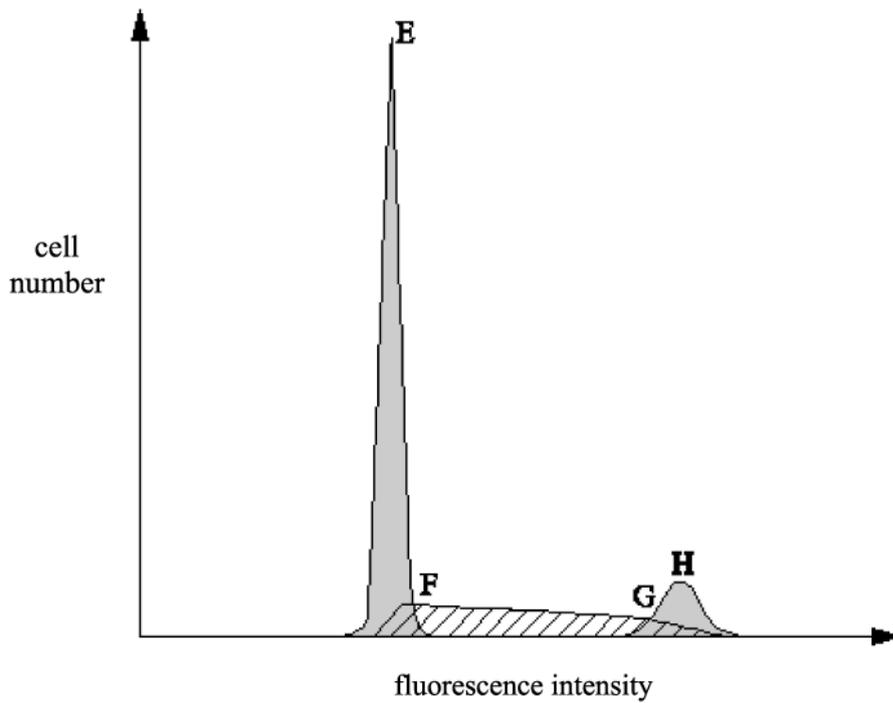
Fig. 7.1

Which of the following statements about the population of dividing cells is correct?

A Region **F** to **G** shows the number of cells dividing by mitosis.
B Peak **H** corresponds to cells in G1 phase.
C Region **F** to **G** corresponds to cells in S phase.
D Peak **E** corresponds to cells in G2 phase.

Your answer

[1]

7. In Fig. 8.1, **Cell M** is a leucocyte, which differentiates to become the plasma cell.

Cell M

K

L

7 μm
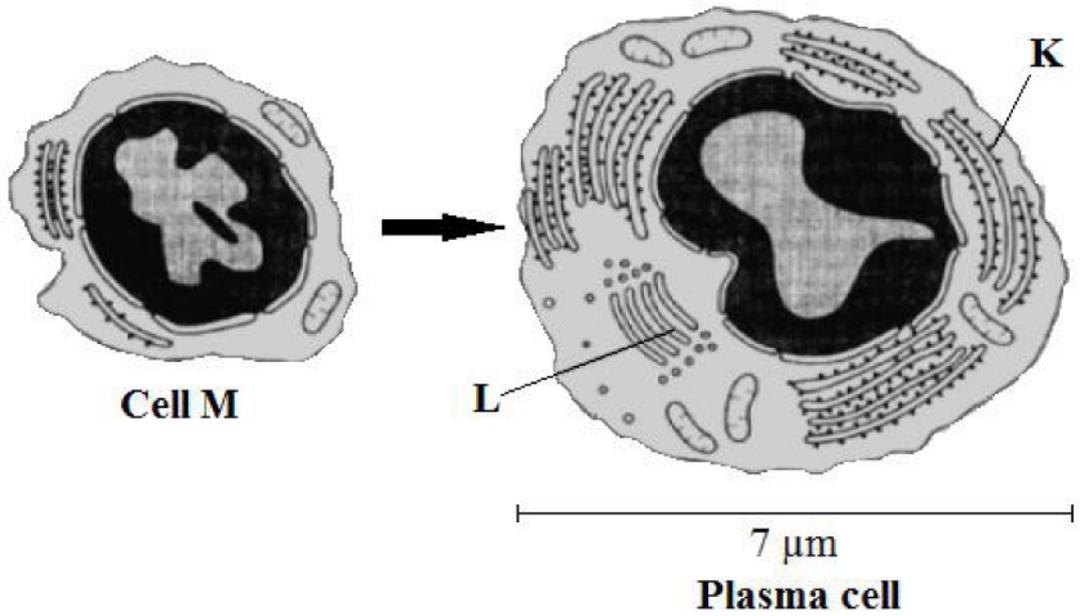
Plasma cell

Fig. 8.1

Which of the following responses correctly describes **Cell M** and the structures in the plasma cell?

A **Cell M** is a T lymphocyte and antibodies are synthesized on structure **K**.
B **Cell M** is a T lymphocyte and antibodies are synthesized on structure **L**.
C **Cell M** is a B lymphocyte and antibodies are synthesized on structure **K**.
D **Cell M** is a B lymphocyte and antibodies are synthesized on structure **L**.

Your answer ☐

[1]

8. Fatty acids are described according to the number of the carbon atoms in the chain and the number of carbon-carbon double bonds. For example, docosadienoic acid ($C_{22}H_{40}O_2$) is described C22:2 as it has two carbon-carbon double bonds.

Table 18.1 shows four different fatty acids.

| Fatty acid name	Description
Stearic acid	C18:0
Oleic acid	C18:1
Linolenic acid	C18:3
Arachidonic acid	C20:4

Table 18.1

Which of the following statements is correct?

A Stearic acid is polyunsaturated.

B Stearic and oleic acid are polyunsaturated.

C Oleic and linolenic acid are polyunsaturated.

D Arachidonic and linolenic acid are polyunsaturated.

Your answer

[1]

9. The diagram below shows the structure of a cell surface (plasma) membrane.
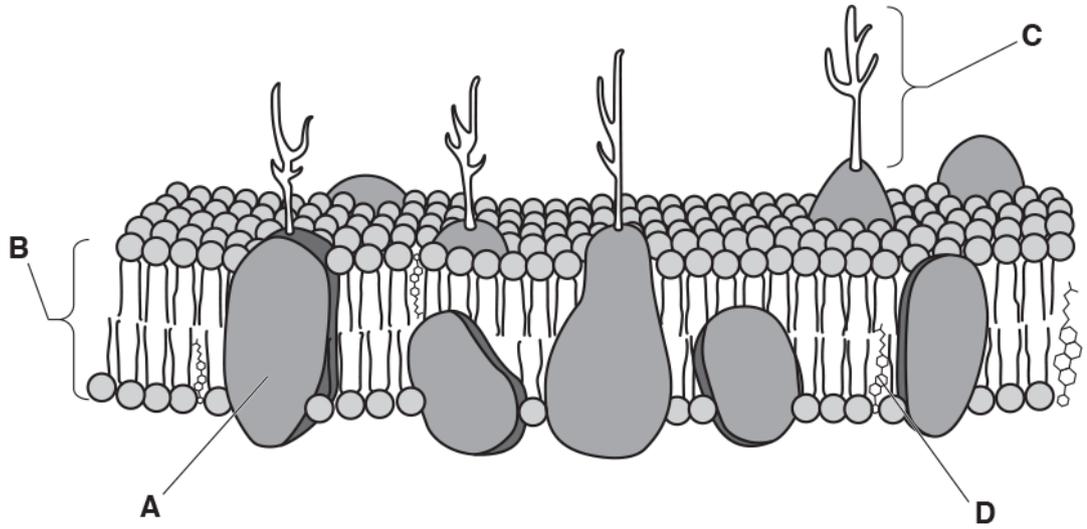
Which of the components, labelled **A** to **D**, regulates the fluidity of the membrane?

Your answer ☐ [1]

10. Flow cytometry can be used to distinguish types of leucocyte depending on the size of the cell and the granularity of the cytoplasm.

The diagram below shows the analysis of a blood sample using flow cytometry.

- Each dot represents a single cell
- The greater the forward scatter of light (FSC) the larger the cell
- The greater the side scatter of light (SSC) the more granular the cell
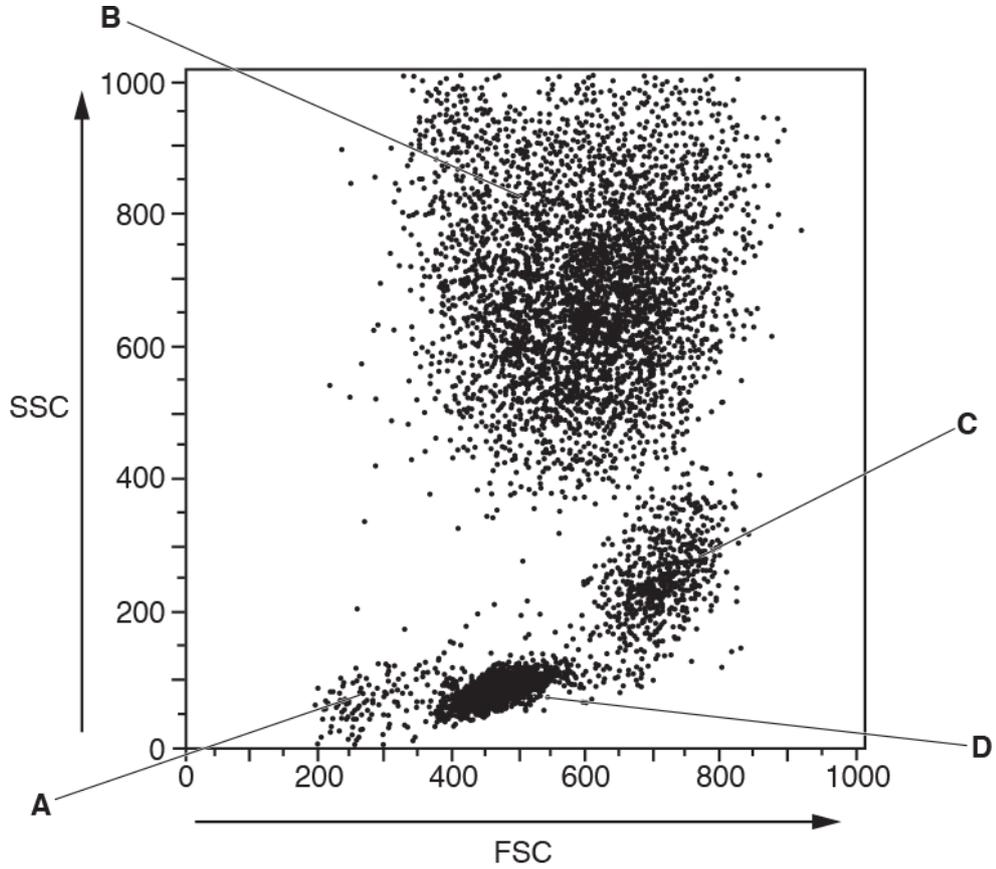
Which of the areas on the diagram, labelled **A** to **D**, shows the position of neutrophils?

Your answer [1]

11. A student was using an eyepiece graticule and a stage micrometer to calculate the length of a human cheek epithelial cell.

The following calibration and measurements were recorded:
- magnification of eyepiece lens = ×10
- magnification of objective lens = ×10
- 20 eyepiece divisions = 25 micrometer divisions
- each micrometer division = 10 µm
- length of epithelial cell observed = 6 eyepiece divisions.

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

	Total magnification	Length of one eyepiece division (µm)	Length of human cheek epithelial cell (µm)
A	20	12.5	75
B	100	50.0	300
C	100	12.5	75
D	20	50.0	300

Your answer [1]

12. Phloem loading is the process whereby plants move sucrose from a source into phloem sieve tubes.

During phloem loading, sucrose must be transported across the cell surface membranes of companion cells.

Which of the statements, **A** to **D**, about the transport of sucrose across the cell surface membrane of a companion cell is correct?

A Hydrogen ions are used to pump sucrose molecules through a carrier protein down a concentration gradient.

B Hydrogen ions are used to pump sucrose molecules through a carrier protein against a concentration gradient.

C Hydrogen ions and sucrose molecules are co-transported through a carrier protein as hydrogen ions move against their concentration gradient.

D Hydrogen ions and sucrose molecules are co-transported through a carrier protein as hydrogen ions move down their concentration gradient.

Your answer [1]

13. The photomicrographs show different types of leucocyte (white blood cell).
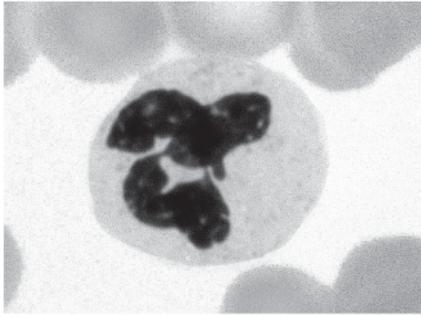
leucocyte A
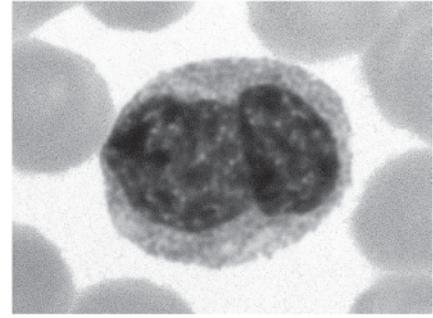
leucocyte B
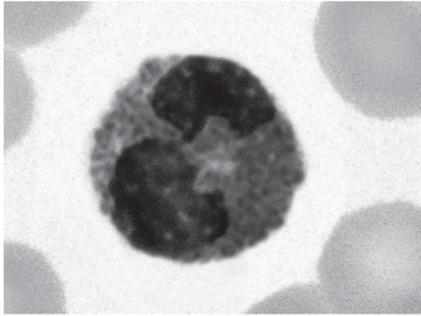
leucocyte C
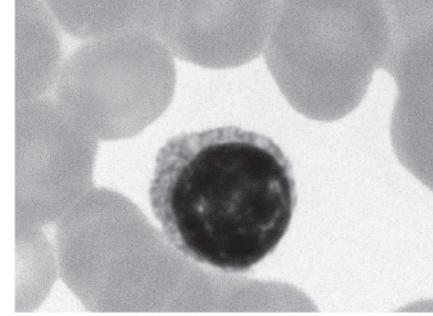
leucocyte D

Which of the leucocytes, **A** to **D**, can differentiate into a plasma cell during the specific immune response?

Your answer [1]

14. The statements below refer to the tissue shown in **Fig. 9.1** and the magnification.

Fig. 9.1

10 μm
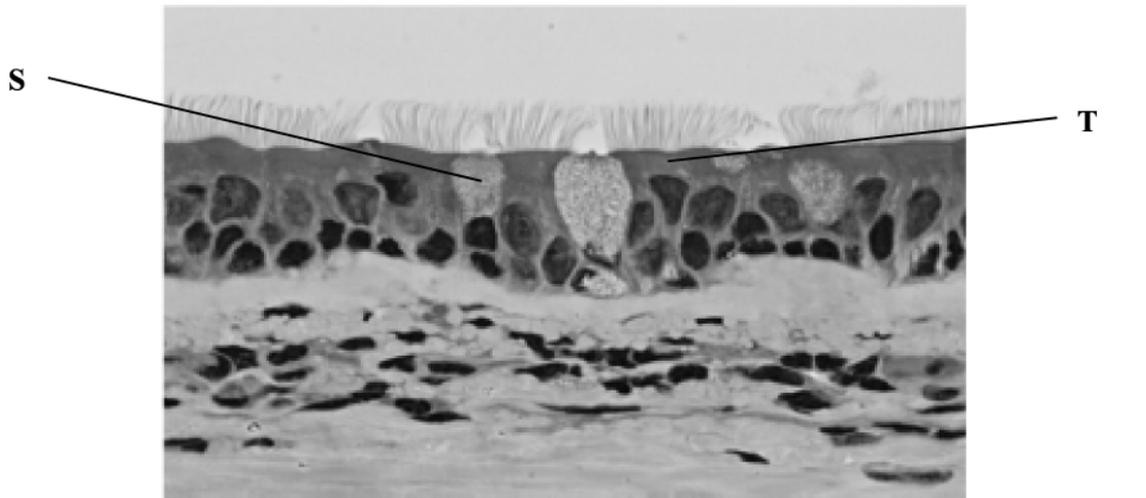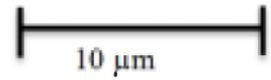
Which of the following statements is / are true?

Statement 1: The magnification of this image is × 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]

15. **Fig. 12.1** shows a section through a dicotyledonous plant leaf.
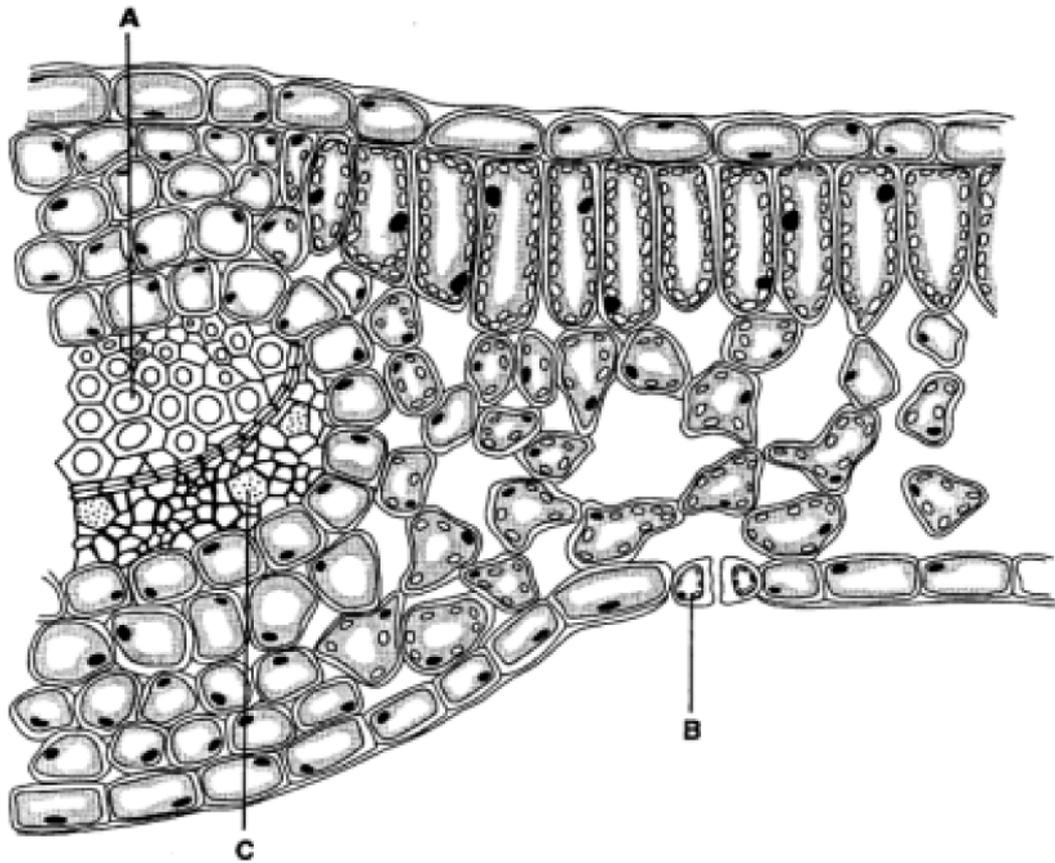
Fig. 12.1

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]

16. 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?
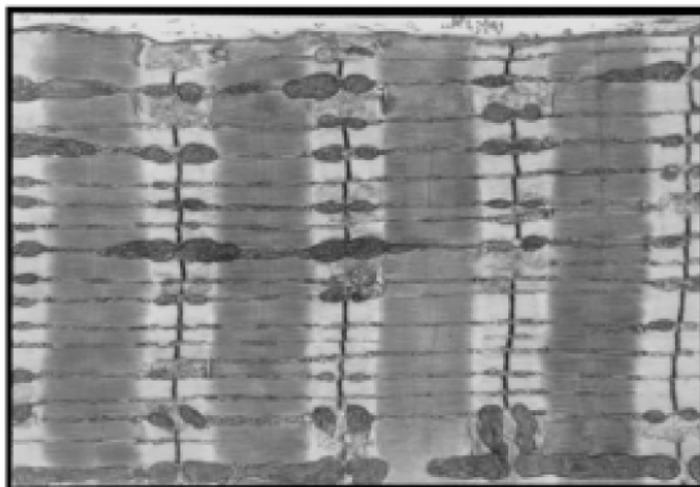
Fig. 17.1

Magnification = × 16800

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

Your answer ☐

[1]

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

A amylase
B cellulose
C lipid
D ribulose bisphosphate

Your answer ☐

[1]

18. Oxygen molecules enter cells by passive diffusion through the plasma (cell surface) membrane.
The rate of diffusion of oxygen is affected by its concentration gradient across the membrane.
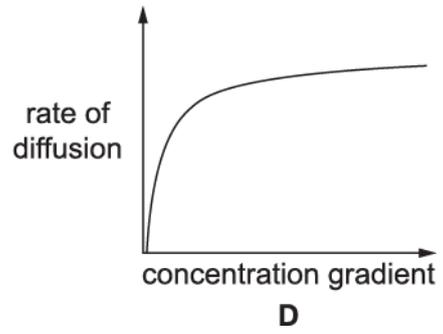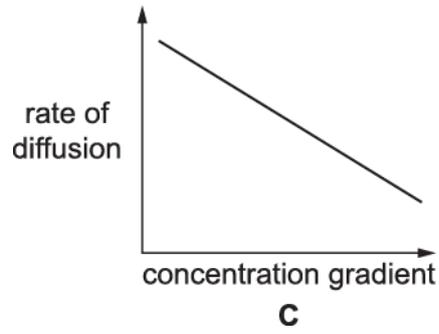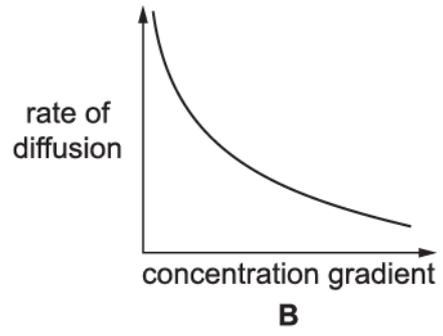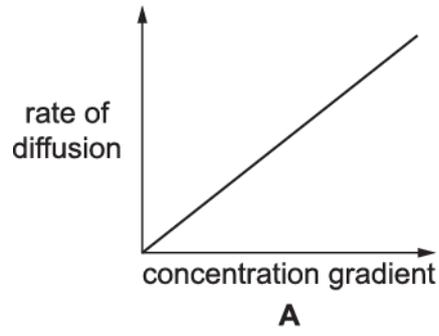
Which of the graphs, **A** to **D**, shows how the rate of diffusion of oxygen changes as its concentration gradient increases?

Your answer ☐

[1]

19. B-lymphocytes produce antibodies. The following organelles are involved in the synthesis and secretion of antibodies:

    1 Golgi apparatus

    2 ribosome

    3 endoplasmic reticulum

    4 nucleus

Which of the options, **A** to **D**, shows the correct sequence of organelles involved in the synthesis and secretion of antibodies?

    A 2, 3, 1, 4

    B 4, 2, 3, 1

    C 4, 3, 2, 1

    D 4, 2, 1, 3

Your answer ☐

[1]

20. *Chlamydomonas* is a small, fresh-water protoctist commonly found in ponds.

   A group of students collected a sample of pond water and counted the number of *Chlamydomonas* using a haemocytometer. The students noted the following:

   - The counting chamber of the haemocytometer had an area of 0.04 mm^2 and a depth below the cover slip of 0.1 mm.
   - The mean number of *Chlamydomonas* counted using this counting chamber = 2.

   Which of the options, **A** to **D**, is the correctly calculated number of *Chlamydomonas* in 1 cm^3 of this pond water sample?

   A 5×10^5
   B 500
   C 5×10^4
   D 50

   Your answer ☐

[1]

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

	Endoplasmic reticulum	Mitochondrion	Ribosome
A	✓	✗	✗
B	✗	✗	✓
C	✓	✓	✗
D	✗	✓	✓

Your answer [ ]

[1]

22. 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]

23. A phospholipid molecule is shown below.

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

$$O = P - O^- \quad \textbf{P}$$

$$CH_2 - CH - CH_2 \quad \textbf{Q}$$
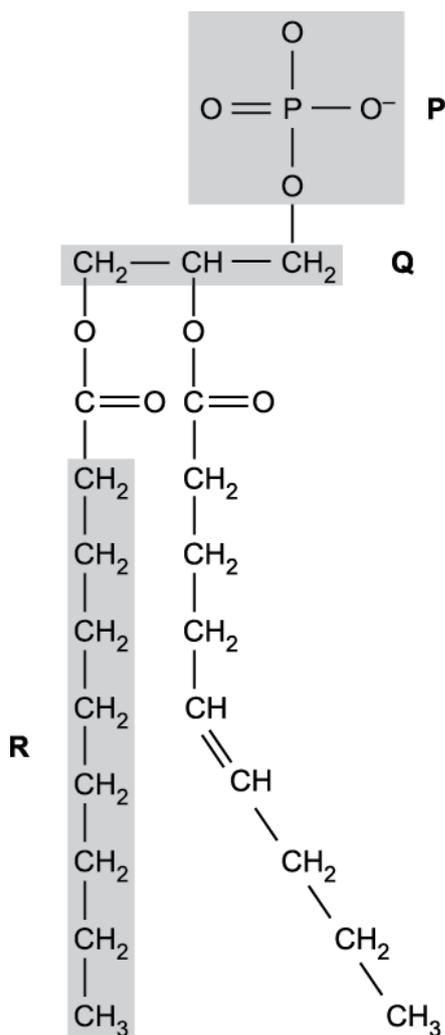
Which of the following statements is/are correct?

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 ▢

24.   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]

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

Two features are labelled **X** and **Y**.
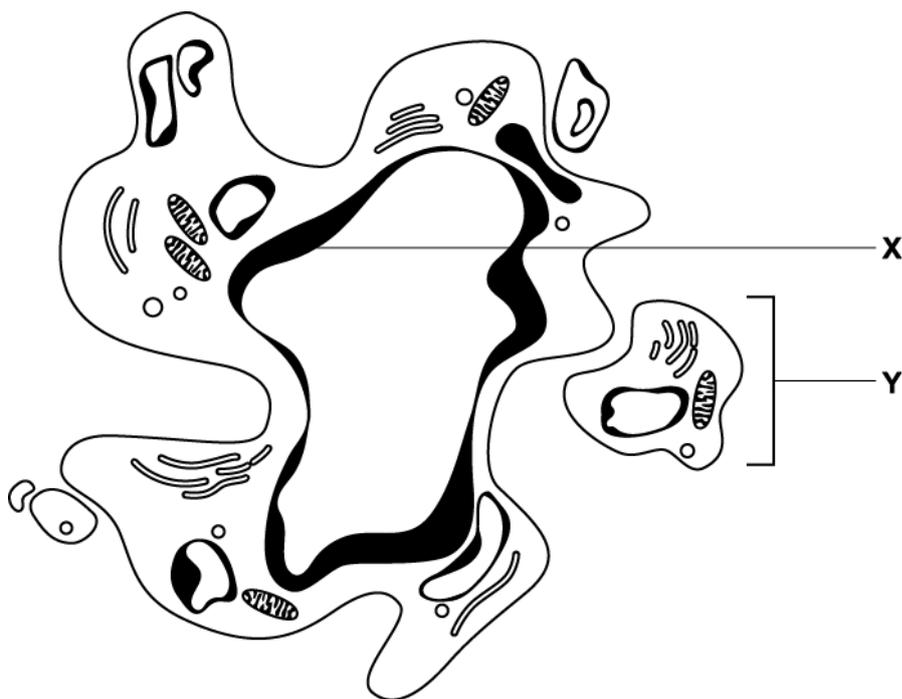
Which of the following statements is/are correct?

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]

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

A triple-ruled square is further divided into 16 smaller squares.
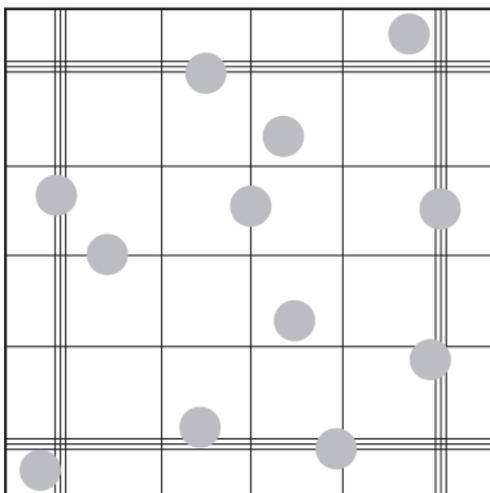
Which of the options, **A** to **D**, is the correct cell count for the triple-ruled square?

A 4

B 6

C 8

D 10

Your answer [1]

27. 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.
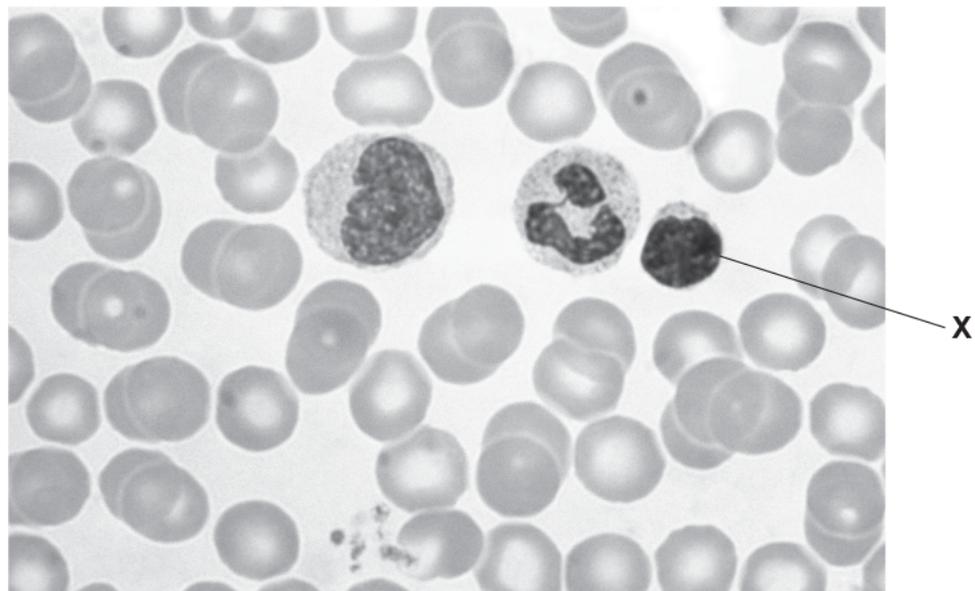
Magnification x750

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

   A 1.5×10^{-5} m

   B 1.5×10^{-6} m

   C 6.8×10^{-5} m

   D 6.8×10^{-6} m

   Your answer [ ]   [1]

28. The image below is a photomicrograph of a human blood smear. Three cells are labelled **X**, **Y** and **Z**.
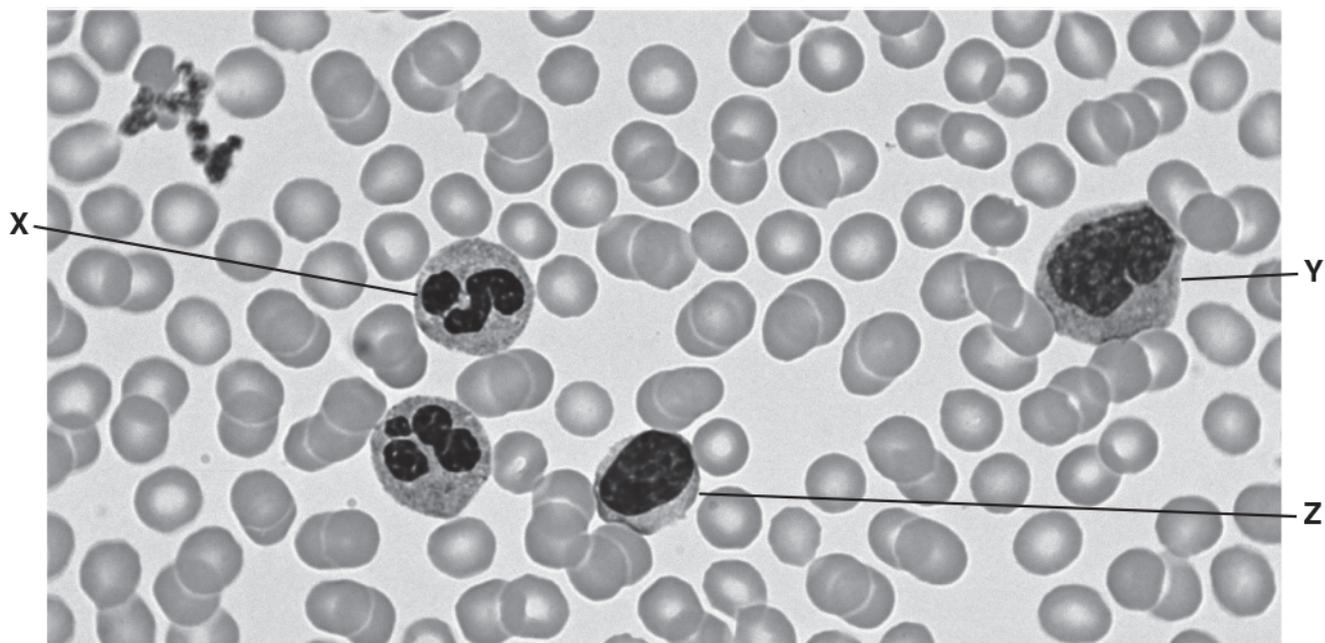
The diameter of cell **X** in the image is 15.5 mm and its actual diameter is 12.4 µm.

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

A   ×125

B   ×800

C   ×1250

D   ×8000

Your answer [ ]   [1]

29. The image below is a photomicrograph of a human blood smear. Three cells are labelled **X**, **Y** and **Z**.
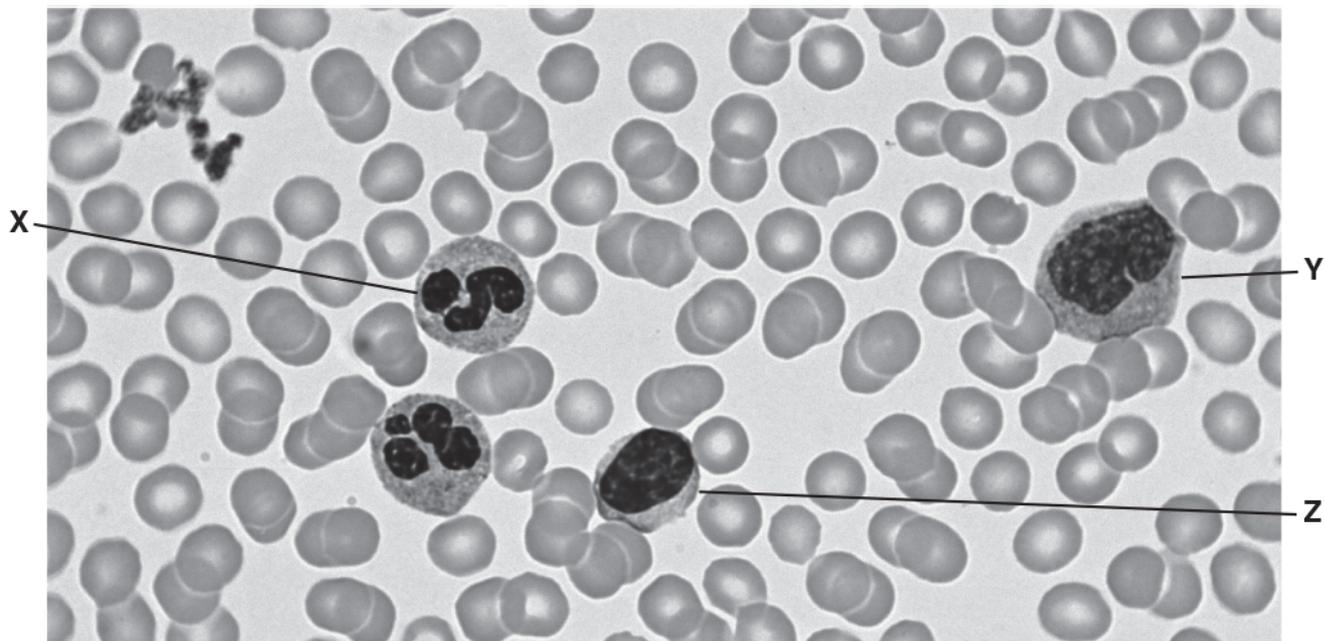
Which of the rows, **A** to **D**, in the table below correctly identifies cells **X**, **Y** and **Z**?

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

Your answer ☐ [1]

30. 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	2.1×10^{-4}
B	cell wall	4.3×10^{-4}
C	pilus	7.7×10^{-4}
D	ribosome	1.8×10^{-4}

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

Your answer [ ]   [1]

END OF QUESTION PAPER

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
1			C	1	
			Total	1	
2			B	1	
			Total	1	
3			D	1	
			Total	1	
4			B	1	
			Total	1	
5			C	1	
			Total	1	
6			C	1	
			Total	1	
7			C	1	
			Total	1	
8			D	1	
			Total	1	
9			D	1	**Examiner's Comments** A straightforward recall question to start the paper was accessible to all candidates across the ability range.
			Total	1	
10			B	1	**Examiner's Comments** This question tested knowledge of the relatively new concept of flow cytometry. Candidates were required to interpret a diagram and process information to formulate their response which did prove challenging for many candidates.
			Total	1	

Question			Answer/Indicative content	Marks	Guidance
11			C	1	**Examiner's Comments** Candidates had to process information and choose appropriate values to perform simple calculations. Many candidates extracted the correct information and used it appropriately to obtain the correct response.
			Total	1	
12			D	1	**Examiner's Comments** This question proved challenging for some, and required attention to detail in order to choose the most appropriate response
			Total	1	
13			D	1	**Examiner's Comments** Whilst the recognition of leucocytes using images proved challenging for some candidates, higher ability candidates were able to correctly identify leucocyte D as the lymphocyte; distinguishing it from the other cells by the shape of the nucleus and the size of the cell.
			Total	1	
14			C	1	
			Total	1	
15			C	1	
			Total	1	
16			D	1	
			Total	1	
17			C	1	
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
18			A	1	**Examiner's Comments** Options **A** and **D** were the two most common responses seen as the majority of candidates had correctly identified that the rate of diffusion would increase with increasing concentration gradient. However, only a small number of candidates offered the correct response so it proved to be a challenging question.
			Total	1	
19			B	1	**Examiner's Comments** This was a straightforward question about the organelles involved in the synthesis of antibodies. Many candidates knew that antibodies were protein molecules but then were unsure of the order of movement through the organelles during protein synthesis. Option C was the most common incorrect response, suggesting confusion in the sequence for ribosomes and endoplasmic reticulum.
			Total	1	
20			A	1	**Examiner's Comments** This was a tough mathematical challenge at the end of this section and there were some omissions. Switching between units of volume i.e. mm^3 and cm^3 and expressing numbers as 'powers of 10' proved difficult for many candidates.
			Total	1	
21			B ✓	1	
			Total	1	
22			D ✓	1	
			Total	1	

Question			Answer/Indicative content	Marks	Guidance
23			B ✓	1	
			Total	1	
24			A ✓	1	
			Total	1	
25			A ✓	1	
			Total	1	
26			B ✓	1	**Examiner's Comments** Most candidates were familiar with the north / west rule for counting cells in a haemocytometer and answered this question correctly.
			Total	1	
27			A ✓	1	**Examiner's Comments** Most candidates could accurately calculate the diameter of the cell and select the correct answer written in standard form.
			Total	1	
28			C	1	
			Total	1	
29			C	1	
			Total	1	
30			B	1	**Examiner's Comments** 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.
			Total	1	