

1. Fig. 7.1 shows an electron micrograph of *M. tuberculosis* bacteria.

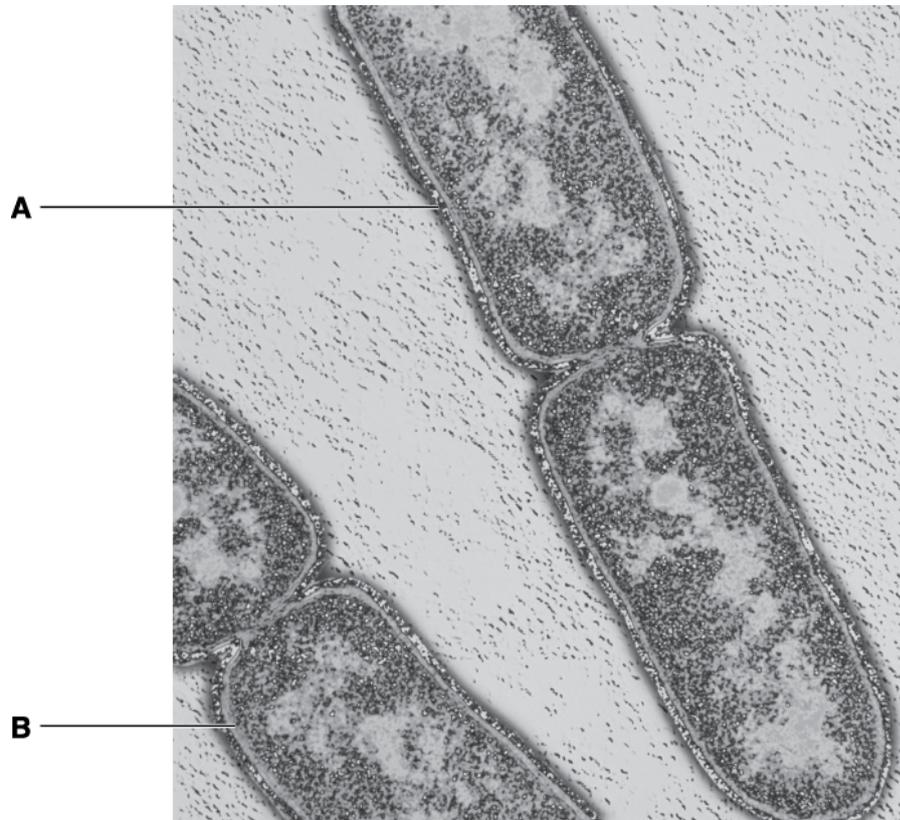


Fig. 7.1

The structure labelled B (pale layer) is a cell wall.

(i) Identify structure A (dark layer).

----- [1]

(ii) Name the substance from which structure B is made ----- [1]

(i) State **one** difference between the DNA in cells such as those shown in Fig. 7.1 and the DNA present in lymphocytes.

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**[1]**

2(a). Listeriosis is a disease caused by eating contaminated food products, such as unpasteurised milk.

The bacterium responsible for the disease, *Listeria monocytogenes*, releases an extracellular protein called p60 which enables the bacterium to invade host cells.

Anti-p60 antibodies have been identified that act as opsonins for the phagocytosis of *L. monocytogenes*.

(i) Explain what is meant by the following terms.

*opsonin*

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*phagocytosis*

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[2]

(ii) Explain how the production and release of extracellular proteins in mammalian cells would differ from that of p60 in *L. monocytogenes*.

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[2]

(b). Listeriosis can be fatal. Pre-screening food products for the presence of *L. monocytogenes* or p60 would be of great benefit to public health.

The protein p60 can be detected using diagnostic methods involving antibodies.

Outline the role of antibodies in the detection of *L. monocytogenes* and p60 in food samples.

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[3]

3(a). The ultrastructure of plant cells has similarities and differences when compared to animal cells.

Fig. 1.1 shows an electron micrograph of a cell from a dicotyledonous plant.

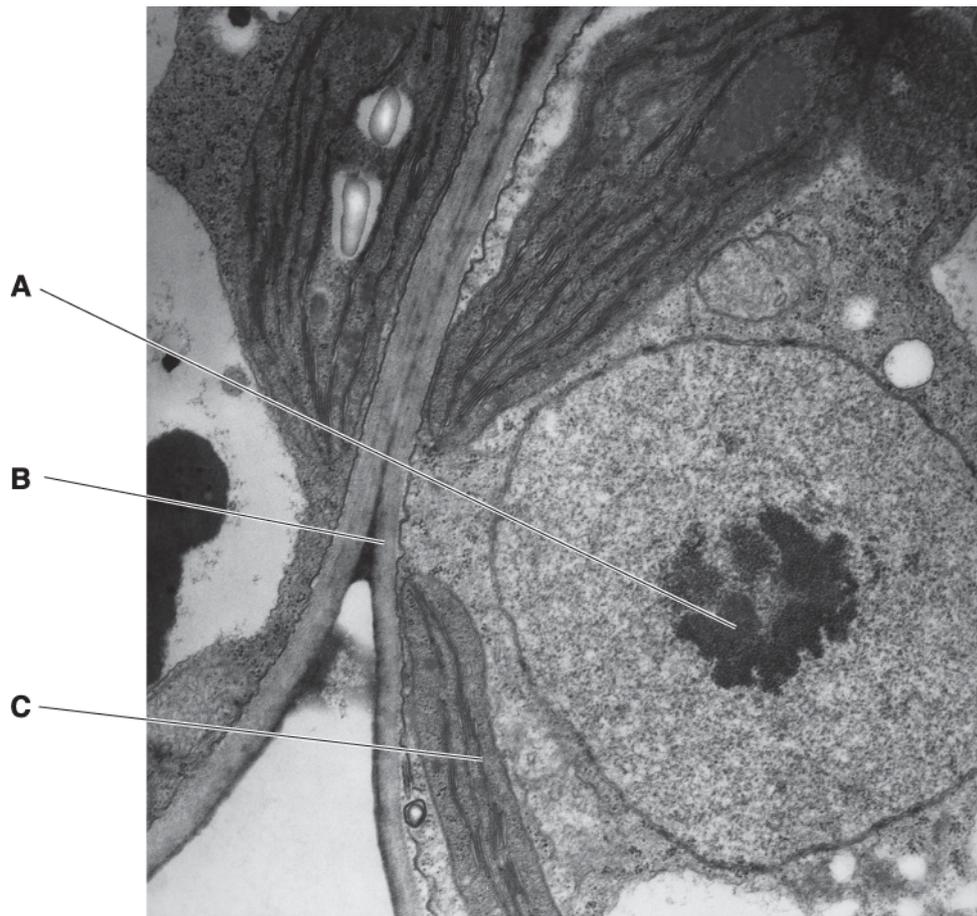


Fig. 1.1

State the function of the cell structures labelled A to C in Fig. 1.1.

A

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B

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C

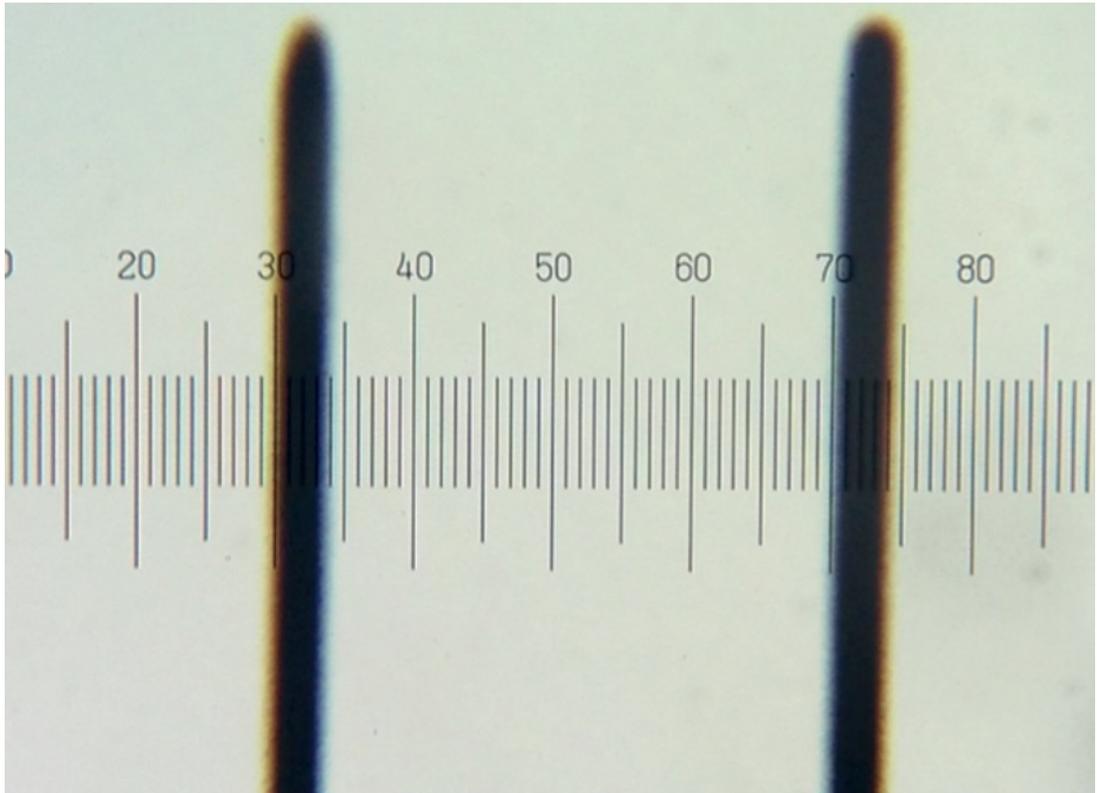
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(b).

(i) A light microscope was used to observe cells in the lower epidermis of a dicotyledonous leaf.

Fig. 1.2 shows a stage micrometer and an eyepiece graticule.

The division shown on the stage micrometer measures 10  $\mu\text{m}$ .



**Fig. 1.2**

Calculate the length of one eyepiece graticule unit.

Show your working.

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

(ii) Fig. 1.3 shows a stoma, guard cells and epidermal cells in the lower epidermis, as seen with a light microscope.



**Fig. 1.3**

The magnification is the same as in Fig. 1.2.

Use the value you calculated in (i) to calculate the length of the guard cell between points X and Y.

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



5(a). Leucocytes (white blood cells) make up approximately 1% of the total blood volume of a healthy adult. These cells can be viewed in stained blood smears using a light microscope.

Neutrophils and monocytes are types of leucocyte.

(i) Compare the structure of a neutrophil and a monocyte, as seen using a light microscope.

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----- [2]

(ii) Describe what happens to monocytes after their release into the blood circulation.

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----- [2]

(b). A full blood count (FBC) is a screening test that can be used to monitor health. The FBC includes a count of the number of each type of leucocyte in a cubic decimetre ( $\text{dm}^3$ ) of blood.

Fig. 1.1 shows the result of a leucocyte count for a healthy adult.

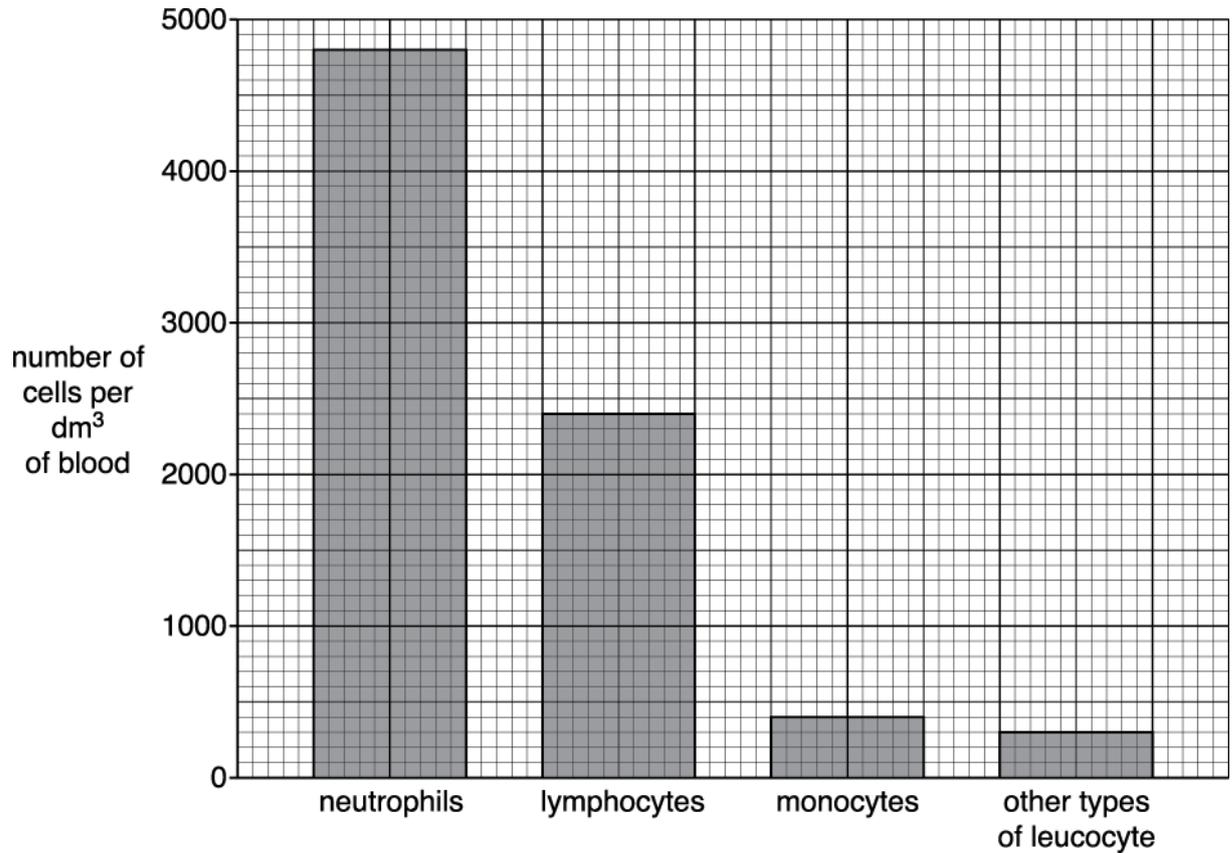


Fig. 1.1

(i) Using Fig. 1.1, calculate the percentage of lymphocytes in the total leucocyte count for this adult.

Show your working. Give your answer to one decimal place.

Answer = \_\_\_\_\_ % [2]

(ii) The result of a FBC for another adult showed more than 50% of the leucocyte count to be lymphocytes.

Suggest **one** reason for the difference in the result for this adult compared with the result for the healthy adult shown in Fig. 1.1.

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----- [1]

(iii) As well as being found in blood plasma, leucocytes may also be present in other body fluids, such as lymph.

Name **one** other component of **blood plasma** that is present in lymph.

----- [1]

(c). Eosinophils are another type of leucocyte circulating in blood. These cells produce a large number of **proteins**, such as cytokines.

Cytokines are proteins that are involved in cell signalling.

Fig. 1.2 shows the structure of an eosinophil.

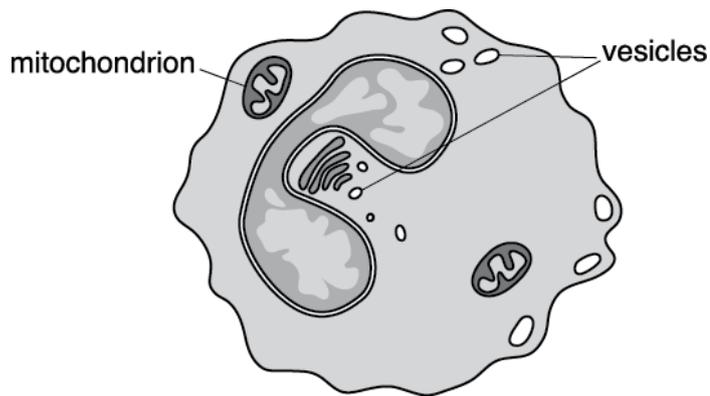


Fig. 1.2

Using Fig. 1.2, describe how **proteins** such as cytokines, made by eosinophils, are processed before being released from the cell.



*In your answer, you should use appropriate technical terms, spelled correctly.*



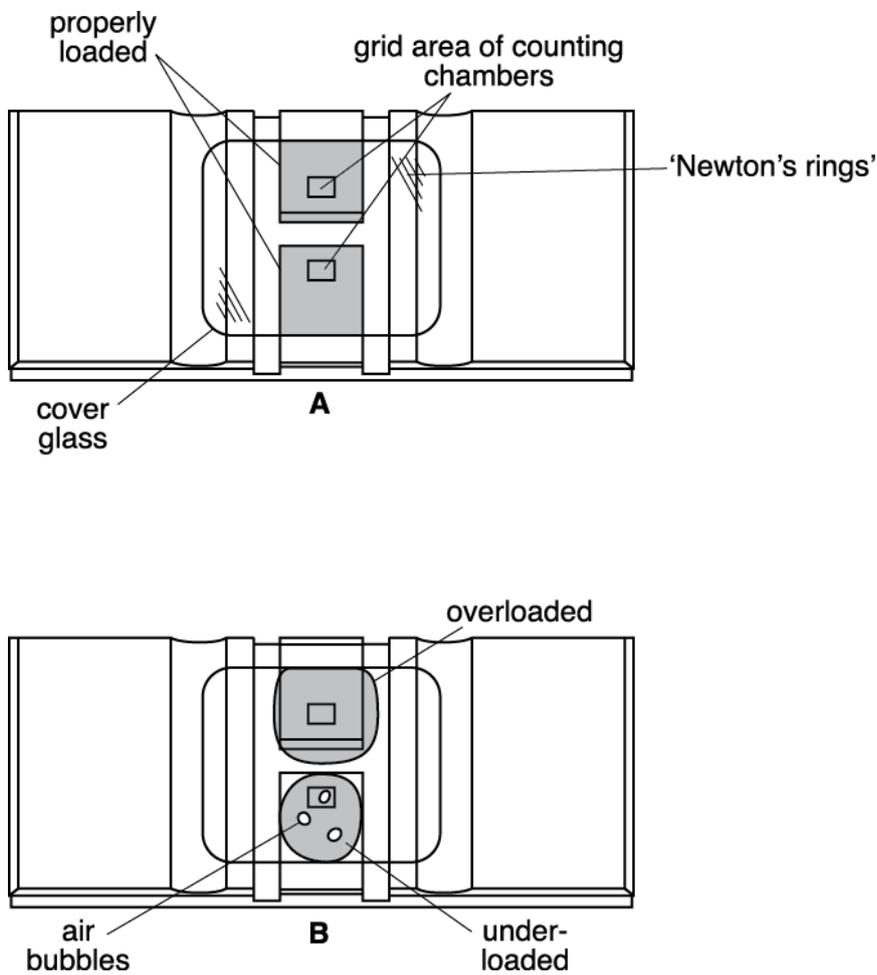


Fig. 1.3

The blood samples had been diluted so that the number of leucocytes could be counted accurately.

Other than diluting the sample, give **two** reasons why haemocytometer **B** would not allow the students to count the cells accurately. Explain your answers.

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[2]

6(a). Fig. 2.1 shows the structure of a phospholipid molecule.

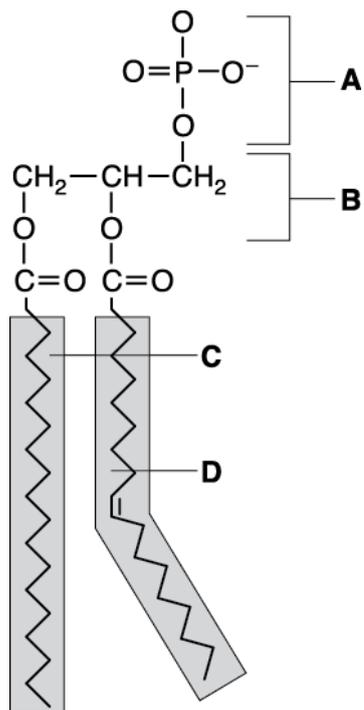


Fig. 2.1

(i) Name the parts of the molecule labelled B, C and D.

B

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C

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D

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[3]

(ii) Which part of the molecule, A, B, C or D, is hydrophilic?

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[1]

(b). Phospholipid molecules are components of cell membranes that surround organelles such as mitochondria and chloroplasts.

Outline the role of membranes **within** the cell.

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----- [2]

7. Biological molecules, such as lipids and carbohydrates, are found in dairy products.

Lipids differ depending on the type of fatty acid they contain.

Stearic acid is a fatty acid commonly found in animal fats. It contains 18 carbon atoms.

The structure of stearic acid is shown in Fig. 1.1.

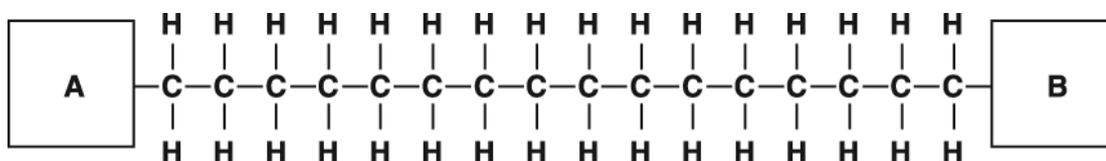


Fig. 1.1

(i) State the chemical groups labelled A and B in Fig. 1.1.

A .....

B .....

[2]

(ii) Fig. 1.2 shows another type of molecule also found in lipids.

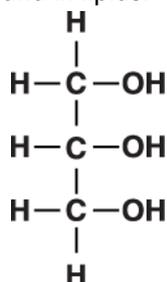


Fig. 1.2

Name the molecule shown in Fig. 1.2.

.....[1]

8. Platelets are small cell fragments found in blood plasma.

Fig. 2.1 is a simplified diagram of a platelet.

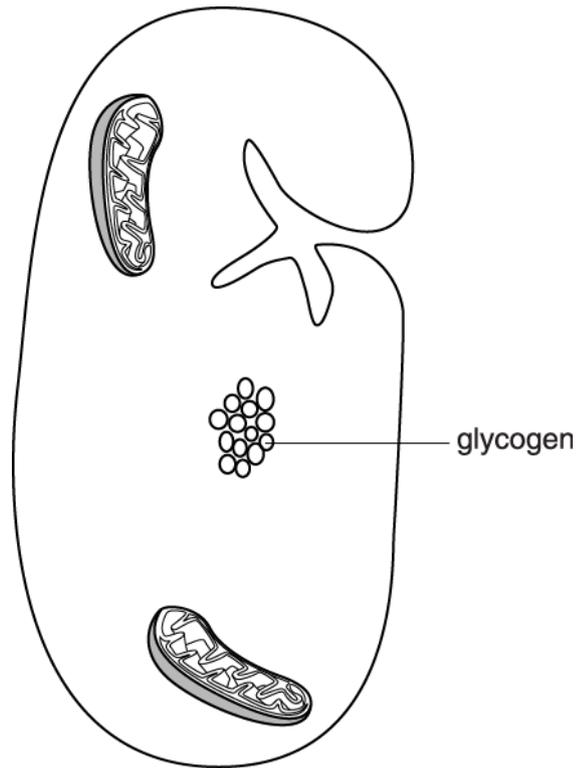


Fig. 2.1

(i) Using Fig. 2.1, compare the cytoplasm of a platelet with that of an erythrocyte.

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[2]

(ii) Platelets can be obtained from whole blood following a blood donation.

Platelets can be stored and used in blood transfusions, but they are not usually used to treat excessive blood loss.

Suggest one condition that could be treated by a transfusion of platelets.



9(a). The table below shows statements about ions found in blood plasma.

Some of these statements are true and some are false.

Complete the table by writing True (T) or False (F) in the box next to each statement.

Statement	True (T) or False (F)
ions found in blood plasma are known as electrolytes	
increasing the concentration of ions in the blood increases the water potential of plasma	
the concentration of ions in the blood can be measured using a haemocytometer	
ions can be transported across cell membranes by facilitated diffusion	

[3]

(b). Box jellyfish are extremely poisonous to humans.

The venom of the box jellyfish produces changes in cell membranes that result in high concentrations of potassium ions in blood plasma. This may lead to the death of cells.

(i) Suggest why the venom of the box jellyfish causes the concentration of potassium ions in blood plasma to increase.

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[2]

(ii) Explain how the loss of potassium ions from the cell may lead to cell death.

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[2]

10. *Amoeba proteus* is a single-celled organism that lives in freshwater habitats. Fig. 1.1 is a drawing of *A. proteus*.

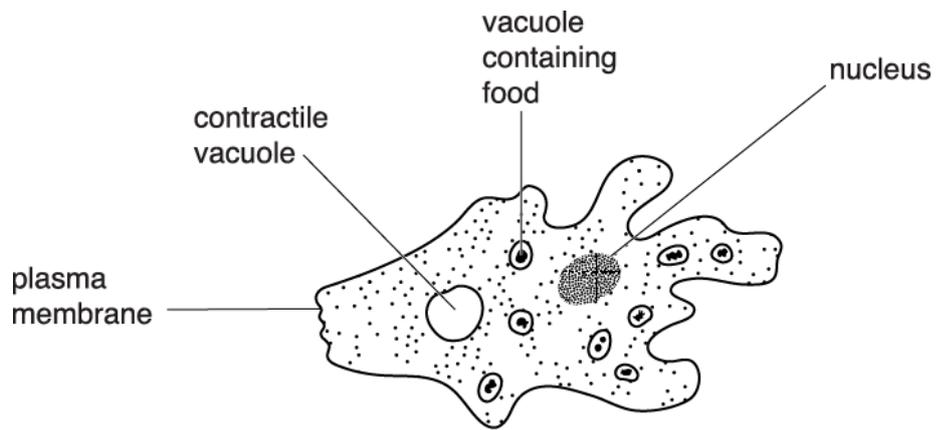


Fig. 1.1

State **one** feature shown in Fig. 1.1 that would **not** be present in a prokaryotic cell.

----- [1]

11(a) State the correct term for each of the following definitions.

The detailed structure of cells visible only with an electron microscope.

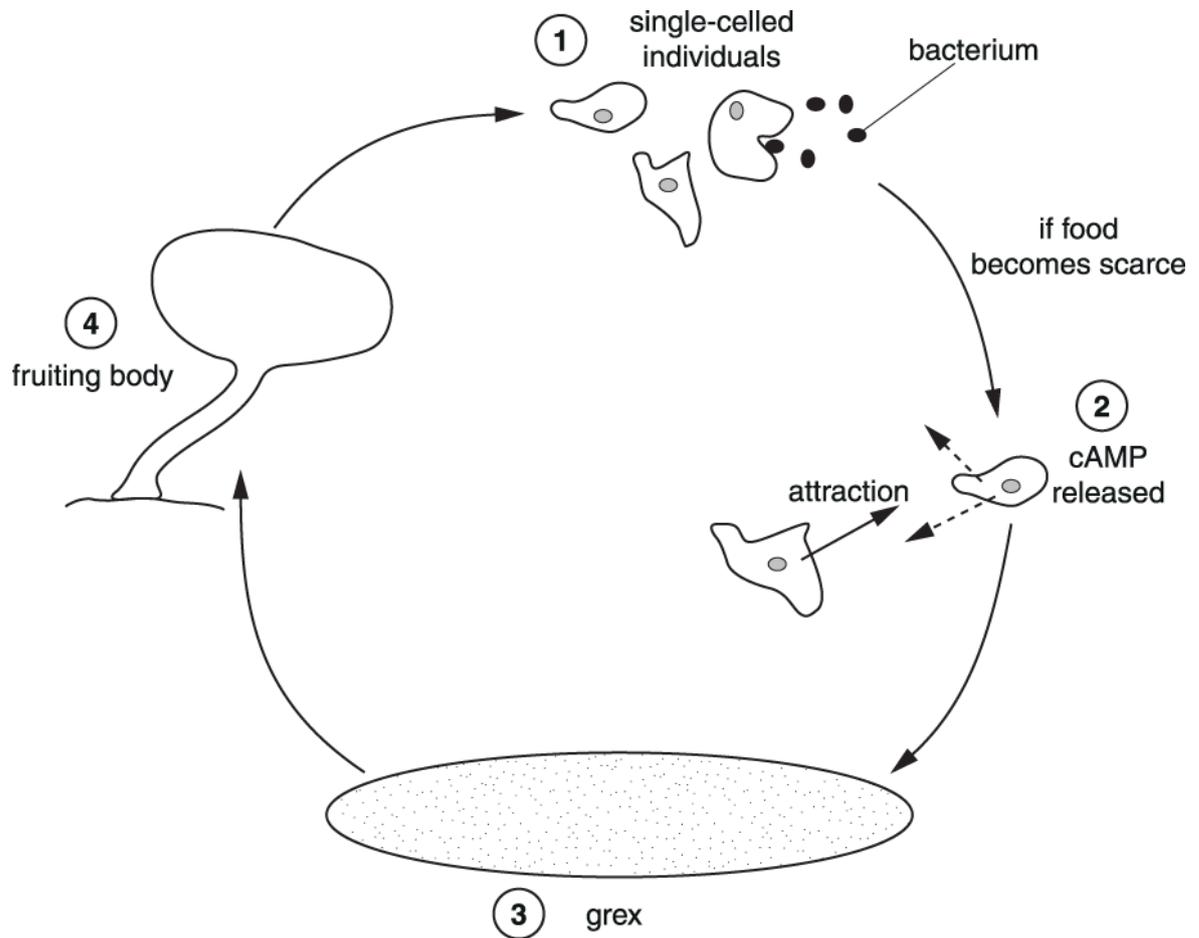
----- [1]

(b). The bulk transport of materials out of a cell.

----- [1]

12. A group of microorganisms called slime moulds includes the species *Dictyostelium discoideum*.

The life cycle of *D. discoideum* is shown in Fig. 5.1.



**Fig. 5.1**

- ① When plenty of food is available this slime mould exists as single-celled individuals which feed and reproduce asexually.  
The slime mould cells feed on bacteria.  
The slime mould cells are attracted to folic acid which has been released by the bacteria.
- ② When food becomes scarce the slime mould cells release a chemical (cAMP) which attracts other slime mould cells.
- ③ The slime mould cells then group and stick together to form a multicellular mass called a grex.  
The grex moves in a coordinated way in search of a more suitable environment.

As the grex moves, the cells release the chemical DIF. DIF causes some cells to become stalk cells and others to become spore cells.

- ④ When the grex reaches suitable conditions, it forms a fruiting body consisting of a stalk and spores. These spores are released and develop into new, individual, slime mould cells.

Communication and cooperation between cells is essential for the survival of *D. discoideum*.

- (i) State the correct term for communication between cells.

----- [1]

- (ii) Describe **two** examples of communication between cells that occur during the life cycle of *D. discoideum*.

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----- [2]

- (iii) The plasma membranes of the slime mould cells are specially adapted for communication.

Using the information in Fig. 5.1 and the text below it, as well as your biological knowledge, suggest how the plasma membrane of *D. discoideum* is adapted for cell communication.

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----- [2]

13. A scientist drew a diagram to explain the mechanism used to load sucrose into the sieve tube elements.

His diagram is shown in Fig. 4.2.

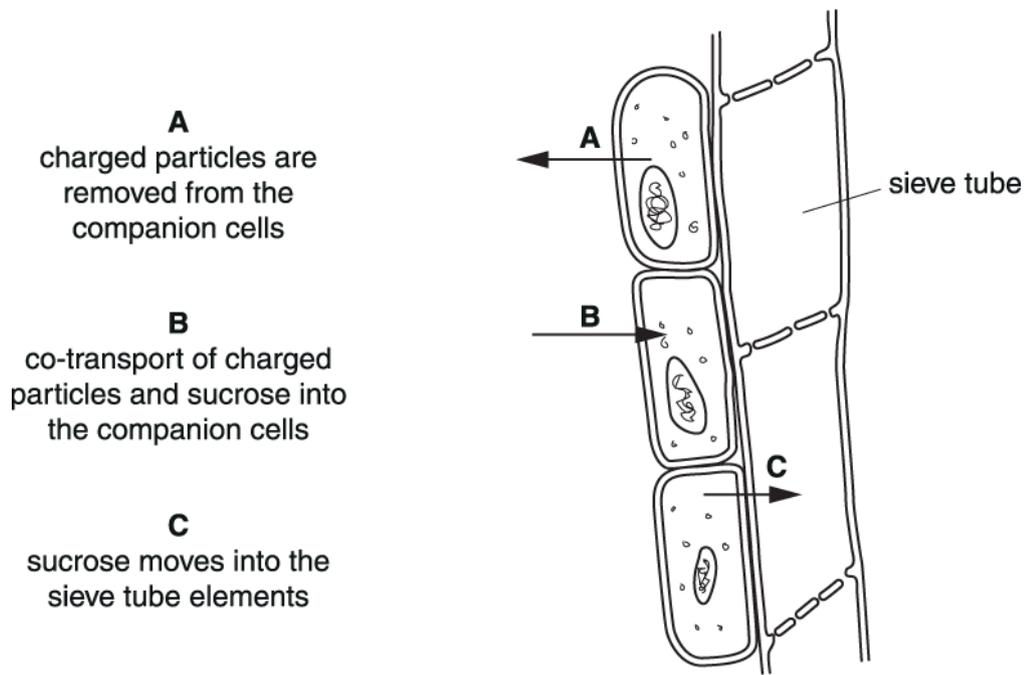


Fig. 4.2

(i) The following paragraph is an extract from the scientist's work.

Complete the paragraph.

At step A, charged particles are moved out of the companion cells by the process of \_\_\_\_\_ .

This creates a \_\_\_\_\_ gradient between the companion cell and its surroundings. At step B,

the charged particles and assimilates are co-transported by \_\_\_\_\_ diffusion

into the companion cells.

The assimilates build up in the companion cells and move by \_\_\_\_\_ into the sieve

tube elements at step C. Assimilates, such as sucrose and \_\_\_\_\_ , can be loaded

in this way.

(ii) The structure of cells is usually adapted to carry out their functions.

The scientist used an electron microscope to look for further evidence to support the mechanism involved in loading sucrose into the sieve tubes.

Suggest what evidence the scientist might expect to see in companion cells, using an electron microscope.

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[2]

14(a) Plant and animal cells have different structural features.

(i) Name **two** features of plant cells that are not features of animal cells.

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2

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[2]

(ii) Name **one** structure present in animal cells that is not present in plant cells.

----- [1]

(iii) The cytoskeleton in cells consists of microtubules and microfilaments.

Describe the roles of the cytoskeleton.

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----- [3]



15(a) Blood is made up of different types of cells.

A haemocytometer can be used to determine the concentration of each type of cell in blood sample.

Fig. 5.1 shows erythrocytes in one section of a haemocytometer chamber.

- The depth of the chamber is 0.1 mm.
- The blood sample was diluted by 1 in 200.

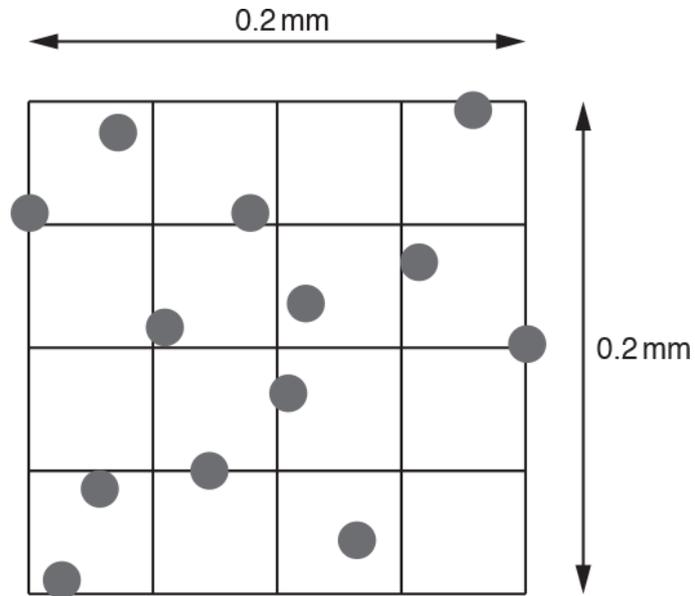


Fig. 5.1

(i) Using Fig. 5.1, calculate the number of cells in  $1 \text{ mm}^3$  of undiluted blood.

Answer = ----- [2]

- (ii) When preparing blood samples for counting different types of cell using a haemocytometer, technicians follow a set procedure.

For each of the steps below, give **one** reason why it would be included in the procedure.

The haemocytometer slide is cleaned with ethanol.

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The blood sample is mixed thoroughly before and after dilution.

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A diluting fluid, such as Dacie's fluid, is used.

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A stain is added to the diluting fluid.

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[4]

Table 5 shows the standard cell count from a blood sample of a **healthy** person.

Cell type	Number of cells ( $\text{dm}^3$ )
Erythrocytes	$4.5 \text{ to } 6.5 \times 10^{12}$
Platelets	$1.5 \text{ to } 4.0 \times 10^{11}$
All Leucocytes	$4.0 \text{ to } 11.0 \times 10^9$
Neutrophils	$2.0 \text{ to } 7.5 \times 10^9$
Lymphocytes	$1.0 \text{ to } 4.5 \times 10^9$

Table 5

A haemocytometer was used by a technician to count the blood cells of a patient suspected of having a blood disorder.



16. Fig. 1.1 is diagram of a cell found in the trachea. The structures labelled A to G are organelles found within the cell.

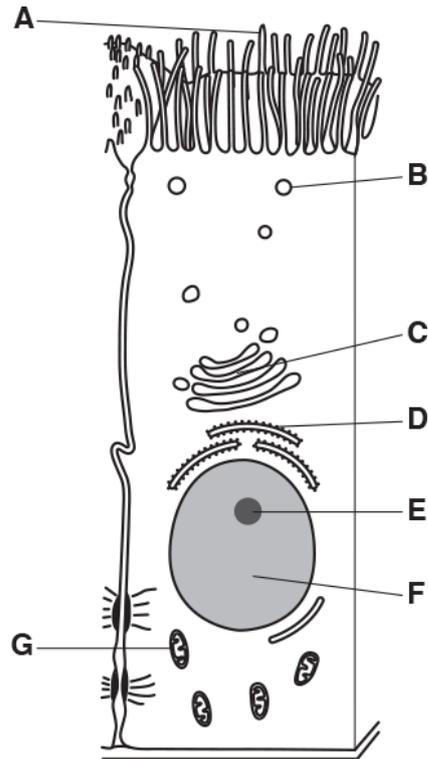


Fig. 1 .1

Using Fig. 1.1, complete the table below with the **letter** of the organelle that corresponds to the function being described.

Function	Letter
Provides ATP	
Modifies proteins	
Involved in protein synthesis	

[3]

17. A student was investigating the effect of sucrose concentration on plasmolysis in onion cells using the following procedure.

- Five Petri dishes were labelled **A** to **E**.
- Six drops of  $0.2 \text{ mol dm}^{-3}$  sucrose solution and two drops of differential stain were added to Petri dish **A**.
- A sample of epidermal tissue from an onion was placed in Petri dish **A**.
- The tissue sample was then removed immediately, placed on a microscope slide and viewed using light microscope.
- The numbers of plasmolysed and unplasmolysed cells were counted.
- This was repeated for Petri dishes **B** to **E** using different concentrations of sucrose solution as shown in Table 6.

(i) What is the purpose of the differential stain in **this** investigation?

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----- [1]

(ii) The student made the following statement:

'The water potential of the onion cells changes when the cells are stained with the differential stain.'

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----- [1]

(iii) Identify **two** sources of error in the procedure used **and** suggest an improvement for each.

error

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improvement

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error

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improvement

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[4]

18(a) *Beta vulgaris* (beetroot) is a species of beet plant.

The membrane-bound vacuole of beetroot cells contains the red pigment, betanin.

Name the membrane that surrounds the vacuole in plant cells.

----- [1]

(b). Beetroot was used by a group of students to investigate the effect of pH on the permeability of cell membranes. When the vacuole membrane is damaged its permeability to betanin increases and betanin leaks out into the surrounding solution.

- The students cut discs of beetroot and placed them in test tubes containing solutions of different pH for ten minutes.
- The students then used a colorimeter with a blue filter to measure the light absorption in the resulting solutions.

(i) During this investigation, the same volume of solution was used in each test tube.

State **two** other variables that must also be controlled in this investigation and suggest how they could be controlled.

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----- [2]



(c). Betanin is soluble in water.

Explain how the properties of the membrane surrounding the vacuole ensure that betanin does not leak out into the cytoplasm of healthy beetroot cells.

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----- [2]

19(a) Pathologists are often required to produce blood smears for analysing blood samples and determining the health of patients.

A pathologist produced a blood smear and then observed it using a light microscope.

Fig. 6 shows the image of the blood smear seen by the pathologist.

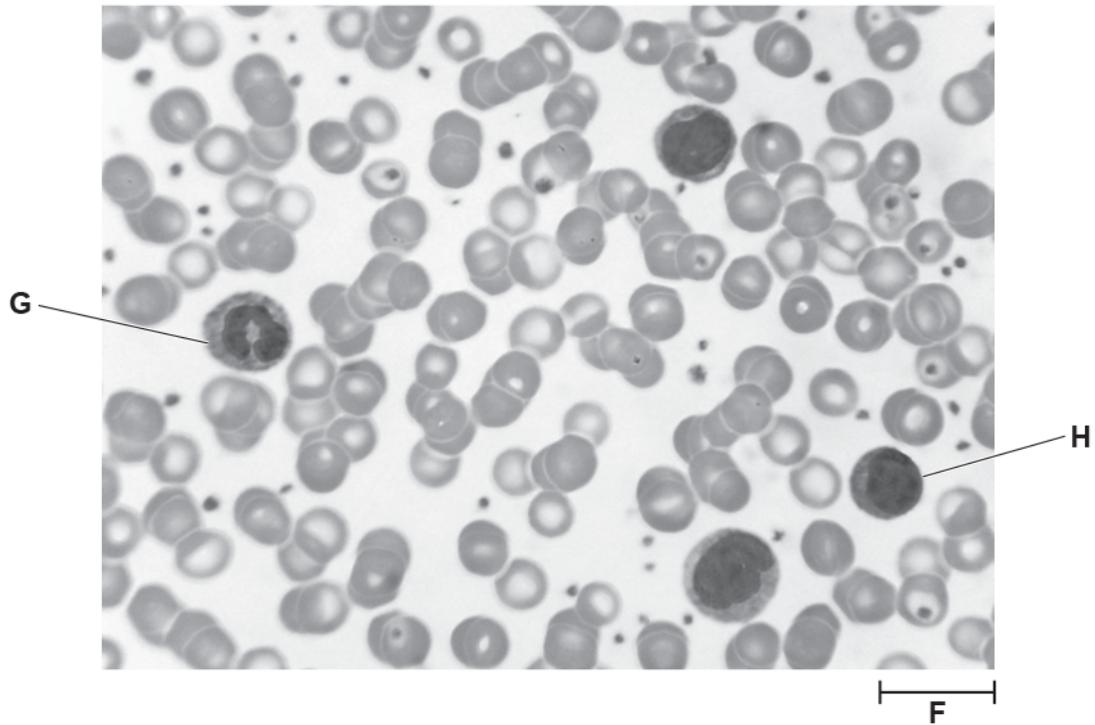


Fig. 6

(i) Name cells G and H in Fig. 6.

G -----

H -----

[2]

(ii) The magnification of the image in Fig. 6 is  $\times 500$ .

Calculate the length represented by the scale bar labelled F.

----- [2]

(b). Stages for preparing a stained blood smear in a school laboratory are outlined in the notes below.

A small drop of blood was placed on a microscope slide and allowed to dry. The slide was labelled and then flooded with Leishman's stain. After two minutes the slide was rinsed with water and left for a further five minutes. The slide was then rinsed again and left to dry.

(i) Give one stage that is missing from the notes and explain the effect this would have on the resulting blood smear.

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----- [2]



20(a) Water also plays an important role in the reactions involved in the formation and breakdown of macromolecules in the human body.

Fig. 23.1 shows the formation and breakdown of one type of macromolecule.

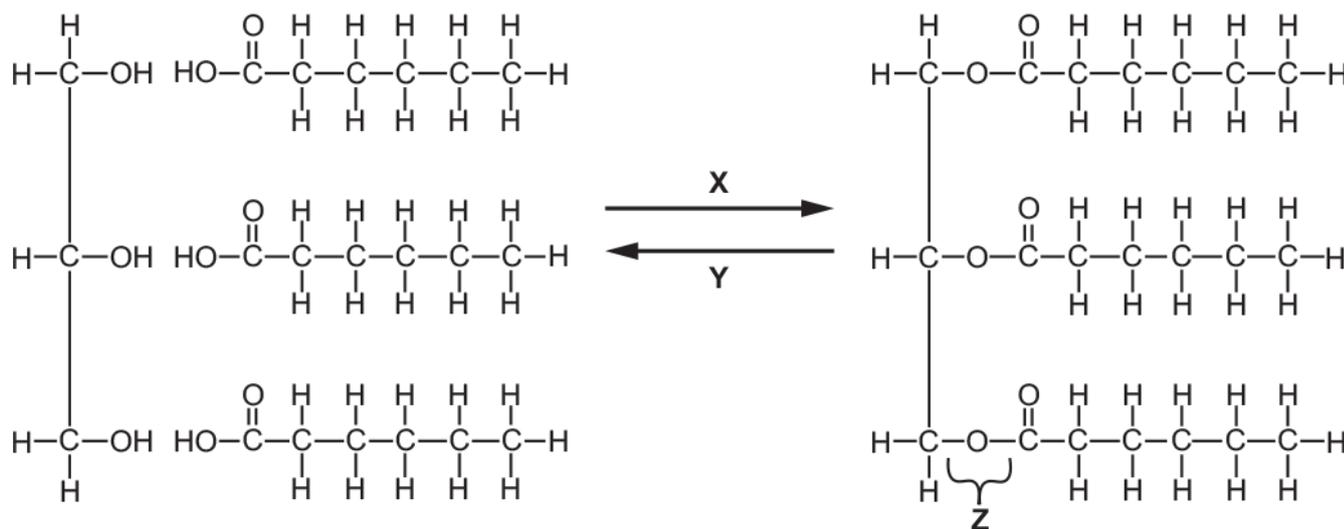


Fig. 23.1

(i) Name the types of reaction taking place at X and Y.

Reaction X .....

Reaction Y .....

[1]

(ii) Name both products of reaction X.

----- [1]

(iii) Name the bond labelled Z.

----- [1]

(b). Fig. 23.3 is a transmission electron micrograph (TEM) of a *C.jejuni* bacterium.

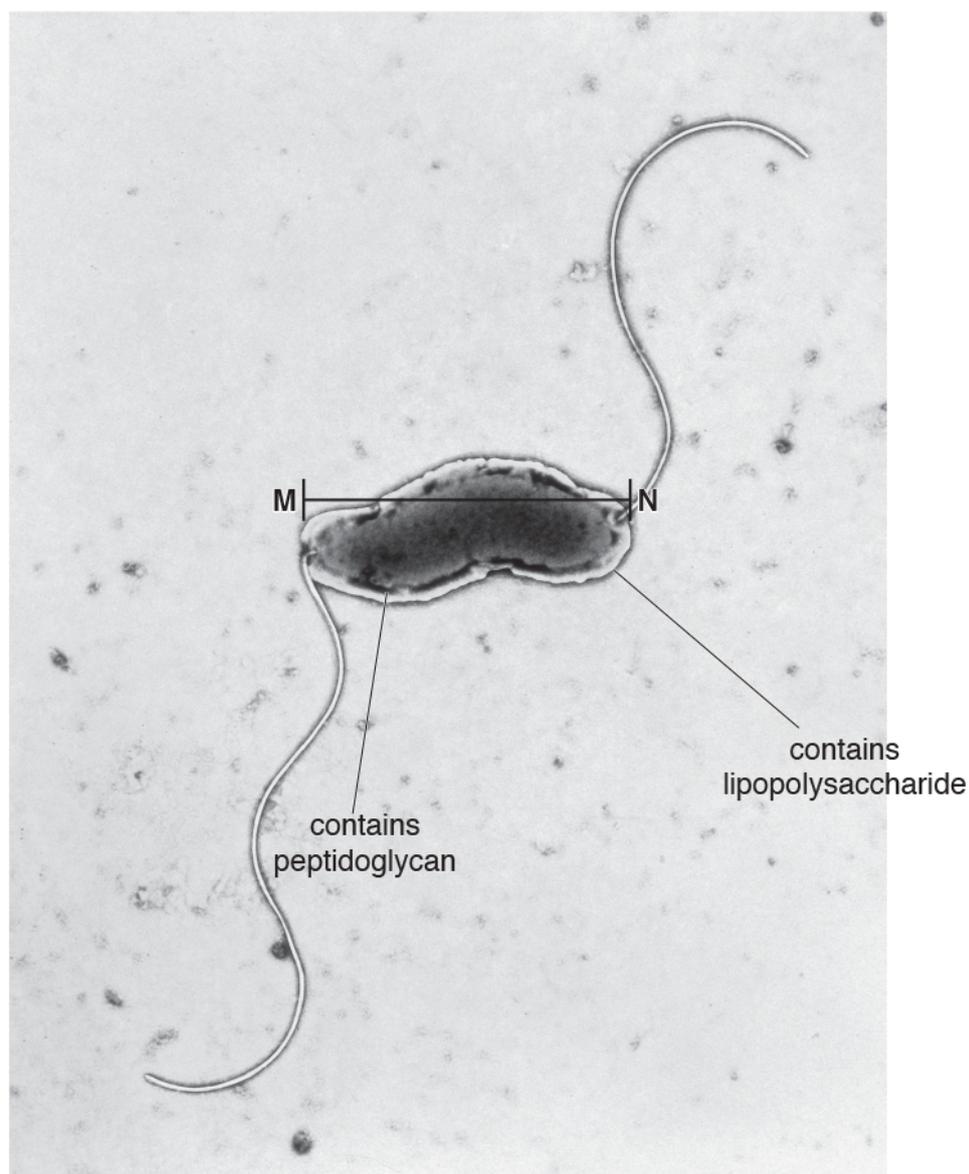


Fig. 23.3

(i) The actual length of the bacterium shown in Fig. 23.3 between points M and N is  $4\ \mu\text{m}$ .

Calculate the magnification of the micrograph.

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





(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]

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

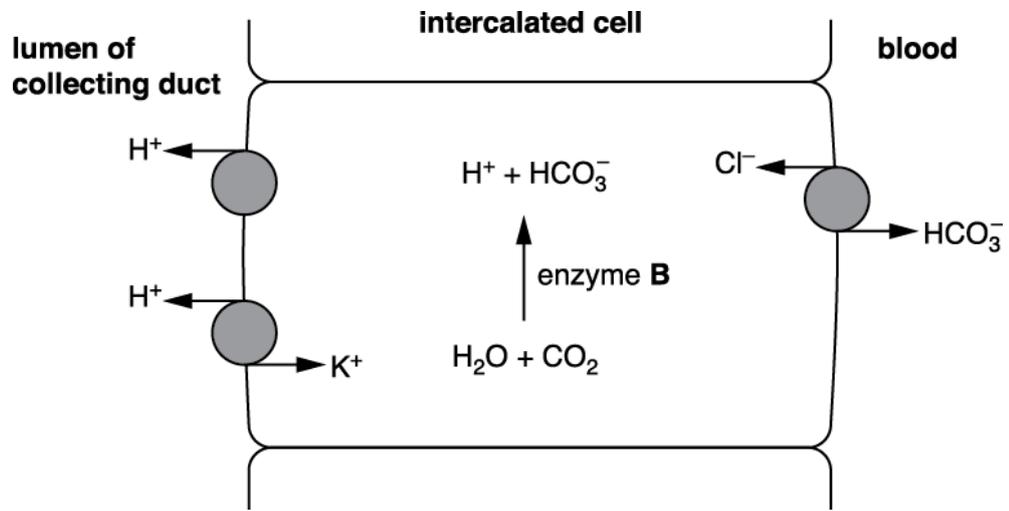
Anabolic steroids are transported in the blood plasma.

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.

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----- [2]

23. 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]

24. 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]

25. This question is based on the Advance Notice article **CATALASE**.

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.

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[2]

26. The recovery time of the heart is a good indicator of aerobic fitness.

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.

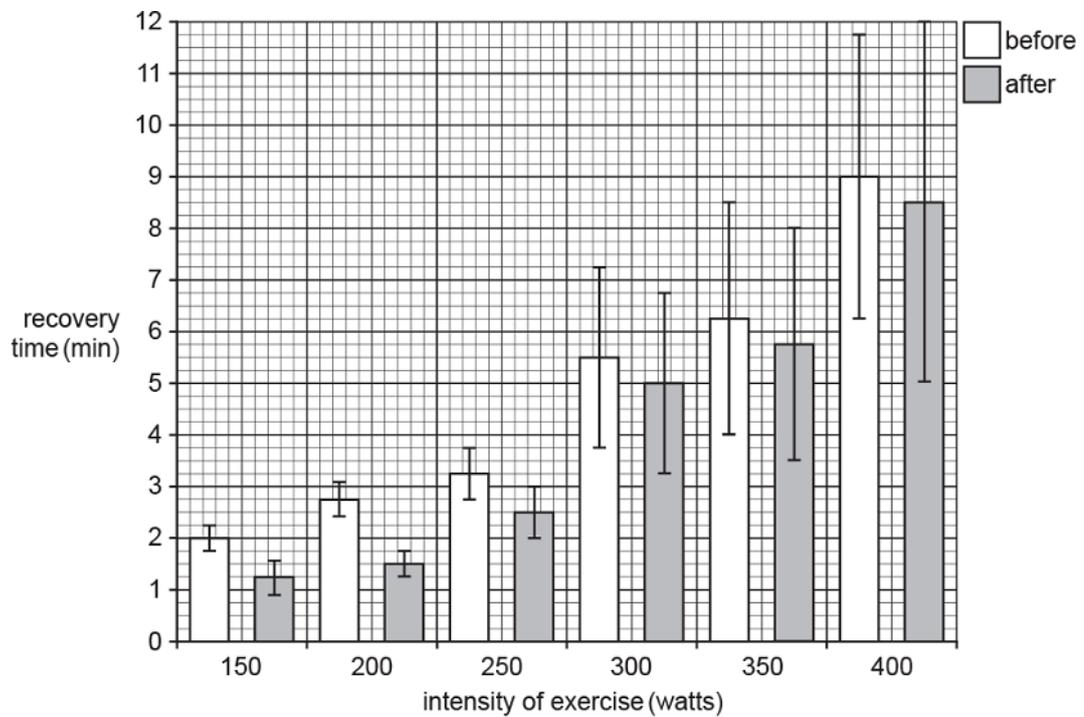


Fig. 36

(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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[2]

27.

Dialysis is a common treatment for kidney failure.

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

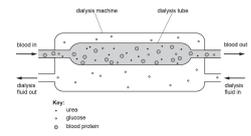


Fig. 37.1

(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]**

28. 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

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cyanobacteria

----- [2]

(iv) Explain how cyanobacteria are able to almost eliminate oxygen ( $O_2$ ) fixation by Rubisco.

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----- [3]

29(a)

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

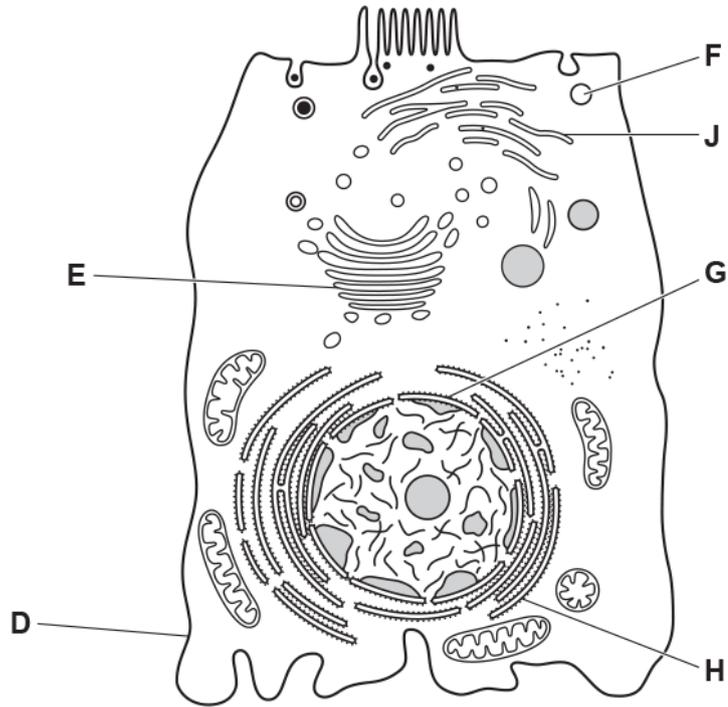


Fig. 7.1

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

D

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E

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F

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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

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H

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J

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[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.

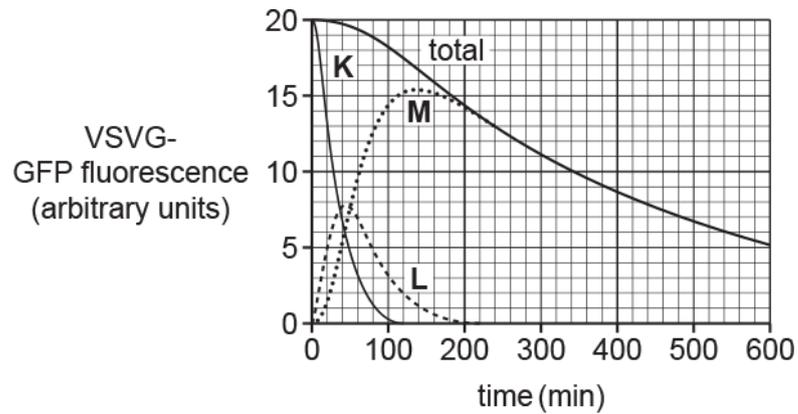


Fig. 7.2

(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.

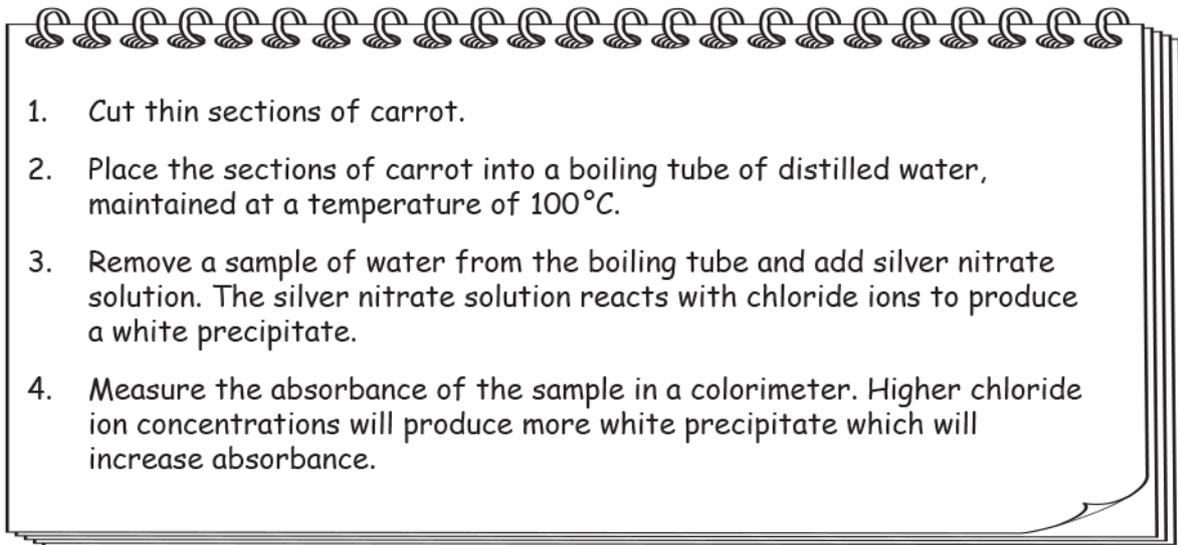
When VSVG-GFP fluorescence was followed through the treated cells, only curve M disappeared.

Suggest why.

[2]

30(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.

-----

----- [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.

-----

----- [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]





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

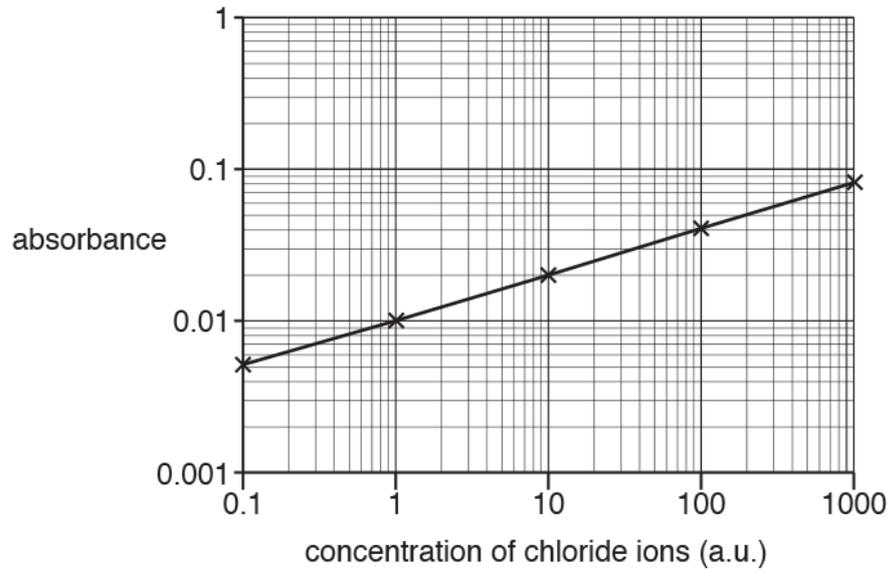


Fig. 2.2

- (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.

-----

----- [2]

END OF QUESTION PAPER

### Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
1		i	capsule;	1	<p><b><u>Examiner's Comments</u></b></p> <p>Weaker candidates often referred to cell wall. Capsid was sometimes seen as an incorrect answer.</p>
		ii	murein / peptidoglycan / carbohydrate and amino acids;	1	<p><b>DO NOT CREDIT</b> cellulose</p> <p><b><u>Examiner's Comments</u></b></p> <p>A wide variety of incorrect responses were given to this question. Murein was the most common correct response. Many candidates followed through from their incorrect Q7bi by stating cellulose.</p>
		iii	<p><i>M. tuberculosis</i> not in nucleus <b>OR</b> circular <b>OR</b> found as plasmids <b>OR</b> no histones;</p>	1	<p><b>ACCEPT</b> ora if clearly stated as lymphocytes</p> <p><b><u>Examiner's Comments</u></b></p> <p>The majority of candidates achieved this mark; the only error seen was stating a difference seen in lymphocytes without stating the cell type.</p>
			<b>Total</b>	<b>3</b>	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
2	a	i	<p><i>opsonin</i> protein / antibody, that enhances phagocytosis by marking antigens / AW ✓</p> <p><i>phagocytosis</i> (the process by which) cell / phagocyte, engulfs bacteria / pathogens / cell debris ✓</p>	2	<p><b>CREDIT</b> other named cells e.g. macrophage  <b>IGNORE</b> references to engulfing antigens  <b>IGNORE</b> digests  <b>DO NOT CREDIT</b> lymphocyte for a phagocyte</p> <p><b>Examiner's Comments</b></p> <p>This question addressed both <b>AO1</b> and <b>AO2</b>. The candidates' knowledge of the concepts surrounding antibodies and protein synthesis were being examined in the novel context of the disease, Listeriosis.</p> <p>Required candidates to provide meanings for two of the terms from the specification and whilst a good number of candidates could explain the meaning of <i>phagocytosis</i>, the term <i>opsonin</i> proved more challenging. Alternative wording was used to credit good responses, but in cases where the full meaning of the term was not provided, marks were not awarded. For candidates who spotted the trigger.</p>

**Mark Scheme**

Question	Answer/Indicative content	Marks	Guidance
	<p>ii</p> <p><i>in mammalian cells</i>  <i>idea that the protein is synthesised on, rough endoplasmic reticulum / rER</i>  <b>OR</b>  <i>protein synthesis on, larger / 80S, ribosomes ✓</i></p> <p><i>idea that the protein is, packaged / modified, by Golgi (apparatus) ✓</i></p> <p><i>idea that the protein is packaged into vesicles which fuse with cell surface membrane ✓</i></p>	<p>2 max</p>	<p>CREDIT ORA throughout for bacterial cells</p> <p>CREDIT exocytosis occurs</p> <p><b>Examiner's Comments</b></p> <p>This question addressed both AO1 and AO2. The candidates' knowledge of the concepts surrounding antibodies and protein synthesis were being examined in the novel context of the disease, Listeriosis.</p> <p>Production of proteins in mammalian cells, this was a fairly straightforward question and there were some good responses demonstrating clear understanding of how proteins are produced and transported within the mammalian cell as opposed to a bacterial (prokaryotic) cell. However, there were a few 'no responses' seen for this part of the question and it is possible that some candidates failed to take on board the context or did not understand that protein synthesis would be different in bacterial cells as they did not have organelles.</p>

### Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
	b	<p>flow cytometry ✓</p> <p><i>idea that</i> bacteria / <i>L. monocytogenes</i>, are tagged by antibodies labelled with fluorescent markers ✓</p> <p><i>idea of</i> antibodies being immobilised ✓</p> <p>antibodies may, bind / attach to, (test) antigen / protein / p60 ✓</p> <p><i>idea that</i> antibodies may be linked to enzymes producing colour reaction ✓</p>	3 max	<p><b>ACCEPT</b> <i>idea of</i> binding leading to production of colour</p> <p><b>ACCEPT</b> description of ELISA</p> <p><b>Examiner's Comments</b></p> <p>This question addressed both <b>AO1</b> and <b>AO2</b>. The candidates' knowledge of the concepts surrounding antibodies and protein synthesis were being examined in the novel context of the disease, Listeriosis.</p> <p>The diagram of the examiners were pleased to see a number of candidates clearly referring to ELISA tests in their responses and whilst not a learning outcome on the specification, descriptions of such techniques were credited as examples of extended reading on this topic. Reference to flow cytometry was rarely seen, but candidates were able to gain marks in other ways by outlining detail such as antibodies binding to p60 or the bacterial antigens.</p>
		<b>Total</b>	<b>7</b>	

### Mark Scheme

Question		Answer/Indicative content	Marks	Guidance	
3	a	<p>A (nucleolus) manufactures ribosomes ✓</p> <p>B (cell wall) prevents the cell from bursting ✓</p> <p>C (chloroplast) (site of) photosynthesis ✓</p>	3	<p>ACCEPT synthesises rRNA</p> <p>ACCEPT maintains shape / allows turgidity</p> <p>IGNORE structure / stability / strengthens</p> <p>ACCEPT description</p> <p><b><u>Examiner's Comments</u></b></p> <p>Many candidates found this question Some candidates named the cell structures and others wrote functions for wrongly identified organelles usually mitochondria for chloroplast or the production of ATP and nucleus for nucleolus or general references to the storage of genetic material. Candidates often lost the mark for cell wall for referring to structure or strength neither of which were enough to gain the mark.</p>	
	b	i	0.25 (µm) ✓✓	2	<p>Correct answer = 2 marks</p> <p>ACCEPT 0.23 – 0.28</p> <p>1/36 – 44 = 1 mark</p> <p>x 10 = 1 mark</p> <p><b><u>Examiner's Comments</u></b></p> <p>This was a straightforward magnification calculation but many candidates did not score any marks. Not all candidates showed their working contrary to the instructions given in the question. It is worth pointing out that there was evidence that a lot of candidates used the IAM formula but most were not able to interpret the answers correctly, they clearly didn't really understand the formula and were not able to appreciate how unlikely it was that some of the answers they obtained were correct. Many candidates forgot to multiply by 10 and therefore lost a mark.</p>

### Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		ii	5 ( $\mu\text{m}$ ) ✓✓	2	<p>Correct answer = 2 marks  <b>ACCEPT</b> 4.6 – 5.6            20 (eye piece graticule units) = 1 mark            x (b)(i) = 1 mark            If answer given is incorrect <b>allow 1 mark for ECF</b></p> <p><b><u>Examiner's Comments</u></b></p> <p>More candidates gained marks in (ii), often thanks to an error carried forward from the previous question. However, the comments made about (i) could equally apply here.</p>
			<b>Total</b>	<b>7</b>	

## Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
4	<p><i>*Please refer to the marking instructions for guidance on how to mark this question.</i></p> <p><b><i>In summary:</i></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 set of level descriptors, Level 1, Level 2 or Level 3, best describes the overall quality of the answer.</i></p> <p><i>Then, award the higher or lower mark, according to the communication statement (in italics).</i></p> <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 (5–6 marks)</b></p> <p>Provides a comprehensive explanation of the transport of proteins into the intestinal cells / transport in the plasma, and the formation of proteins including reference to both transcription and translation and RNA structure.</p> <p><i>There is a well-developed line of reasoning which is clear and logically structured and flows. All the information presented is relevant.</i></p> <p><b>Level 2 (3–4 marks)</b></p> <p>A partial explanation of both the transport of proteins into the intestinal cells / transport in the plasma, and the formation of proteins including reference to both transcription and translation and RNA structure.</p> <p><i>There is a line of reasoning presented with some structure. The information presented is mostly relevant.</i></p> <p><b>Level 1 (1–2 marks)</b></p> <p>An explanation of either the transport of proteins into the intestinal cells / transport</p>	6	<p><b>scientific points may include</b></p> <p>transport</p> <ul style="list-style-type: none"> <li>• dissolves / soluble in plasma</li> <li>• polar molecule</li> <li>• contraction of heart</li> <li>• details of facilitated diffusion</li> <li>• details of action of channel / carrier proteins</li> <li>• passive process</li> <li>• high to low concentration</li> </ul> <p>formation of proteins</p> <ul style="list-style-type: none"> <li>• 4 nucleotide bases</li> <li>• adenine, thymine, cytosine and guanine</li> <li>• codon and anti-codon</li> <li>• hydrogen bonding between bases</li> <li>• unzipping / breaking of hydrogen bonds</li> <li>• production of mRNA</li> <li>• formation of phosphodiester bonds between nucleotides, condensation reactions</li> <li>• role of tRNA</li> <li>• formation of peptide bonds between amino acids</li> <li>• complementary base pairing</li> <li>• details of protein structures</li> </ul> <p><b><u>Examiner's Comments</u></b></p> <p>The most common level achieved in was two, with many candidates getting three to four marks. This was often due to the fact that students wrote a lot about protein synthesis and very little, correct, information about the transport of amino acids to the muscle cell. Very few</p>

### Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
			<p>in the plasma, or the formation of proteins.  <i>The information is communicated with little structure. Communication is hampered by the inappropriate use of technical terms.</i></p> <p><b>0 marks</b>                      No response or no response worthy of credit.</p>		<p>candidates wrote enough to justify levels five or six being awarded.</p>
			<b>Total</b>	<b>6</b>	

**Mark Scheme**

Question			Answer/Indicative content	Marks	Guidance
5	a	i	<p>neutrophil has, lobed / AW, nucleus <b>AND</b> monocyte has, bean-shaped / AW, nucleus;</p> <p>neutrophil , has granular cytoplasm / is a granulocyte <b>AND</b> monocyte has , no / much finer , granules in cytoplasm;</p> <p>monocyte may have vacuoles in cytoplasm but neutrophil does not;</p> <p><i>idea that</i> nucleus occupies more of the cell in monocytes;</p>	2 max	<p><b>CREDIT</b> responses on labelled diagrams</p> <p><b>CREDIT</b> alternative descriptions of lobed</p> <p><b>CREDIT</b> 'kidney shaped'</p> <p><b>CREDIT</b> is an agranulocyte / agranular cytoplasm</p> <p><b>CREDIT</b> ora</p> <p><b>Examiner's Comments</b></p> <p>The majority of candidates were able to make a good attempt at this question and few confused the two types of leucocytes. If candidates failed to gain marks it was due to incomplete comparisons such as giving a correct description of the shape of one leucocytes nucleus but not the other. Statements such as 'neutrophils have a granular cytoplasm but monocytes do not' imply that monocytes have no cytoplasm.</p>
		ii	<p>(monocytes) move into tissues / leave blood;</p> <p>differentiate / become macrophages;</p>	2	<p><b>CREDIT</b> correct reference to a named tissue e.g. alveoli ,liver tissue</p> <p><b>CREDIT</b> correct reference to a named macrophage e.g. Kupffer cells</p> <p><b>Examiner's Comments</b></p> <p>Many candidates recognised that monocytes differentiated into macrophages but relatively few were able to describe their migration to tissues. Many described them as carrying out phagocytosis in blood.</p>

### Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	b	i	30.4 (%);;	2	<p>If incorrect answer given allow 1 mark for:</p> <p>answer not given to 1 decimal place e.g. 30% or 30.37%</p> <p><b>OR</b></p> <p>incorrect rounding (30.3)</p> <p><b>OR</b></p> <p>a number divided by 7900</p> <p>ECF if total cell number is incorrect</p> <p><b>Examiner's Comments</b></p> <p>The calculation proved very accessible with most candidates gaining full marks. The most common mistake was incorrect rounding or misreading the figures from the graph.</p>
		ii	<p>(so) patient may , have / be recovering from , an infection</p> <p><b>OR</b></p> <p>autoimmune disease</p> <p><b>OR</b></p> <p>blood cancer;</p>	1	<p><b>CREDIT</b> a correct reference to pathogens or disease</p> <p><b>DO NOT CREDIT</b> reference to patient being unwell</p> <p><b>CREDIT</b> reference to an allergic response</p> <p><b>CREDIT named</b> blood cancer e.g. leukaemia</p>
		iii	<p>Any <b>one</b> from:</p> <p>electrolytes or <b>named</b> dissolved ion(s) e.g. sodium ion;</p> <p><b>named</b> dissolved nutrient(s) e.g. glucose, amino acids; water;</p> <p>AVP;</p>	1 max	<p><b>IGNORE</b> oxygen (as this is mostly transported in combination with haemoglobin rather than in plasma)</p> <p><b>CREDIT</b> correct symbol e.g. Na+</p> <p>e.g. carbon dioxide, urea, antibodies, protein, fibrinogen, hormones</p> <p><b>Examiner's Comments</b></p> <p>(ii) and (iii) were both answered well with references to electrolytes or ions being the commonest answers in (iii).</p>



### Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
	d	<p><i>idea that</i> air bubbles could increase cell count as they could be counted;</p> <p><i>idea that</i> air bubbles could give lower cell count as reduce volume in chamber / AW;</p> <p><i>idea that</i> overloading could give increase cell count (as there would be increased volume in chamber) / AW;</p> <p>AVP;</p>	2 max	<p><b>LOOK FOR</b> how the count would change e.g. higher or lower <b>AND</b> a reason</p> <p><b>CREDIT</b> reverse argument for underloading</p> <p>e.g. lower number as cells not seen clearly if slide flooded as some on top of others</p> <p><b>Examiner's Comments</b></p> <p>While many candidates were able to identify the problems on the haemocytometer slides, too many merely re-stated the question by saying this would make the count inaccurate without specifying that the numbers of cells counted would be higher or lower.</p>
		<b>Total</b>	<b>14</b>	

### Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
6	a	i	B glycerol; C saturated fatty acid; D unsaturated fatty acid;	3	ACCEPT 'hydrocarbon (tail) for fatty acid
		ii	A;	1	CREDIT phosphate (group)  Examiner's Comments  Parts (i) and (ii) proved to be very accessible.
	b		separates organelle contents from other parts of the cell OR separates the cell into compartments / AW;  reference to a <b>named</b> example;  AVP;	2 max	CREDIT 'controls what enters and leaves organelles' or 'to keep chemical reactions separate from other reactions within the cell'  CREDIT reference to specific organelle plus contents being separated e.g. lysosome <b>AND</b> digestive enzymes OR mitochondria <b>AND</b> respiratory enzymes OR sarcoplasmic reticulum <b>AND</b> calcium ions OR vesicles <b>AND</b> proteins  e.g. holds ETC components  Examiner's Comments  In this part, too many candidates assumed the question referred to the cell surface membrane and it was rare to see any reference to compartmentalisation.
			<b>Total</b>	<b>6</b>	

### Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
7		i	A methyl / CH <sub>3</sub> ; B carboxyl (group) / carboxylic (acid) / COOH;	2	CREDIT A and B given in either order  <b>Examiner's Comments</b>  This question incorporated a range of assessment objectives (AOs 1, 2 and 3) with a biochemical thread running throughout. Some questions were in the context of the procedure for testing for blood glucose. Some candidates did not recognise Figure 1.1 as a fatty acid and many incorrect responses for (i) gave 'amine' as well as 'carboxylic' group, suggesting that they considered this molecule to be an amino acid. The majority of candidates went on to correctly identify glycerol in (ii).
		ii	glycerol;	1	
			<b>Total</b>	<b>3</b>	

### Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
8		(ii) bone marrow failure OR leukaemia OR correctly named platelet disorder;	1	<p><b>ACCEPT</b> after surgical procedures or chemotherapy</p> <p><b>Examiner's Comments</b></p> <p>First Aid procedure for blood loss and blood products provided the theme for this question which offered candidates a variety of question styles including 'tick box completion' and 'quality of written communication' to address both AO1 and AO2.</p> <p>For (i), candidates who noticed from Figure 2.1 that platelets had mitochondria but no nucleus within their cytoplasm were able to gain both marks for comparing with an erythrocyte. Some candidates also correctly referred to existing knowledge about the presence of haemoglobin in erythrocytes (lack of it in platelets). There were many varied responses about glycogen which would be present (in small quantities) in both components. It was pleasing to see many correct responses for (ii), but haemophilia is still the most common incorrect response for why a transfusion of platelets would be given.</p>
		<b>Total</b>	<b>3</b>	

### Mark Scheme

Question		Answer/Indicative content	Marks	Guidance										
9	a	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;">statement</th> <th style="text-align: center;">True (T) or False (F)</th> </tr> </thead> <tbody> <tr> <td>ions found in blood plasma are known as electrolytes</td> <td style="text-align: center;">T</td> </tr> <tr> <td>increasing the concentration of ions in the blood increases the water potential of plasma</td> <td style="text-align: center;">F</td> </tr> <tr> <td>the concentration of ions in the blood can be measured using a haemocytometer</td> <td style="text-align: center;">F</td> </tr> <tr> <td>ions can be transported across cell membranes by facilitated diffusion</td> <td style="text-align: center;">T</td> </tr> </tbody> </table> <p style="text-align: right;">:::</p>	statement	True (T) or False (F)	ions found in blood plasma are known as electrolytes	T	increasing the concentration of ions in the blood increases the water potential of plasma	F	the concentration of ions in the blood can be measured using a haemocytometer	F	ions can be transported across cell membranes by facilitated diffusion	T	3	<p>All correct for 3 marks            3 correct for 2 marks            2 correct for 1 mark</p> <p><b>Examiner's Comments</b></p> <p>Despite two challenging AO2 style questions in (i) and (ii), there were still few 'no response' questions at the end of the paper suggesting that candidates had managed their time effectively during the examination. The question assessed the ability of candidates to demonstrate application of their knowledge and understanding of electrolytes, water potential and ECG interpretation in the context of conditions that would affect potassium ion concentration. This part was very well-answered with many candidates achieving maximum marks.</p>
statement	True (T) or False (F)													
ions found in blood plasma are known as electrolytes	T													
increasing the concentration of ions in the blood increases the water potential of plasma	F													
the concentration of ions in the blood can be measured using a haemocytometer	F													
ions can be transported across cell membranes by facilitated diffusion	T													

### Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
	b i	<p>(venom) increases permeability / AW (of cell membrane); (so) potassium ions diffuse out of cell;</p> <p>AVP;;</p>	2 max	<p><b>ACCEPT</b> well-reasoned argument e.g. sodium-potassium pumps may stop working (so) no active transport of potassium ions</p> <p><b>Examiner's Comments</b></p> <p>Despite two challenging AO2 style questions in (i) and (ii), there were still few 'no response' questions at the end of the paper suggesting that candidates had managed their time effectively during the examination. The question assessed the ability of candidates to demonstrate application of their knowledge and understanding of electrolytes, water potential and ECG interpretation in the context of conditions that would affect potassium ion concentration.</p> <p>In (i) was challenging for weaker candidates who struggled to link the reference to cell membranes in the question stem with the possibility of disruption to the mechanism of potassium ion transport across the membrane. There were, however, some good responses gaining credit for AVPs, for example, some reasoned that the potassium ion channels could be blocked by the toxin so that there would be no facilitated diffusion.</p>

### Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		ii	(loss of potassium ions) increases water potential inside the cell; water leaves cell by osmosis; cell, crenates / shrivels; <i>idea that</i> cell metabolism is affected;	2 max	<b>CREDIT ORA</b>  <b>Examiner's Comments</b>  Despite two challenging AO2 style questions in (i) and (ii), there were still few 'no response' questions at the end of the paper suggesting that candidates had managed their time effectively during the examination. The question assessed the ability of candidates to demonstrate application of their knowledge and understanding of electrolytes, water potential and ECG interpretation in the context of conditions that would affect potassium ion concentration. The responses to (ii) showed that this concept was well understood and candidates could discuss the consequence of altering osmotic balance.
			<b>Total</b>	<b>7</b>	
10			<u>nucleus</u> ; (contractile / food) vacuole;	max 1	<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 then = <b>0 marks</b>  <b>Examiner's Comments</b>  Well answered and nearly all candidates gave a correct response as 'nucleus' or 'food vacuole'. Some candidates obviously relied on memorised differences between Eukaryotes and Prokaryotes and provided answers such as 'different sized ribosomes'. When a question states 'shown in Fig. 1.1', candidates should understand that they must refer to the figure rather than rely on memory.
			<b>Total</b>	<b>1</b>	

### Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
11	a	ultrastructure ;	1	<p><b>Mark the first answer for each question part.</b> If the answer is correct and a further answer is given that is incorrect or contradicts the correct answer then = 0 marks</p> <p><b>Examiner's Comments</b></p> <p>The term ultrastructure was not so well known and common errors were to write 'organelles' or cytoskeleton'.</p>
	b	<u>exocytosis</u> ;	1	<p><b>DO NOT CREDIT</b> endocytosis / mass flow <b>IGNORE</b> bulk flow</p> <p><b>Mark the first answer for each question part.</b> If the answer is correct and a further answer is given that is incorrect or contradicts the correct answer then = 0 marks</p> <p><b>Examiner's Comments</b></p> <p>This term was well known to the majority of candidates.</p>
		<b>Total</b>	<b>2</b>	

**Mark Scheme**

Question			Answer/Indicative content	Marks	Guidance
12		i	cell signalling ;	1	<p><b>Examiner's Comments</b></p> <p>Most candidates gave the correct term for communication between cells.</p>
		ii	<p>1 attraction of cell(s) to folic acid from bacteria ;</p> <p>2 attraction of cells to each other by cAMP ;</p> <p>3 coordinated movement in grex ;</p> <p>4 differentiation / described, of (grex / slime mould) cells in response to DIF ;</p>	2 max	<p><b>NOTE</b> must name the chemical involved for description (except mp 3 coordinated movement)</p> <p><b>ACCEPT</b> attraction of cells to bacteria by folic acid</p> <p><b>IGNORE</b> makes cells stick together</p> <p><b>Examiner's Comments</b></p> <p>Most candidates could identify two stages in the life cycle where cell signalling takes place. In this case describing an example of cell signalling needed both the name of the signalling molecule and the response it produced in the receiving cells. A good number of candidates did not manage to provide this level of detail and candidates must be trained to understand that the command word 'describe' does require a reasonable level of detail in the response. Well-trained candidates were able to give full descriptions in clear and succinctly worded responses.</p>
		iii	<p>contains , receptors / glycoproteins / glycolipids / glycocalyx ;</p> <p>for , folic acid / cAMP / DIF ;</p>	2	<p><b>DO NOT CREDIT</b> <i>consists</i> of receptors</p> <p><b>Examiner's Comments</b></p> <p>Most candidates appreciated that a cell surface membrane adapted for cell signalling would contain receptor molecules. Fewer candidates were able to specify that the receptor molecules must be specific to one of the named molecules used for cell signalling by the slime mould cells.</p>
			<b>Total</b>	<b>5</b>	

### Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
13	i	<p>active transport ;</p> <p>concentration / pH / H<sup>+</sup> / proton / electrochemical ;</p> <p>facilitated ;</p> <p>diffusion ;</p> <p>amino acids ;</p>	5	<p><b>Mark the first answer.</b> If the answer is correct and a further answer is given that is incorrect or contradicts the correct answer then = <b>0 marks</b></p> <p><b>IGNORE</b> active loading</p> <p><b>IGNORE</b> high <b>DO NOT ACCEPT</b> diffusion</p> <p><b>ACCEPT</b> facilitated diffusion</p> <p><b>ACCEPT</b> plasmodesmata <b>DO NOT CREDIT</b> facilitated diffusion</p> <p><b>DO NOT CREDIT</b> glucose / fructose / ions</p> <p><b>Examiner's Comments</b></p> <p>Was a gap fill question in which the candidate's knowledge of the active loading process was tested. Most candidates scored two or three marks appreciating that active transport must be required to create a concentration gradient and that the hydrogen ions must move through the membrane by facilitated diffusion, while the sucrose could diffuse through plasmodesmata into the sieve tube. Few candidates appreciated that assimilates are molecules that have become part of the organism and that amino acids are often transported. This part of the question was more difficult as the molecule mentioned had to be an assimilate and one that is transported in the phloem.</p>

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Question		Answer/Indicative content	Marks	Guidance
	ii	<p>many / large, mitochondria ;</p> <p>plasmodesmata (between companion cell and sieve tube) / described ;</p> <p>many ribosomes / extensive RER ;</p> <p>many proteins in the, plasma / cell surface, membrane ;</p>	2	<p><b>IGNORE</b> qualification of type of protein</p> <p><b>Examiner's Comments</b></p> <p>Candidates were asked what evidence for the active loading mechanism might be gained from observation using an electron microscope. Most candidates appreciated that mitochondria were required to produce the ATP used in active transport. Some did not link the need for many mitochondria in particularly active tissues. Fewer candidates were able to provide a second line of evidence such as the presence of plasmodesmata. Weaker candidates need to be trained to recall what features of cells are visible under an electron microscope as some were suggesting that the movement of sucrose and even hydrogen ions could actually be observed.</p>
		<b>Total</b>	<b>7</b>	

**Mark Scheme**

Question			Answer/Indicative content	Marks	Guidance
14	a	i	<p>cellulose / cell, wall ;</p> <p>chloroplast(s) ; starch grain(s) / amyloplast(s) ; large / permanent, vacuole ;</p> <p>tonoplast ; plasmodesma(ta) ;</p>	2 max	<p><b>Mark the first answer on each prompt line.</b> If the answer is correct and a further answer is given that is incorrect or contradicts the correct answer then = 0 marks</p> <p><b>DO NOT CREDIT</b> wall unqualified, <b>DO NOT CREDIT</b> if incorrect compound e.g peptidoglycan / chitin</p> <p><b>IGNORE</b> plastid <b>IGNORE</b> vacuole alone – must be qualified as large or permanent</p> <p><b>Examiner's Comments</b></p> <p>Candidates were asked to name two characteristics of plant cells that were not found in animal cells. The most common responses were 'chloroplasts' and 'cell wall'. A number of candidates need to be more specific in their responses to such questions, as 'vacuole' was not sufficient to gain a mark at this level. Examiners were looking for the more specific response of a large or permanent vacuole.</p>
		ii	<p>centriole / glycogen granule ;</p>	1	<p><b>Mark the first answer.</b> If the answer is correct and a further answer is given that is incorrect or contradicts the correct answer then = 0 marks</p> <p><b>ACCEPT</b> lysosomes, cilia, flagella</p> <p><b>Examiner's Comments</b></p> <p>Candidates needed to name one structure present in animal cells that was not found in plant cells. Many candidates gave a correct response. 'Centrioles' was the most common such response, closely followed by cilia / flagella. The mark scheme allowed 'lysosomes' even though this is a feature that is still being debated - plant cells certainly have small vacuoles that contain lytic enzymes, but they are not always called lysosomes in plants.</p>

### Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
	<p>iii</p> <p>1 (whole) cell, support / stability / scaffolding / maintain shape ;</p> <p>2 movement of, cilia / flagella / undulipodia OR use of cilia / flagellum / undulipodium to move cell ;</p> <p>3 changing shape of cell / cytokinesis / pseudopodia / phagocytosis / endocytosis / exocytosis / muscle contraction ;</p> <p>4 (named) organelles, moved / held in place ;</p> <p>5 movement of, chromosomes / chromatids / (m)RNA ;</p>	<p>3 max</p>	<p><b>IGNORE</b> 'movement of, cell / membrane' unqualified</p> <p><b>IGNORE</b> strength / structure / rigid</p> <p><b>IGNORE</b> make up cilia / flagella</p> <p><b>ACCEPT</b> descriptions</p> <p><b>ACCEPT</b> movement of vesicle <b>IGNORE</b> movement of substances / materials</p> <p><b>ACCEPT</b> formation of spindle / centrioles</p> <p><b>Examiner's Comments</b></p> <p>Candidates were asked to describe the roles of the cytoskeleton. Most candidates were able to give some correct responses. Many stated that the cytoskeleton was involved with transporting vesicles or organelles around the cell. Some candidates need however to be more specific, as transporting 'substances' around the cell was not accepted. Movement of cilia or flagella and provision of support for the cell were also commonly stated.</p>

### Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
	b	<p>1 nucleus, contains gene (for protein) / site of <b>transcription</b> / produces mRNA ;</p> <p>2 <b>ribosomes / rough endoplasmic reticulum</b> / RER, site of, protein synthesis / <b>translation</b> ;</p> <p>3 <b>vesicles</b> for transport (of protein) ;</p> <p>4 <b>Golgi</b> (apparatus / body), processes / modifies / (re)packages, proteins ;</p> <p>5 (vesicles) fuse to, <b>cell surface / plasma, membrane</b> ;</p>	4 max	<p>Max 4 marks for content Look for name of organelle and its function / role <b>ACCEPT</b> enzyme / protease for protein <b>MAX 3</b> if answer refers to insulin or incorrect protein</p> <p><b>ACCEPT</b> DNA / genetic material / genetic information for 'gene' <b>IGNORE</b> 'mRNA leaves nucleus'</p> <p><b>ACCEPT</b> description of assembling a <i>chain</i> of amino acids</p> <p>mp3 can be awarded either for transport between ER and Golgi or between Golgi and Plasma membrane</p> <p>E.G. tertiary folding / quaternary structure / carbohydrate added / converted to glycoprotein / placed in vesicles <b>IGNORE</b> ref to RER</p> <p><b>IGNORE</b> binds / attach / joins <b>IGNORE</b> exocytosis <b>IGNORE</b> ref to vesicles leaving cell <b>ACCEPT</b> merges with / becomes part of</p>

### Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
			QWC ;	1	<p>Any <b>two</b> technical terms from the list below used appropriately and spelled correctly :</p> <p><b>ribosomes</b>  <b>rough endoplasmic reticulum (NOT RER for QWC)</b>  <b>transcription (and derivatives)</b>  <b>translation (and derivatives)</b>  <b>golgi</b>  <b>vesicles</b>  <b>plasma membrane / cell surface membrane</b></p> <p><b>Examiner's Comments</b></p> <p>Candidates were asked to outline how organelles work together to secrete a specific protein. Most candidates gave excellent responses that were well organised and clearly worded. The QWC mark was usually awarded. In certain areas candidates need to be more specific with their wording of responses. For example, they should describe the secretory vesicle as 'fusing to the cell surface membrane' rather than 'binding to the membrane'. Binding does not necessarily suggest that the vesicle membrane becomes a part of the cell surface membrane and that the contents of the vesicle are released through the membrane.</p>
			<b>Total</b>	<b>11</b>	

### Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
15	a	i	550,000 ✓✓	2	<p><b>ALLOW</b> one mark for (1 ÷ 0.004) <b>OR</b> 250 <b>OR</b> X11</p> <p><b>Examiner's Comments</b> This question tested the candidates on the method of using a haemocytometer to count blood cells and then to analyse some test results.</p> <p>Candidates did not answer well with very few candidates seeming to know the northwest rule or how to calculate an accurate count.</p>
		ii	<p>removes grease / finger prints ✓</p> <p><i>idea that</i> cells are equally distributed ✓</p> <p>solution is not too concentrated to Cells accurately✓</p> <p><b>OR</b> Dacie's fluid preserves shape of RBCs so they are easier to count ✓</p> <p>makes, nuclei / white blood cells, visible ✓</p>	Max 4	<p><b>ALLOW</b> allows leucocytes to be identified</p> <p><b>Examiner's Comments</b> In very few candidates mentioned degreasing the microscope slide. Some candidates just repeated the question for parts two and three. Many simply stated 'to identify different cells' for part four without saying how (nucleus visible) or which (leucocyte).</p>
	b		<p>high white blood cell count ✓</p> <p>normal red blood cell count ✓</p> <p>supporting figures e.g. WBC is <math>6.0 \times 10^{10}</math> per <math>\text{dm}^3</math></p> <p><b>OR</b> RBC count is <math>5.0 \times 10^{12}</math> per <math>\text{dm}^3</math> ✓</p> <p><i>idea that</i> could not diagnose platelet disorder ✓</p> <p><i>idea that</i> could not tell which WBCs are low so couldn't diagnose specific disorder✓</p>	Max 4	<p><b>Examiner's Comments</b> Many candidates were unable to convert the units between the technician's notes and the table of normal values in (b) and therefore came up with an incorrect analysis of the results. Those that did it correctly scored highly.</p>
			<b>Total</b>	<b>10</b>	

### Mark Scheme

Question		Answer/Indicative content	Marks	Guidance												
16		<table border="1"> <thead> <tr> <th>Description</th> <th>Letter</th> <th></th> </tr> </thead> <tbody> <tr> <td>Provides ATP</td> <td>G</td> <td style="text-align: right;">✓</td> </tr> <tr> <td>Modifies enzymes</td> <td>C</td> <td style="text-align: right;">✓</td> </tr> <tr> <td>Involved in protein synthesis</td> <td>D</td> <td style="text-align: right;">✓</td> </tr> </tbody> </table>	Description	Letter		Provides ATP	G	✓	Modifies enzymes	C	✓	Involved in protein synthesis	D	✓	3	<p><b>IGNORE</b> anything outside the table  <b>ALLOW</b> names of organelles i.e.            G = mitochondria,            C = Golgi (body), D = rough endoplasmic reticulum (rER)</p> <p><b>Examiner's Comments</b>            Candidates were first tested on their knowledge of cell ultrastructure and the function of organelles. The rest of the question focused on the role of carcinogens in the development of cancer, the diagnosis and treatment of cancer and a data question including a calculation using a graph about the incidence of cancer in the population.</p> <p>Some candidates mixed up RER and Golgi.</p>
		Description	Letter													
		Provides ATP	G	✓												
		Modifies enzymes	C	✓												
Involved in protein synthesis	D	✓														
<b>Total</b>		3														

### Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
17	i	<p><i>idea that</i> the cell (surface membrane)/ tonoplast , can be seen ✓</p> <p>plasmolysed cells can be seen ✓</p>	Max 1	<p><b>Examiner' Comments</b></p> <p>n this question, candidates were asked about the method used in an investigation into the water potential of onion cells and then had to analyse the results obtained.</p> <p>Many candidates suggested that the differential stain made the cells easier to see for <b>Q6(a)(i)</b> without any mention of plasmolysed or unplasmolysed (or tonoplast). Candidates should be taught that very vague answers like this rarely score marks</p>
	ii	<p>the student is correct</p> <p><b>AND</b></p> <p><i>idea that</i> the water potential of the cells decreases / dye is soluble in the cytoplasm ✓</p>	1	<p><b>Examiner' Comments</b></p> <p>The common mistake in <b>Q6(a)(ii)</b> was to simply state that water potential decreases without saying inside the cell, another type of answer that is much too vague.</p>
	iii	<p><b>Error</b></p> <p>immediately remove ✓</p> <p><b>Improvement</b></p> <p>immersion time should be, longer / stated ✓</p> <p><b>Error</b></p> <p>drops (of solution)✓</p> <p><b>Improvement</b></p> <p><i>idea that</i> should be flooded to ensure full coverage ✓</p>	Max 4	<p><b>Examiner's Comments</b></p> <p>Candidates often suggested an improvement as the error in part <b>Q6(a)(iii)</b>.</p>
		<b>Total</b>	<b>6</b>	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
18	a		tonoplast ✓	1	<p><b>Examiner's Comments</b> All three assessment objectives were addressed in this question which had a practical theme involving beetroot plants and betalain pigments. In Q22(a) the majority of candidates were able to correctly state the membrane surrounding the plant cell vacuole as the <i>tonoplast</i>.</p>
	b	i	<p>Any <b>two</b> variables with control measure</p> <p>same size of beetroot discs <b>AND</b> use (cork) borer to cut discs <b>OR</b> use , gauge / ruler , to measure , thickness / length ✓</p> <p>temperature <b>AND</b> use a water bath ✓</p> <p>colour of beetroot discs <b>AND</b> cut discs from same beetroot (plant) ✓</p>	2 max	<p>Control measure <b>must</b> be linked to variable described. <b>IGNORE</b> same volume of solution in test tubes <b>IGNORE</b> time in solution <b>ALLOW</b> e.g. SA or diameter or thickness or length of beetroot discs for size <i>idea that</i> the discs have the same dimensions is required for mp1 <b>ALLOW</b> micrometer or laser sensor or callipers to measure thickness or length <b>Examiner's Comments</b> Q22(b)(i) required candidates to demonstrate their understanding of controlling experimental variables and references to temperature and size of beetroot discs were the most commonly seen creditworthy responses. However, some candidates stated length of time or volume of the solution which could not be credited as these possible variables had already been given in the question stem. There were also several responses in which the candidates had named variables but then failed to explain how they would be controlled.</p>

### Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
	ii	<p><i>description</i> as pH increases , absorption decreases ✓ data quote from graph ✓</p> <p><i>explanation</i> at low pH the solution , is more acidic / has more, protons / H<sup>+</sup> ions ✓ <i>idea that</i> H<sup>+</sup> ions / protons , denature proteins so disrupt the (cell) membranes ✓ <i>idea that</i> H<sup>+</sup> ions / protons , affect ionic bonds in (membrane) proteins ✓ (so) permeability of the (cell) membranes to betanin increases ✓ <b>max 3 for explanation</b></p>	4 max	<p><b>ALLOW</b> as pH increases, transmission increases e.g. at pH 10 the absorbance is , very low / less than 0.1</p> <p><b>ALLOW</b> ora if high pH is explained <b>Examiner's Comments</b> Many candidates were able to correctly describe the trend in <b>Q22(b)(ii)</b> but few were able to go on to offer detailed explanation of the effect of low pH, i.e. high level of H<sup>+</sup> ions on the structure of cell membranes with regards to protein channels and the permeability to betalain. Centres are encouraged to continue to impress on candidates the importance of using scientific theory in their explanations.</p>
	c	<p>(has) phospholipid bilayer ✓ (so) hydrophobic region prevents betanin passing <b>OR</b> (so) prevents diffusion of water soluble substances ✓</p> <p>(has) channel / carrier , proteins ✓ <i>idea that</i> these proteins are specific so control movement of , betanin / water soluble substances ✓</p>	2 max	<p><b>ALLOW</b> ora <b>Examiner's Comments</b> For <b>Q22(c)</b> many candidates were able to gain one mark, usually for reference to the phospholipid bilayer but examiners saw a few excellent, detailed responses from higher attaining candidates.</p>
		<b>Total</b>	<b>9</b>	

### Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
19	a	i	G neutrophil ✓ H lymphocyte ✓	2	ALLOW granulocyte  <u>Examiner's Comments</u>  A number of candidates got these cells the wrong way around.
		ii	30 μm OR 0.03 mm ✓ ✓	2	Correct units required ALLOW for 1 mark 30 / 0.03 OR 15 000 ÷ 500 OR 15 ÷ 500  <u>Examiner's Comments</u>  A common error was to miscalculate conversion of units and to use the incorrect use of the magnification formula.
	b	i	<i>missing stage</i> use of spreader ✓ <i>effect</i> <i>idea that</i> blood cells could not be seen clearly because the film would be too thick ✓  OR <i>missing stage</i> add , methanol / fixative <i>effect</i> <i>idea that</i> cells would be washed off the slide ✓	Max 2	Effect must be linked to correct missing stage
		ii	stains some structures darker / provides contrast ✓ allows the shape of the nucleus to be seen ✓ allows the type of cell to be identified ✓	2 max	

### Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
	c	<p><i>useful for counting cells ✓</i>  <i>idea that it can count large numbers of cells quickly ✓</i>                      allows analysis of , physical / chemical , characteristics ✓                      diagnosis of blood cancers ✓</p>	<p style="text-align: center;">1</p> <p style="text-align: center;">Max 2</p>	<p><b>ALLOW</b> can analyse size and shape</p> <p>Allow disease of the blood</p> <p><b>Examiner's Comments</b></p> <p>Apart from some candidates knowing that flow cytometry is used for counting cells, very little seemed to be known about this process.</p> <p><b>Exemplar 3</b></p> <p><i>Flow cytometry is very useful ✓ it's an electronic way of counting blood samples. It's useful because it's very quick and effective and can count huge amount of cells in short space of time. It can also identify the physical and chemical characteristics of the blood samples which is useful. You are also able to target/tag specific cells by using fluorescent tag.</i></p> <p>An answer of this standard was rarely seen in response to this question and showed that it could be done. The three points that gained the marks credited are clearly made and could almost be straight from the mark scheme.</p>
		<b>Total</b>	<b>11</b>	

### Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
20	a	i	X condensation AND Y hydrolysis ✓	1	BOTH required for one mark
		ii	triglyceride AND (three) water ✓	1	BOTH required for one mark
		iii	ester ✓	1	<p>IGNORE covalent</p> <p><b>Examiner's Comments</b></p> <p>There were many good responses across the ability range for these biochemical questions in parts (b)(i), (ii) and (iii). In (b)(ii) some responses omitted water as a possible product and as both products were required for the response these did not gain credit.</p>
	b	i	(M-N measured at 43mm) 10 800 (x) ✓✓	2	<p>ALLOW 2 marks for correct calculation if M-N is measured between 42 and 43mm If answer incorrect: ALLOW 1 mark for e.g. (using 43mm) <math>43\text{mm} \div 4 \mu\text{m} / 4.3\text{cm} \div 4\mu\text{m}</math> OR <math>43000 \div 4</math> OR 10 750</p> <p><b>Examiner's Comments</b></p> <p>Many candidates were credited with two marks for this calculation. Many others gained one mark for a correct calculation because they had not written their response to three significant figures. Most candidates were able to measure the line from M to N as between 42 and 43mm and demonstrated knowledge of the correct calculation for magnification. The challenge for some candidates was then to convert mm into <math>\mu\text{m}</math>, a mathematical skill required to achieve the correct response.</p>

### Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
	<p>ii</p> <p><i>(C. jejuni)</i> would stain , pink / red (with Gram stain) ✓</p> <p>(because) peptidoglycan cell wall is covered by lipopolysaccharide layer OR (because) the peptidoglycan cell wall is very thin ✓</p> <p>(so) purple stain / crystal violet, is washed out (by alcohol) ✓ safranin / counter-stain / pink stain, binds to peptidoglycan cell wall ✓</p>	3 max	<p><b>ALLOW</b> <i>(C. jejuni)</i> is Gram -ve</p> <p><b>Examiner's Comments</b></p> <p>Many candidates gained one mark for recognising <i>C.jejuni</i> as being Gram negative or would stain pink using the information in Fig.23.3. Higher ability candidates went on to give detailed explanations to support this comment. There were some unclear or confused responses where candidates could not remember the differences between Gram positive and Gram negative bacteria.</p> <p><b>Exemplar 3</b></p> <p>Gram-negative bacteria stain pink/red whereas Gram-positive bacteria/organisms stain purple/blue. Peptidoglycan is Gram-positive so would stain purple. Lipopolysaccharide is Gram-negative so would stain pink.</p> <p>This response could be improved by applying the information to <i>C.jejuni</i> rather than giving a general statement about both types of bacteria. There was also confusion about how the staining technique affected the cell wall and lipopolysaccharide layer surrounding the bacterium, so no marks could be credited.</p>
	<b>Total</b>	<b>8</b>	

**Mark Scheme**

Question		Answer/Indicative content	Marks	Guidance
21	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 (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;  water moves out of cells, by osmosis / down water potential gradient;	2	CREDIT ORA for inside cells  CREDIT ORA for mucus
		iii	<i>idea of easier</i> 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
22	<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
23		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 <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
24	i	<p>1 FSH and / or LH cannot, cross / AW, membrane OR oestrogen can cross the, membrane / phospholipid bilayer; 2 (because) oestrogen is lipid soluble OR 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 <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 = 0 marks</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>	
25		i	<i>tissue</i> (mature) xylem (no mark)  <i>justification</i>  <i>idea that xylem vessels, are hollow / have no cytoplasm / have no organelles ✓</i>	1	<b>DO NOT ALLOW</b> xylem without further explanation  <b>IGNORE</b> reference to xylem being dead
		ii	lysosomal enzymes produced on, RER / rough endoplasmic reticulum ✓  <i>idea that</i> lysosomal enzymes are enclosed in vesicles ✓  lysosomes bud off Golgi (body) ✓	max 2	
			<b>Total</b>	<b>3</b>	

### Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
26		i	(Student's) t-test ✓ paired / measurements from same people (before and after) ✓	2	<b>Examiner's Comments</b> 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) ✓ improvement falls as intensity / wattage rises ✓ uncertainty in making conclusion because standard deviations / error bars (for before-and-after) overlap ✓	2	<b>ORA</b> <b>Examiner's Comments</b> (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 ✓ weightlifting is not an aerobic exercise ✓ weightlifting occurs over a short duration / in short bursts ✓	2	<b>ORA</b> <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 <b>Examiner's Comments</b> (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>	

**Mark Scheme**

Question	Answer/Indicative content	Marks	Guidance
27	i any 2 from: decrease in urea concentration (in blood) ✓ glucose concentration (of blood) remains unchanged ✓ protein, composition / concentration, (of blood) remains unchanged ✓	max 2	<p><b>IGNORE</b> reference to glucose increasing or decreasing</p> <p><b>Examiner's Comments</b>                      (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>

### Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
	ii	passage of molecules through partially permeable membrane via (passive) <u>diffusion</u> ✓ urea (diffuses) from a high concentration to a low concentration / down concentration gradient ✓ glucose (stays the same) because of, equilibration of molecules either side of membrane / no net diffusion ✓ protein too large to pass through membrane / tubing ✓	max 3	ALLOW 'semi-permeable membrane'  DO NOT ALLOW ECF from 37 (a)(i) <b>Examiner's Comments</b> (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.
		<b>Total</b>	<b>5</b>	

**Mark Scheme**

Question			Answer/Indicative content	Marks	Guidance
28		i	(in) thylakoid / grana / lamellae. ✓	1	<b>Examiner's Comments</b> 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 <i>ora</i> ✓  (cyanobacteria thylakoids ) near, cell surface membrane / cell wall. ✓	2	<b>IGNORE</b> ref to thylakoids attached (to cell surface membrane). <b>Examiner's Comments</b> 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) ✓  carboxysomes (in cytoplasm) ✓	2	<b>Examiner's Comments</b> (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>ACCEPT <i>idea</i> of CO<sub>2</sub> outcompetes O<sub>2</sub></p> <p><b>Examiner's Comments</b>                      (a)(iv) was also generally well answered and candidates clearly used and understood the literature provided to complement this question.                      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.                      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.                      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.                      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
29	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> (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> 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> 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> 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> 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
30	a	i	<p>to remove <u>chloride</u> ions  <b>OR</b>                      to remove other chemicals, that could react with silver nitrate ✓</p> <p>contamination would reduce, <u>validity</u> of results  <b>OR</b>                      removes contamination to, increase, validity of the results ✓</p>	1 max	<p><b>IGNORE</b> generic comments about contamination</p> <p><b><u>Examiner's Comments</u></b></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><b><u>Examiner's Comments</u></b></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>  <u>volume</u> of distilled water in the boiling tube ✓</p> <p><i>Explanation</i>  <u>larger</u> volume <u>reduce</u>, the concentration of chloride ions / precipitate formed / absorbance <b>ORA</b> ✓</p> <p><i>Variable</i>  <u>volume</u> of distilled water removed in the sample ✓</p> <p><i>Explanation</i>  <u>larger</u> volume will <u>increase</u>, number of chloride ions / precipitate formed / absorbance <b>ORA</b> ✓</p> <p><i>Variable</i>                      time boiling tube remains in water bath ✓</p> <p><i>Explanation</i>                      time in water bath should allow for desired temperature to be reached <b>OR</b>                      if time is too short, fewer chloride ions will have diffused across the membrane(s) / <b>ORA</b> ✓</p> <p><i>Variable</i>                      size / volume / number / surface area, of carrot sections ✓</p> <p><i>Explanation</i>  <u>larger surface area</u> (to volume ratio) will <u>increase</u> diffusion (rate) / <b>ORA</b> ✓</p> <p><i>Variable</i>                      concentration/ volume/ number of drops, of silver nitrate ✓</p> <p><i>Explanation</i>                      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> same filter used in colorimeter ✓</p> <p><i>Explanation</i> the filter affects the wavelengths that reach, the sample / the detector ✓</p> <p><i>Variable</i> same reference solution used in colorimeter ✓</p> <p><i>Explanation</i> prevents zeroing errors ✓</p> <p><i>Variable</i> sections of carrot / tissue, taken from same carrot ✓</p> <p><i>Explanation</i> different carrots will, have/store, different chloride ion concentrations ✓</p>		<p><b><u>Examiner's Comments</u></b></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><b><u>Examiner's Comments</u></b></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>	