GCSE · AQA · Biology

46 questions

Cell Biology - 2025

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Total Marks **/412**

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1 (a) Organisms must transport substances to and from the external environment.

Identify **one** substance which cells must transport across the cell membrane to support cell functions.

Answer

A substance that cells must transport across the cell membrane might include:

Any **one** from the following:

- Carbon dioxide / oxygen; [1 mark]
- Glucose / amino acids / fatty acids + glycerol; [1 mark]
- Mineral ions / water; [1 mark]

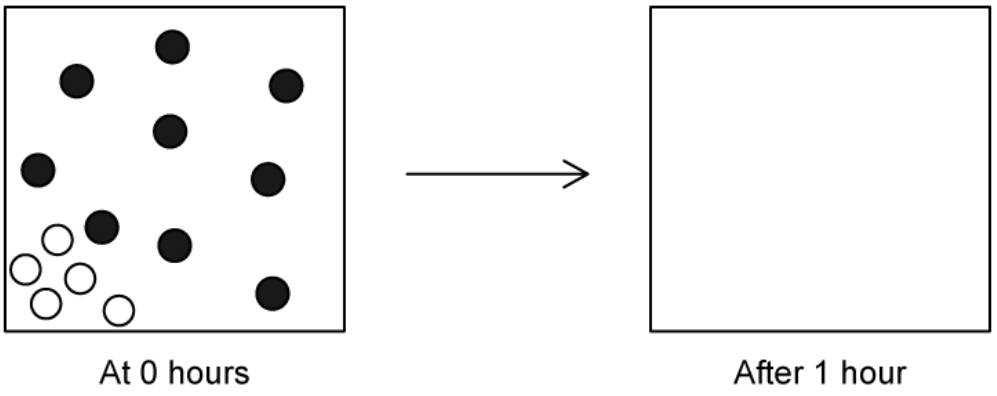
[Total: 1 mark]

There are many substances that cells need which exceed the list given in this mark scheme. The substances named in this question are key to the most fundamental processes that take place in cells, including photosynthesis and respiration.

(1 mark)

(b) **Figure 1** shows particles of two gases.

Figure 1



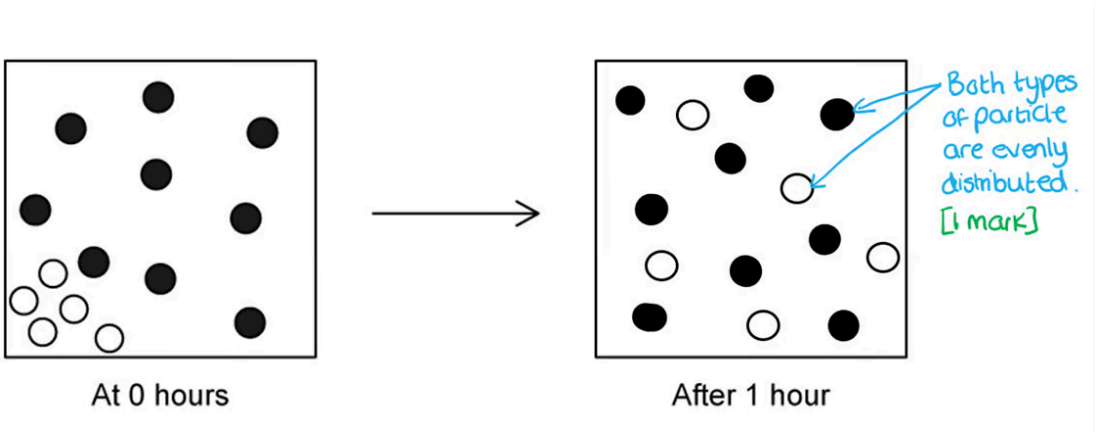
Complete **Figure 1** by drawing the arrangement of the gas particles after 1 hour.

Answer

The gas particles should appear as follows:

- The particles should be evenly distributed in the space; [1 mark]

[Total: 1 mark]



(1 mark)

(c) Name the process shown in **Figure 1.**

Answer

The process in **Figure 1** is...

- (Simple / gaseous) diffusion; [1 mark]

[Total: 1 mark]

This couldn't be osmosis as there are no water particles or partially permeable membrane.

(1 mark)

(d) Which of the following is an example of simple diffusion?

A. Movement of water into the root of a plant

B. Movement of mineral ions into the root of a plant

C. Movement of oxygen into the leaf of a plant

D. Movement of glucose into the epithelial cells of villi in the small intestine

Answer

The correct answer is C.

B and **D** are both examples of where substances move from a low concentration to a higher concentration requiring the process of active transport.

A is referring to water molecules passing across a partially permeable membrane and therefore relates to osmosis.

(1 mark)

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2 (a) Complete the sentence using the correct words from the box.

A chromosome is a threadlike structure found in the nucleus of a _____ cell. In a _____ human body cell, there are _____ pairs of chromosomes. The _____ of an organism is determined by the combination of _____ (different versions of genes) that are inherited from each parent.

DNA	46	Allele	Phenotype	Gene
Eukaryotic	Haploid	Diploid	Prokaryotic	23

Answer

The sentence should be filled using the words as follows:

- A chromosome is a threadlike structure found in the nucleus of a **eukaryotic** cell. In a **diploid** human body cell, there are **23** pairs of chromosomes. The **phenotype** of an organism is determined by the combination of **alleles** (different versions of genes) that are inherited from each parent.

Allow [1 mark] for each word correctly entered.

[Total: 5 marks]

(5 marks)

(b) A diploid nucleus from the body cell of a dog contains 78 chromosomes.

How many chromosomes would be found in the nucleus of a dog's gamete?

Answer

A gamete of a dog would have..

- 39 (individual) chromosomes; [1 mark]

[Total: 1 mark]

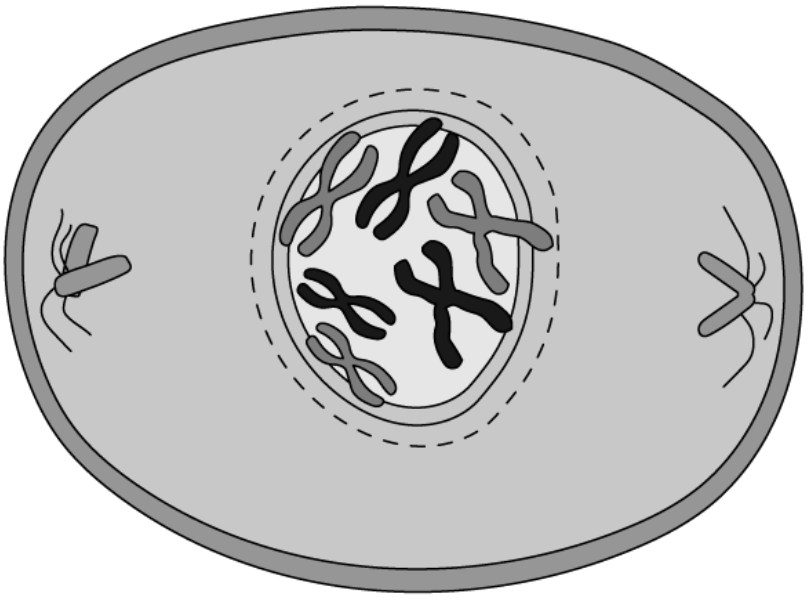
Gametes have half the number of chromosomes of body cells. 78 ÷ 2 = **39**

(1 mark)

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(c) **Figure 1** shows a cell preparing for mitosis.

Figure 1



Which of the following statements indicates that the cell in **Figure 1** is preparing to divide?

A. The nucleus has visible pores

B. The nucleus is visible and 'X' shaped

C. The chromosomes are visible and 'X' shaped

D. There is a haploid number of chromosomes

Answer

The correct answer is C.

Prior to cell division the DNA must double inside the nucleus of the cell. This creates the characteristic 'X' shape of the chromosomes.

(1 mark)

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(d) Identify the three stages of the cell cycle.

Answer

The three stages of the cell cycle:

- Growth / DNA replication; [1 mark]
- Mitosis / nuclear division; [1 mark]
- Cytokinesis / division of the cytoplasm; [1 mark]

Accept *interphase for growth phase.*

[Total: 3 marks]

You need to know these 3 stages of the cell cycle with a general overview of what happens in mitosis.

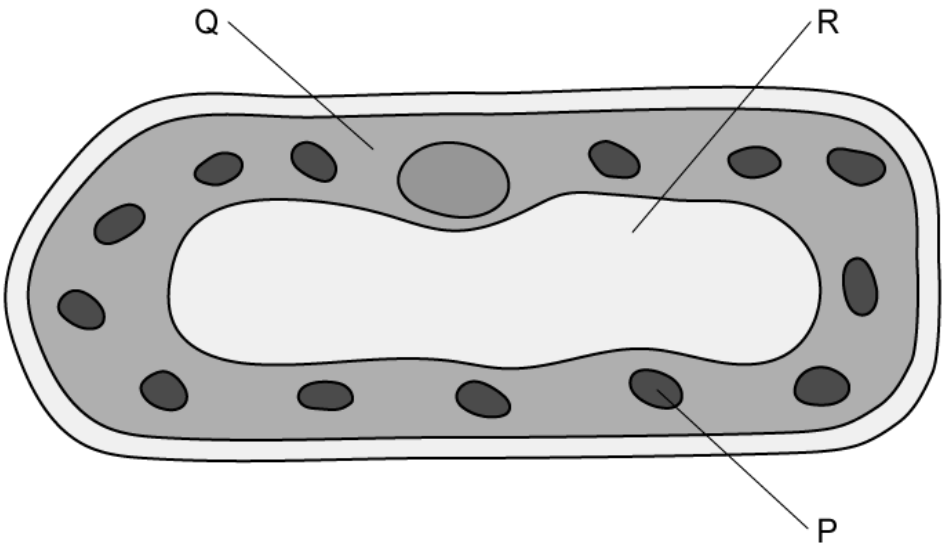
(3 marks)

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3 (a) **Figure 1** shows an image of a plant cell.

Identify structures P, Q and R**.**

Figure 1



Answer

Structures P, Q and R are....

- P = Chloroplast **OR** mitochondria; [1 mark]
- Q = Cytoplasm; [1 mark]
- R = Vacuole; [1 mark]

[Total: 3 marks]

In a simplistic diagram such as that in **Figure 1**, the organelle labelled P could be either mitochondria (the site of respiration) or a chloroplast (the site of photosynthesis).

(3 marks)

(b) Which of the following structures is not found in a prokaryotic cell.

A. A cellulose cell wall

B. Ribosomes

C. Plasmids

D. A circular loop of DNA

Answer

The correct answer is A.

Cellulose cell walls are not found in prokaryotic cells. They are found in plant cells, which are eukaryotic.

B, **C** and **D** are incorrect because ribosomes, plasmids and a circular loop of DNA can all be found in prokaryotic cells.

(1 mark)

(c) Complete the table by adding a (✓) or a (X) to compare the components seen in plant cells and animals cells.

Component	Animal cell	Plant cell
Cell wall		
Nucleus		
Mitochondria		
Ribosomes		
Vacuole		
Cytoplasm		

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Answer

The table should be completed as follows:

Component	Animal cell	Plant cell
Cell wall		✓
Nucleus	✓	✓
Mitochondria	✓	✓
Ribosomes	✓	✓
Vacuole		✓
Cytoplasm	✓	✓

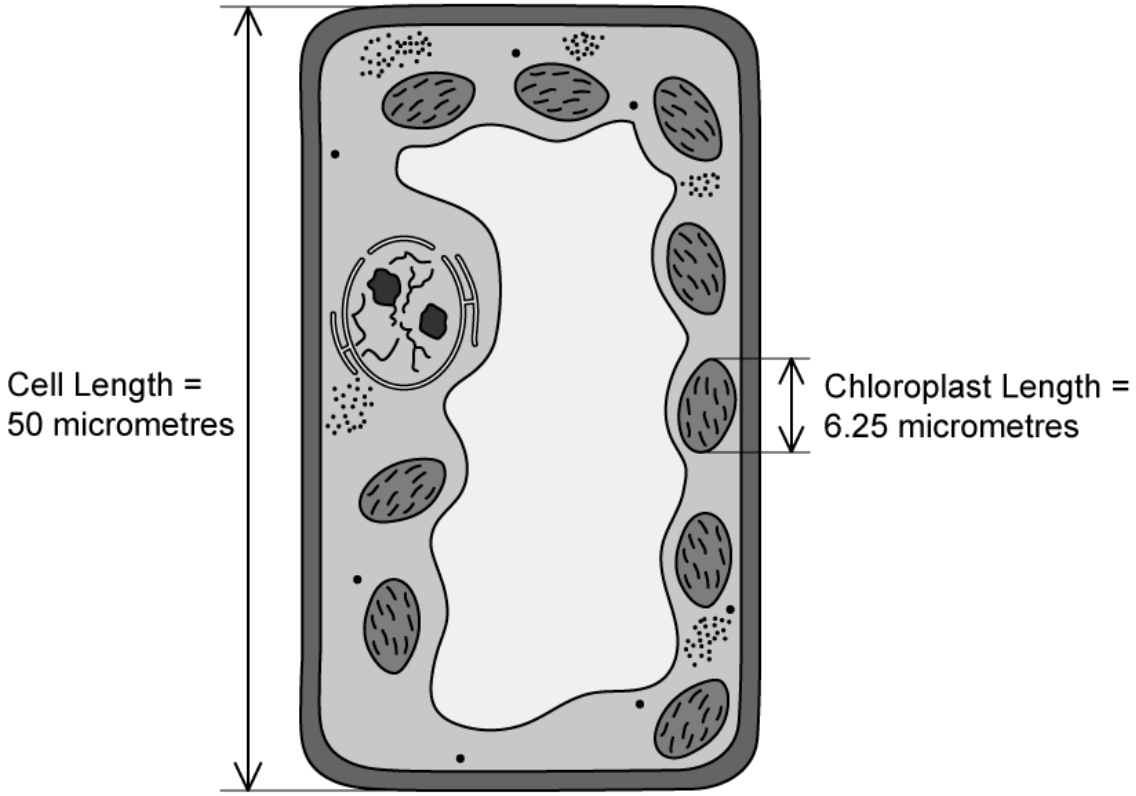
- Award [1 mark] for each correct column.

[Total: 2 marks]

(2 marks)

(d) **Figure 2** shows a plant cell drawn to scale.

Figure 2



Calculate how many times longer the cell length is compared to the chloroplast length.

Answer

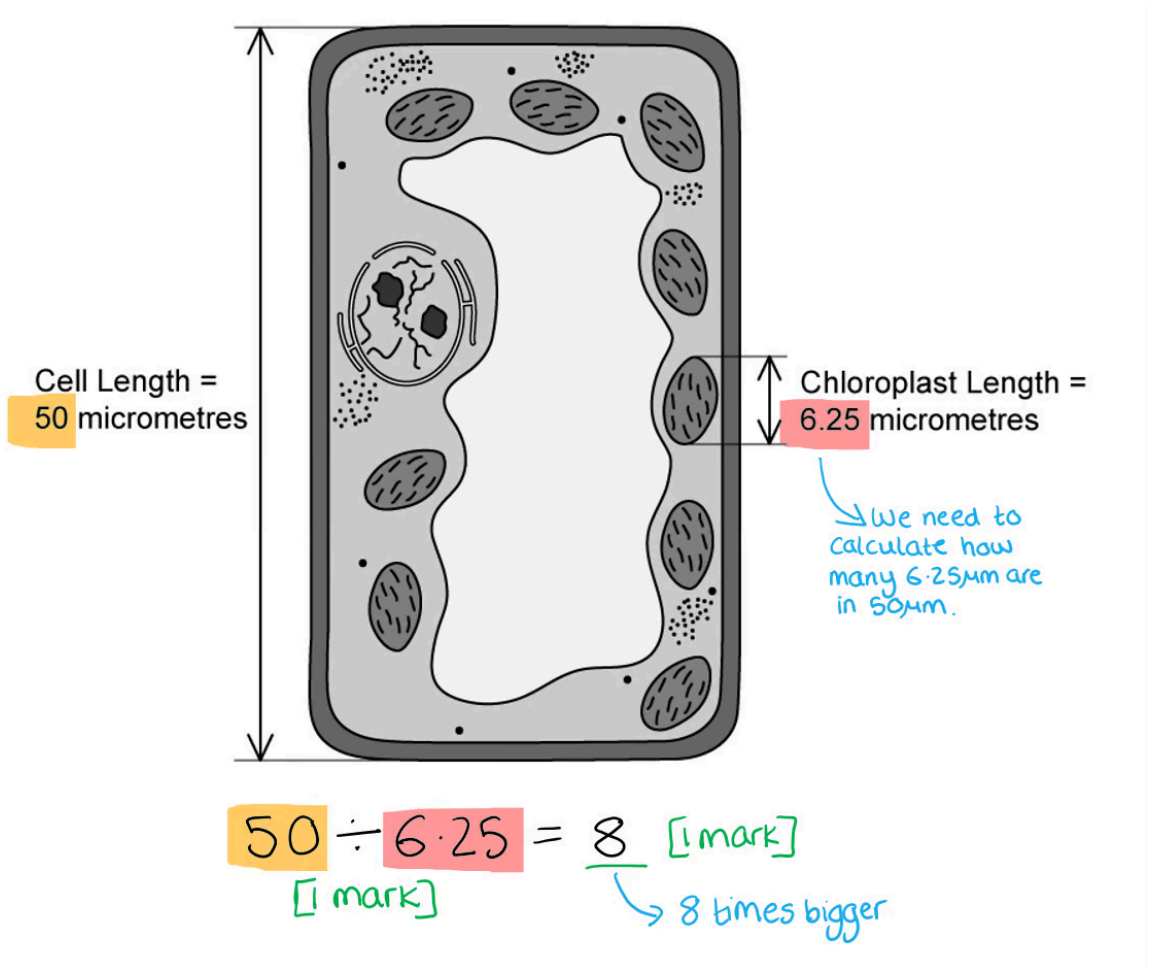
The following calculation shows how much longer the cell length is compared to the chloroplast:

- 50 ÷ 6.25; [1 mark]
- = 8 times longer; [1 mark]

Full marks to be awarded for correct answer without calculation

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[Total: 2 marks]

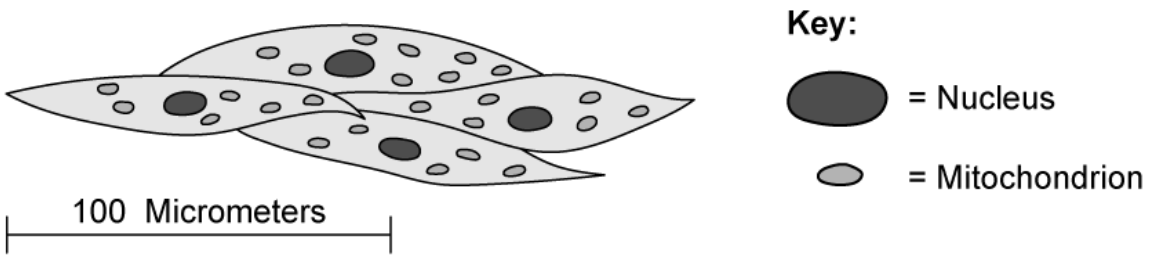


(2 marks)

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4 (a) **Figure 3** shows some muscle cells.

Figure 3



Identify the function of a muscle cell and explain how they are adapted for this function.

Answer

The function of a muscle cell is to...

- Contract for movement; [1 mark]

They are adapted as follows:

- They have many mitochondria; [1 mark]
- They can release energy **OR** they can produce ATP; [1 mark]

Award a mark for 'transfer energy' instead of 'release energy'

*Do **not** award a mark for statements saying that mitochondria can "make/produce energy".*

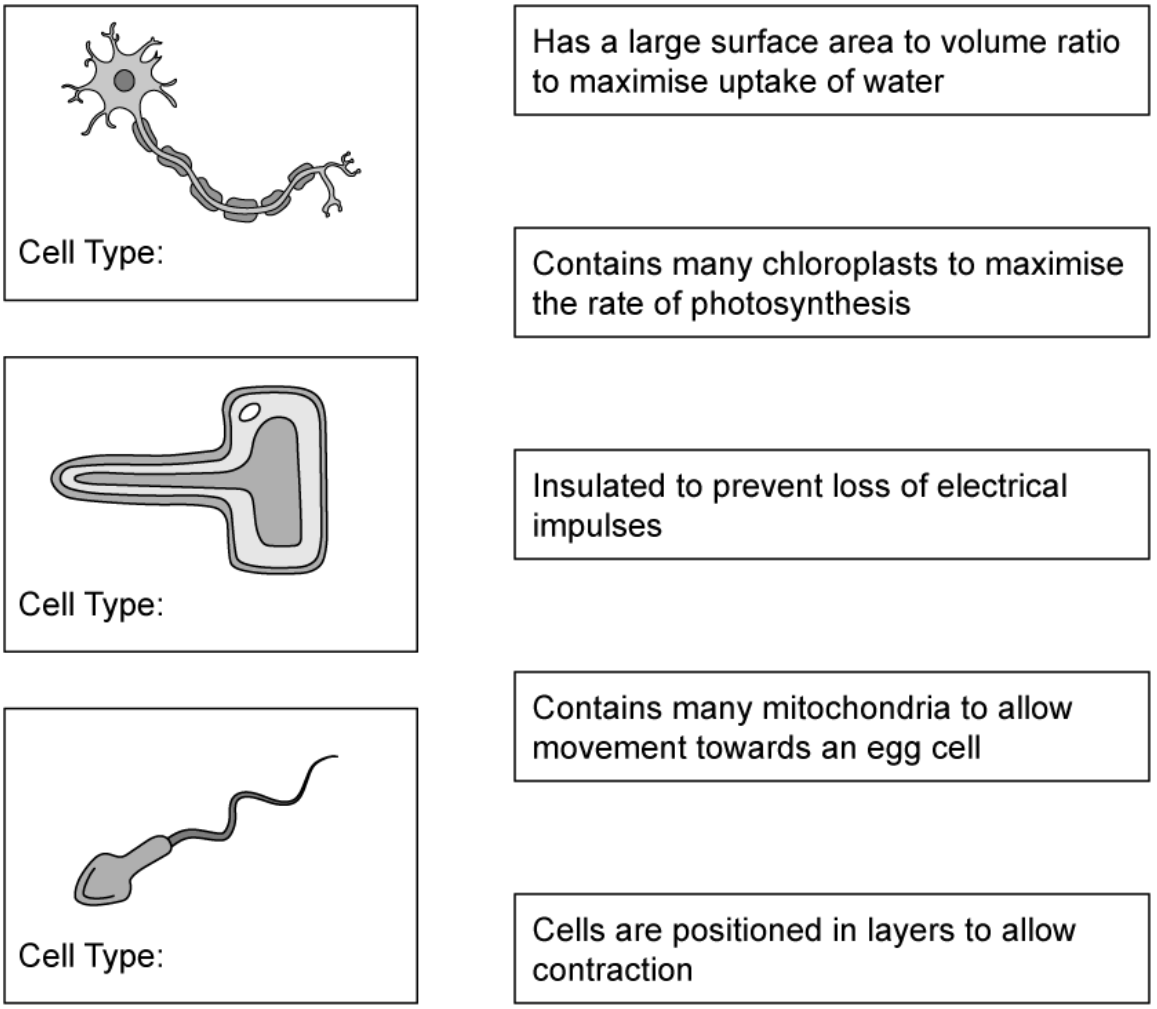
[Total: 3 marks]

(3 marks)

(b) **Figure 4** shows some information about specialised cells.

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Figure 4

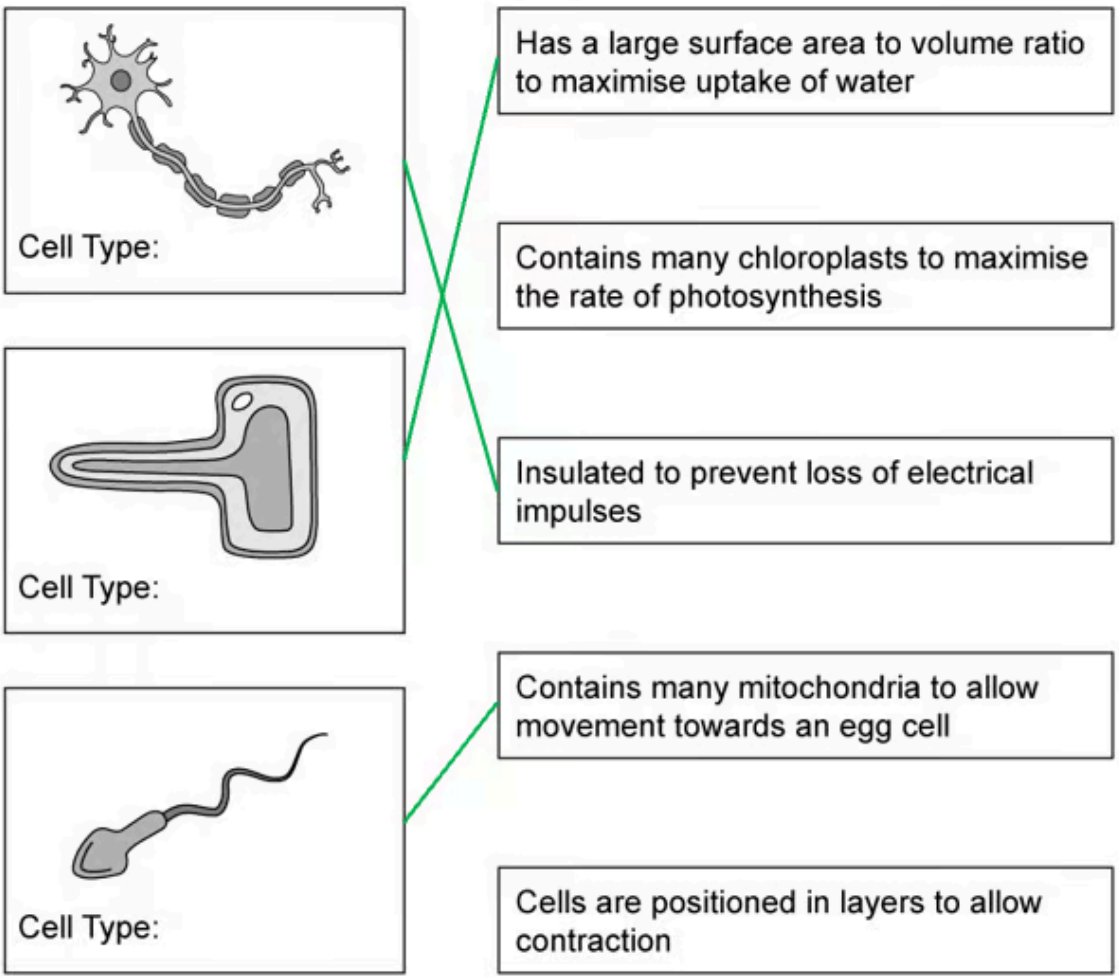


Identify the type specialised cell shown and match each one to the correct function.

Answer

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The cells should be identified as follows:



[1 mark] should be awarded for each cell which is correctly labelled and linked to the correct function

[Total: 3 marks]

(3 marks)

(c) Describe how the xylem is adapted for carrying water and mineral ions around a plant.

Answer

Xylem is adapted for carrying water and mineral ions as follows:

Any **one** of the following:

- Cells are hollow / form hollow tubes / have no cell contents/organelles; [1 mark]
- Walls contain lignin / are strengthened/strong; [1 mark]

[Total: 1 mark]

(1 mark)

(d) Name the process by which a cell changes to become specialised.

Answer

The process by which cells become specialised is...

- (Cell) differentiation; [1 mark]

[Total: 1 mark]

(1 mark)

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5 (a) Complete each row of **Table 1** with a tick (✓) or a cross (✕) to indicate whether it is a feature of osmosis.

Table 1

Feature	✓ / ✕
Involves the movement of gases	
Requires energy from respiration	
Movement occurs through a partially permeable membrane	
Particles move down a concentration gradient	

Answer

Table 1 should be completed as follows:

Feature	✓ / ✕
Involves the movement of gases	✕
Requires energy from respiration	✕
Movement occurs through a partially permeable membrane	✓
Particles move down a concentration gradient	✓

Allow [1 mark] for each correct ✓ or ✕

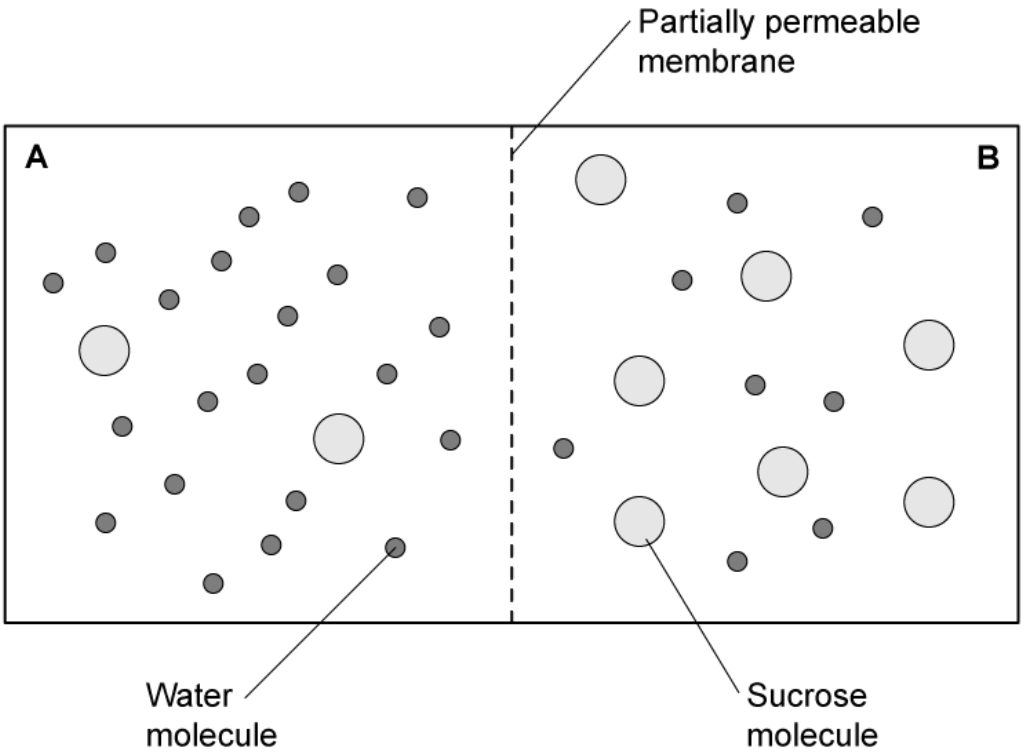
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[Total: 4 marks]

(4 marks)

(b) Draw an arrow on the diagram in **Figure 2** to show the overall direction that the water particles will move in (net water movement).

Figure 2

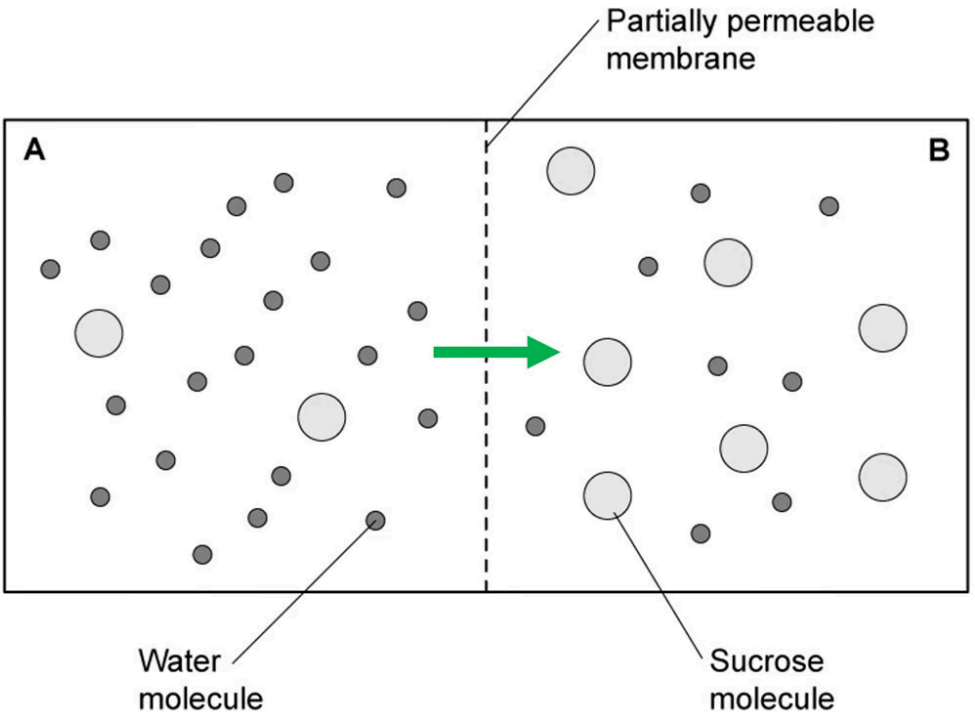


Answer

The water particles will move...

- From left to right; [1 mark]

[Total: 1 mark]



(1 mark)

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(c) Describe an example of where diffusion of gasses is important in multicellular organisms.

Answer

An example of where diffusion of gases are important in multicellular organisms may include:

Any **three** from the following:

- Gas exchange in the lungs (of animals) for respiration **OR** gas exchange in the leaves for respiration **OR** Gas exchange in the gills for respiration; [1 mark]
- Oxygen moves from alveoli into the blood (animals) **OR** in from the air (spaces) into the spongy mesophyll cells (plants) **OR** from water in the into the blood (fish); [1 mark]
- Carbon dioxide moves from the blood into the alveoli (animals) **OR** out from the spongy mesophyll cells into the air spaces (plants) **OR** from the blood to the water (fish); [1 mark]

OR

- Gas exchange in the leaves for photosynthesis; [1 mark]
- Oxygen moves out from the spongy mesophyll/palisade cells into the air (spaces); [1 mark]
- Carbon dioxide moves in from the air (spaces) into the palisade/spongy mesophyll cells; [1 mark]

[Total: 3 marks]

(3 marks)

(d) Identify one feature of a gas exchange surface which maximises the rate of diffusion.

Answer

A gas exchange surface may have the following features to maximise diffusion

Any **one** from the following:

- Thin/Short diffusion distance; [1 mark]
- Steep concentration gradient; [1 mark]
- Large surface area (to volume ratio) for gas exchange; [1 mark]

[Total: 1 mark]

(1 mark)

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6 (a) State why mitosis is important in multicellular organisms.

Answer

Mitosis is important in multicellular organisms because...

- It allows growth **OR** repair of damaged tissues; [1 mark]

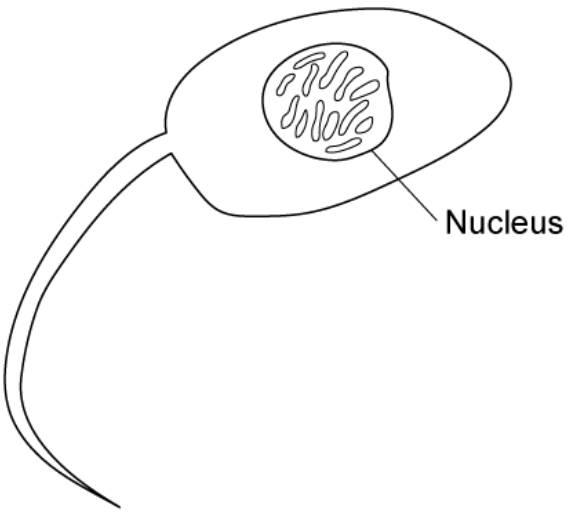
Allow descriptions of specific growth/repair processes

[Total: 1 mark]

(1 mark)

(b) **Figure 2** shows the nucleus of a male gamete from a frog.

Figure 2



What is the diploid number of chromosomes for a body cell in a frog?

Answer

The diploid number of chromosomes for a body cell in a frog would be....

- 26: [1 mark]

[Total: 1 mark]

Remember that a gamete shows the haploid number of chromosomes which is half the total number of chromosomes found in a diploid cell.

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When the sperm cell fertilises the egg cell, the chromosome number from the egg is added to the sperm to make the diploid number, in this case 13 + 13 = 26.

(1 mark)

(c) Complete the table to identify which statements about mitosis are true and which are false.

Table 1

Statement	True	False
Mitosis produces genetically identical cells		
A cell divides twice in the process of mitosis		
Daughter cells from mitosis are haploid		
DNA is replicated before a cell can divide		

Answer

The table should be completed as follows:

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Statement	True	False
Mitosis produces genetically identical cells	✓	
A cell divides twice in the process of mitosis		✓
Daughter cells from mitosis are haploid		✓
DNA is replicated before a cell can divide	✓	

[Total: 4 marks]

Make sure you know the difference between mitosis and meiosis as the false options here are both relating to features of meiosis and not mitosis.

(4 marks)

(d) Most human cells that divide by mitosis are specialised to carry out a particular function. This is because the parent cell from which they originated was already differentiated.

Give the name that can be used to describe these parent cells and state where they might be found in the human body.

Answer

These cells are...

- Stem cells; [1 mark]

They are found in...

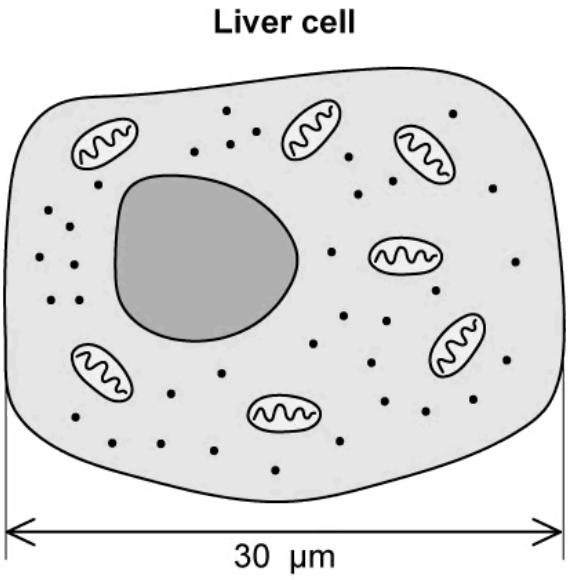
- (Some) organs / named example, e.g. bone marrow / skin / liver / brain; [1 mark]

[Total: 2 marks]

(2 marks)

7 (a) **Figure 5** shows liver cell which measures 60 mm.

Figure 5



Calculate the magnification of the liver cell using the equation below:

$$Magnification = \frac{Image\ size}{Actual\ size}$$

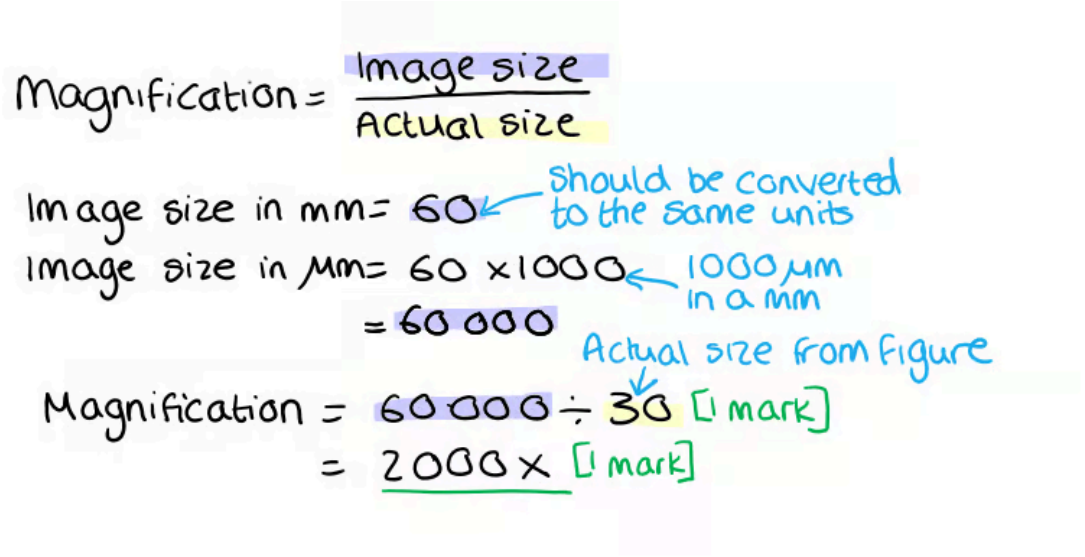
Answer

The magnification of the image is calculated as follows:

- 60 000 ÷ 30; [1 mark]
- = 2000 X; [1 mark]

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[Total: 2 marks]



(2 marks)

(b) A light microscope could not be used to observe a cell as seen in **Figure 5**.

Identify the evidence from **Figure 5** that supports this statement.

Answer

The evidence to support the statement that a light microscope could not be used to observe the cell as shown in **Figure 5** includes:

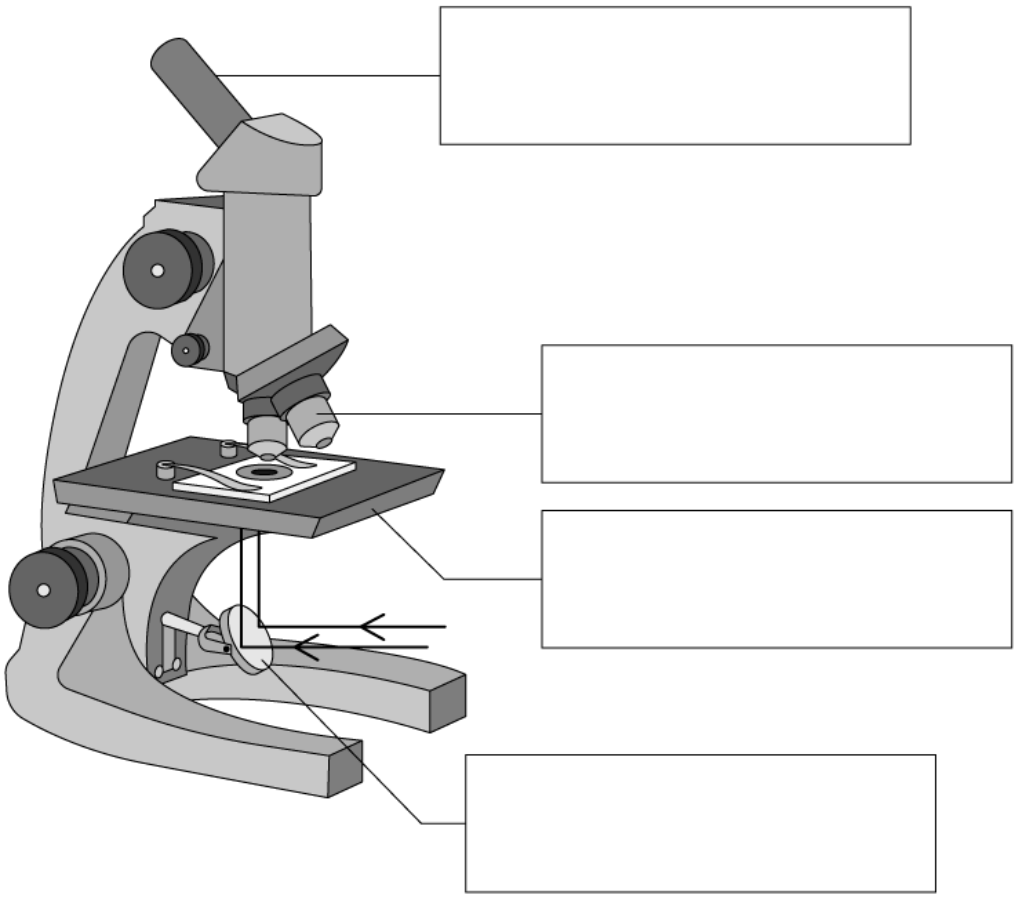
Any **one** from the following:

- Mitochondria / ribosomes are visible **OR** mitochondria / ribosomes would not be visible using a light microscope; [1 mark]
- The resolution would not be high enough on a light microscope to see the smaller organelles / mitochondria / ribosomes; [1 mark]

[Total: 1 mark]

(1 mark)

(c) Label the microscope in **Figure 6.**



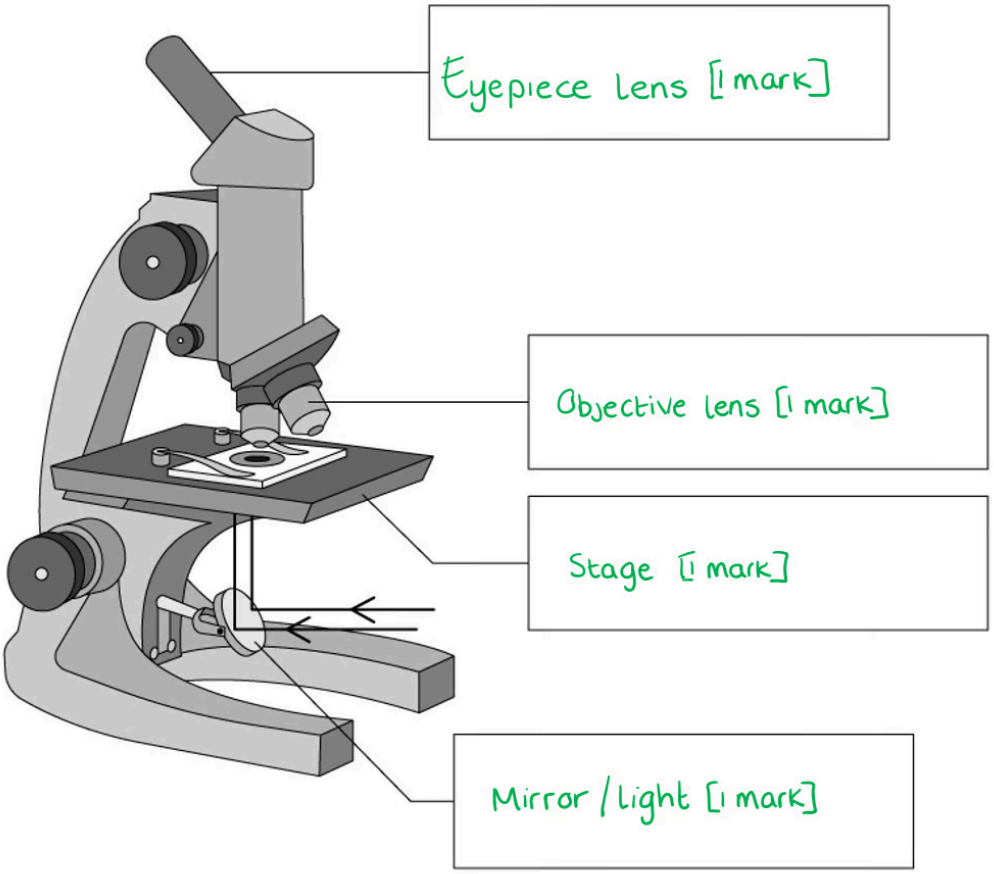
Answer

The microscope should be labelled as follows:

- Eyepiece (lens); [1 mark]
- Objective lens; [1 mark]
- Stage; [1 mark]
- Mirror / light; [1 mark]

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[Total: 4 marks]



(4 marks)

(d) A student set up a light microscope to observe a specimen. The magnification of the eyepiece lens was x10 and the magnification of the objective lens was x 20.

Calculate the overall magnification of the light microscope.

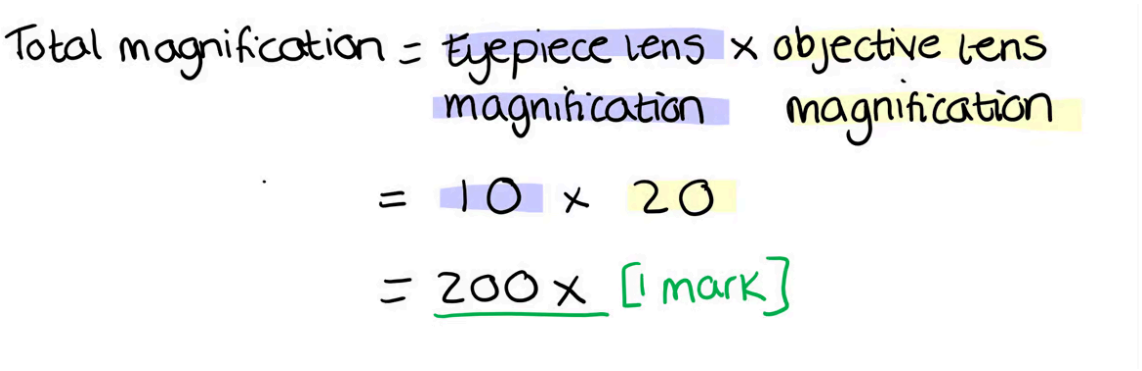
Answer

The magnification of the microscope was

- 200 x; [1 mark]

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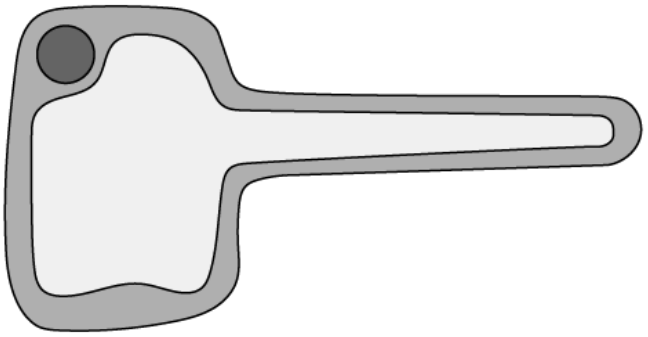
[Total: 1 mark]



(1 mark)

8 (a) Describe how the root hair cell in **Figure 3** is adapted for absorption of water by osmosis.

Figure 3



Answer

The root hair cell has the following adaptations to maximise osmosis:

Any **two** of the following:

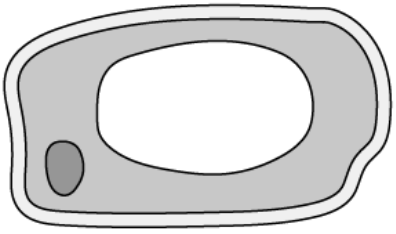
- A large surface area (to volume ratio); [1 mark]
- Short diffusion distance / short distance between the soil and the cytoplasm; [1 mark]
- Many mitochondria **OR** a large vacuole; [1 mark]

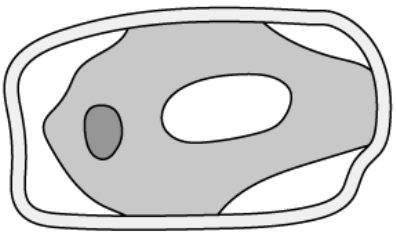
[Total: 2 marks]

(2 marks)

(b) **Figure 4** shows two cells after the effects of osmosis.

Figure 4





A plant cell in distilled water

An animal cell in highly concentrated sugar solution

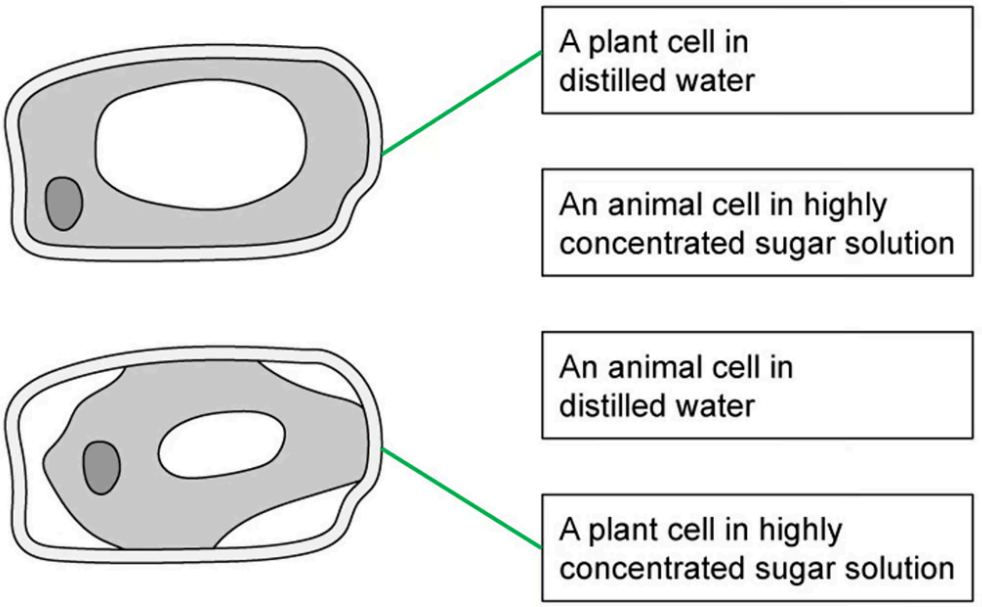
An animal cell in distilled water

A plant cell in highly concentrated sugar solution

Draw a line from each cell to the correct description.

Answer

The lines should be drawn as follows:



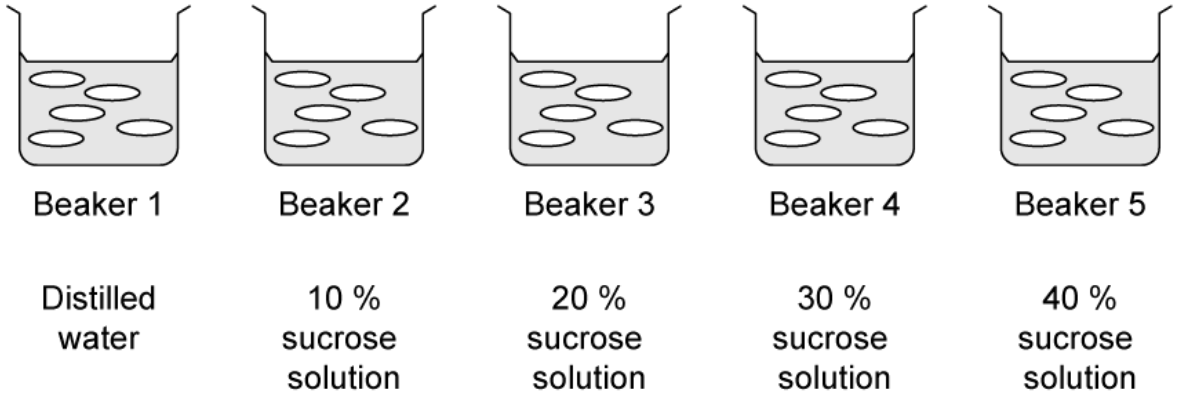
Award [1 mark] for each correct line

[Total: 2 marks]

(2 marks)

(c) A student carried out an experiment into osmosis in plant tissue. They set up their investigation as shown in **Figure 5.**

Figure 5



Each beaker contained potato discs in a solution of sugar or distilled water. The student found that the potato discs in Beaker 5 decreased in mass.

Explain why this is with reference to osmosis.

Answer

The potato disks in Beaker 5 decreased in mass because...

- Water moved out of the potato
- By osmosis; [1 mark]
- From a high water concentration (in the potato) to a low water concentration (in the sucrose solution); [1 mark]

[Total: 2 marks]

(2 marks)

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(d) Which of the following is a suitable control variable for the investigation carried out by the student in part **(c)?**

A. Maintain the same sugar concentration in each beaker

B. Repeat the experiment 3 times

C. Use the same size potato pieces in each beaker

D. Calculate an average of the results

Answer

The correct answer is C.

Keeping the potato pieces the same size (and the same total mass) makes this a fair test, which is what a control variable should do.

A is incorrect because the sugar concentration is the independent variable, the thing that the student is deliberately changing to examine the effects of changing it.

B is incorrect because repeating the experiment will add reliability but does not control any of the variables of the experiment.

D is incorrect because calculating an average (the mean) does not control the variables that might affect the results.

(1 mark)

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9 (a) Give the definition of a stem cell.

Answer

A stem cell is...

- An undifferentiated cell; [1 mark]
- A cell that can divide to produce different cell types; [1 mark]

[Total: 2 marks]

It is important that you do not imply that the stem cell 'becomes' another cell type. Stem cells remain stem cells, but divide to 'give rise to' other cell types.

(2 marks)

(b) Which of the following statements about stem cells is not true?

A. Meristem cells can differentiate into any type of plant cell throughout the life of the plant

B. Adult stem cells are partially specialised

C. Umbilical cord stem cells can develop into any of the different cell types in the human body

D. Embryonic stem cells could be used to cure type 1 diabetes

Answer

The correct answer is C.

Umbilical cord stem cells have the same capabilities as adult stem cells as they are partially differentiated.

A is incorrect because a whole new plant can be generated from meristem cells, so the meristem can differentiate into all cells types required for a new organism.

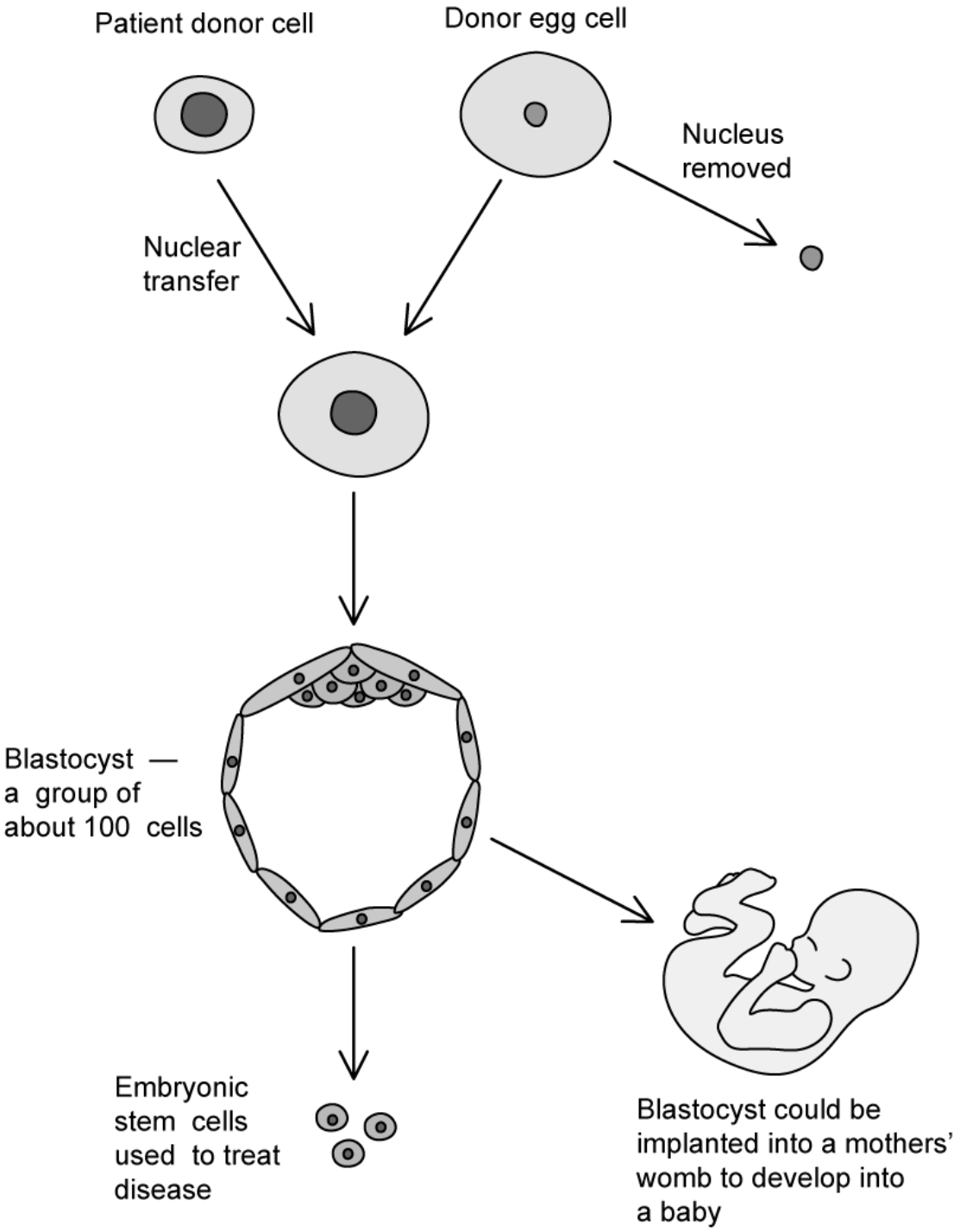
B is incorrect because adult stem cells are partly differentiated.

D is incorrect because this is one of the hopes that medicine can benefit from stem cell therapy to replace dead or damaged cells/tissues in a Type 1 diabetic patient's pancreas.

(1 mark)

(c) Identify the process shown in **Figure 3.**

Figure 3



Answer

The process shown is

- Therapeutic cloning (to obtain embryonic stem cells); [1 mark]

[Total: 1 mark]

Therapeutic cloning cannot be used (legally / morally / ethically) in the way shown, it is merely a representation of a process which could cultivate embryonic stem cells.

(1 mark)

(d) Identify **two** cells from **Figure 3** which would contain a diploid number of chromosomes.

Answer

Cells from **Figure 3** which would contain a diploid number of chromosomes could be...

Any **two** from the following:

- The donor cell; [1 mark]
- A cell from the blastocyst; [1 mark]
- The zygote / cell produced after nuclear transfer; [1 mark]
- The stem cells; [1 mark]
- Any cell from the fetus; [1 mark]

[Total: 2 marks]

The nucleus that is removed from the donor egg cell is the only haploid component in **Figure 3**

(2 marks)

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(e) Explain why the production of stem cells as shown in **Figure 3** is opposed by many people.

Answer

The method of producing stem cells is opposed by many because of the following:

- The embryo may die in the process **OR** the embryo has a right to life / cannot consent to donating stem cells; [1 mark]
- If implanted, the embryo would develop into a clone of the patient; [1 mark]
- Religious / moral / ethical beliefs; [1 mark]

[Total: 2 marks]

Consider how you phrase your answer in this question as it is important not to be too vague.

Note that human cloning is illegal in all countries.

(2 marks)

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10 (a) Pre-cut potato chips can be stored in salt solution before being cooked in restaurants. To avoid the chips becoming too salty, it is important to make sure that water does not move in or out of the chips as they are stored.

A scientist wanted to collect some data about the salt content of potato chips to inform the restaurants of the best storage concentration.

The steps in **Table 2** refer to the method that the scientist used to collect his results.

Table 2

1	Measure out 100ml of each salt solution into 5 different test tubes
	Remove the chips, pat dry and reweigh
	Cut 5 potato chips of similar size and dimensions
	Place 1 chip into each concentration of salt solution and leave for 1 hour
	Record the mass of the potato chips

Complete the table to place the steps in the correct order by adding numbers **2** to **5** into the left hand column of **Table 2**. The first stage has been labelled for you.

Answer

Table 2 should be completed as follows:

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1	Measure out 100ml of each salt solution into 5 different test tubes
5	Remove the chips, pat dry and reweigh
2	Cut 5 potato chips of similar size and dimensions
4	Place 1 chip into each concentration of salt solution and leave for 1 hour
3	Record the mass of the potato chips

Allow [2 marks] for a correct order as shown above.

Allow [1 mark] for answers with 1 step out of place

No marks should be awarded for answers with more than 1 step in the wrong order

[Total: 2 marks]

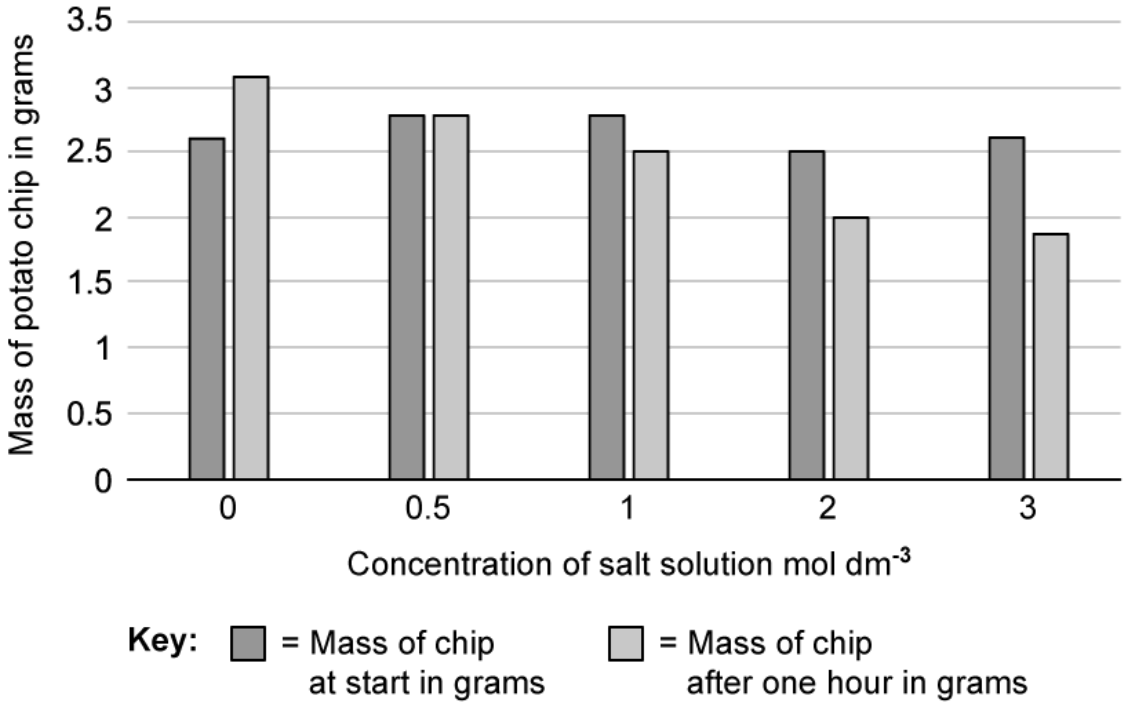
You don't necessarily need to be familiar with the practical method to answer this question, but you should be careful to ensure that the steps are in a logical order.

(2 marks)

(b) Figure shows the results obtained by the scientist when completing the investigation from part **(a).**

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Figure 6



In which salt solution did the mass of the chip increase after one hour?

Answer

The mass of the chip increased in

- 0 mol dm^{-3} / distilled water; [1 mark]

[Total: 1 mark]

(1 mark)

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(c) Explain what led to this increase in mass of the chip identified in part **(b)**.

A. Water moved out of the chip by osmosis

B. Salt moved into the chip by diffusion

C. Water moved into the chip by osmosis

D. The chip reacted with the salt in the solution

Answer

The correct answer is C .

The water moved from a high water concentration (distilled water is pure water) to a low water concentration (in the potato).

The mass gained comes from the water that moves into the potato, therefore A cannot be correct.

The salt does not move so B is not correct.

There is no reaction so D is not correct.

[Total: 1 mark]

(1 mark)

(d) The scientist concluded that the best solution for storing chips in would be 0.5 mol dm^{-3} salt solution because there would be no net (overall) movement of water into or out of the potato chips.

Suggest how the scientist can tell this from the results in **Figure 6.**

Answer

The scientist could tell this from the results in the graph because...

- The mass (of the chip in 0.5 mol dm^{-3} salt solution) remained the same after 1 hour; [1 mark]

[Total: 1 mark]

(1 mark)

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11 (a) Below is a list of statements regarding use of stem cells from plants.

A - Clones can be produced quickly

B - Populations of species under threat can be cultivated

C - There will be low genetic diversity in the cloned plants

D - Crops with resistance to pests can be cloned

Table 2

Advantages	Disadvantages

Write the letter of each statement in the correct column of **Table 2** to show whether it is an advantage or a disadvantage of stem cell use.

Answer

The table should be filled out as follows:

Advantages	Disadvantages
A, B, D	C

Allow [1 mark] for 2 correctly placed letters

[Total: 2 marks]

Genetic diversity is important as it makes a species or population resilient. For example, a population with a very small genetic diversity were to be infected with a disease, there is a smaller chance that there will be individuals with advantageous genes allowing them to survive, the population would be wiped out.

(2 marks)

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(b) Name the location of the stem cells in plants.

Answer

The stem cells in a plant are found in the....

- Meristem / root tip / shoot tip; [1 mark]

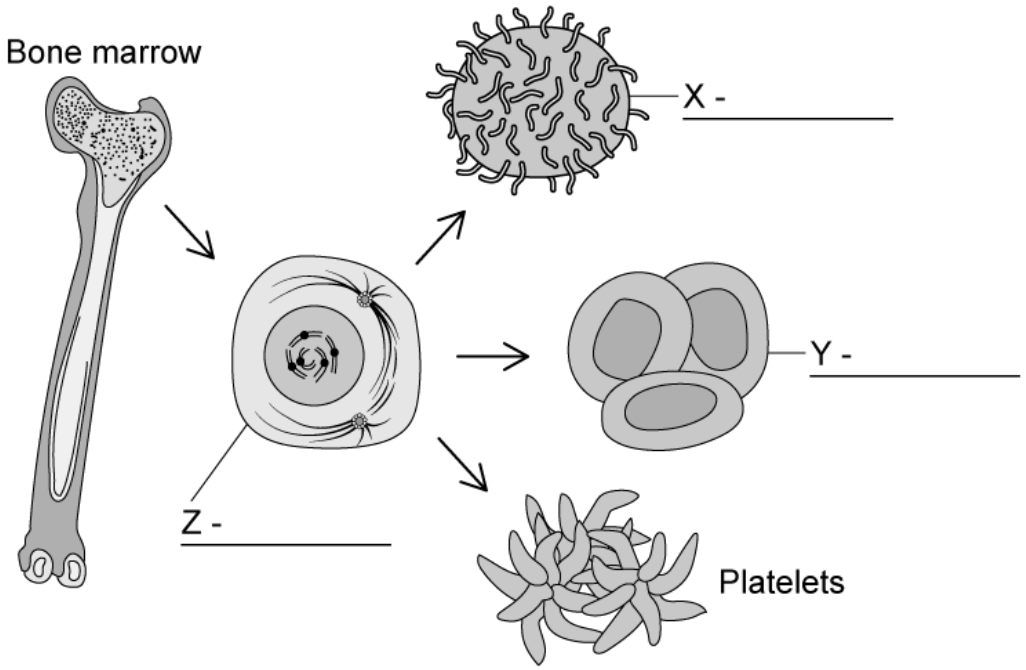
[Total: 1 mark]

The meristem is the dividing region of the root or shoot tips of a plant.

(1 mark)

(c) Identify the correct labels from the words provided to complete the diagram in **Figure 4**

Figure 4



White Blood Cell	Red Blood Cell	Embryonic Stem Cell
Meristem	Egg Cell	Adult stem Cell

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Answer

The correct labels are as follows:

- X - White blood cell; [1 mark]
- Y - Red blood cell; [1 mark]
- Z - Adult stem cell; [1 mark]

[Total: 3 marks]

(3 marks)

(d) Which statement correctly explains the label given to cell Z in **Figure 4** from part (c)?

A. Cell Z produces antibodies

B. Cell Z is found in a 5 day old embryo

C. Cell Z is a haploid cell

D. Cell Z is partially differentiated in the bone marrow

Answer

The correct answer is D.

The cell which produces antibodies is actually Cell X, the white blood cell.

It is an adult stem cell as it is produced in the bone marrow and can only become a limited number of different cell types as it is already partially differentiated.

Cell Z is not a gamete so is not haploid.

(1 mark)

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12 (a) Describe the method used to prepare an onion cell specimen on a microscope slide for observation with a light microscope.

Answer

An onion cell specimen can be prepared on a microscope slide in the following way

- Use tweezers to peel back a layer of epidermal tissue
- Add a drop of water to a clean slide
- Spread the epidermal tissue out on the slide
- Ensure the tissue is one cell thick
- Add a drop of dye / iodine / stain so structures are visible / clear
- Place a cover slip over the top
- Tap gently to remove air bubbles
- Dab away any excess dye from the slide

Level 2 [3–4 marks]:

- A method is described in some detail with key equipment identified
- Most key stages are identified and logically ordered
- The answer communicates ideas showing evidence of clarity and organisation and uses scientific terminology appropriately
- Spelling, punctuation and grammar are used with accuracy

Level 1 [1–2 marks]:

- A vague method is implied which mentions some key equipment e.g. microscope slide
- Some key stages are identified but may be in the incorrect order
- The answer communicates ideas using simple language and uses limited scientific terminology

- Spelling, punctuation and grammar are used with limited accuracy

This is a 'level of response' answer. You should decide which level your answer fits against and then consider whether it meets that level securely to achieve the higher mark, or partially to achieve the lower mark.

Examples of correct points in relation to the question are given in the mark scheme, but it is important to note that each point does not equate to a mark.

(4 marks)

(b) A student set up the investigation described in part **(a)** and produced a biological drawing of one cell that they observed with the microscope.

Give one rule which should be observed when creating a biological drawing.

Answer

One rule which should be observed when creating a biological drawing is...

Any **one** from the following:

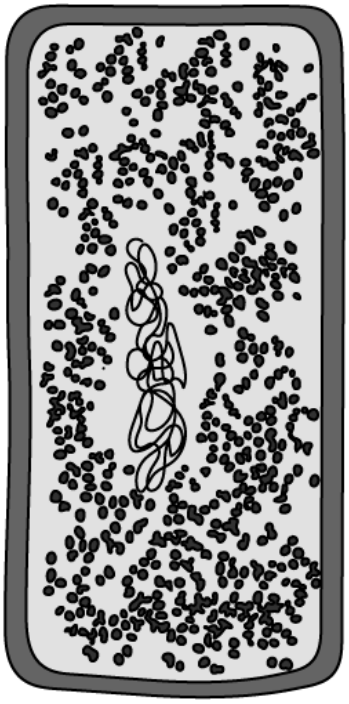
- No shading / sketching **OR** use clean / single lines / no feathered lines; [1 mark]
- Draw structures in proportion; [1 mark]
- Label features with clear uncrossed lines; [1 mark]

[Total: 1 mark]

(1 mark)

(c) **Figure 7** shows a bacterial cell before it divides.

Figure 7



Describe the process by which bacteria cells divide.

Answer

The process by which bacterial cells divide can be described as follows:

Any **two** from the following:

- (The process is called) Binary fission; **[1 mark]**
- Cell contents / DNA / organelles doubles; [1 mark]
- Cytoplasm divides **OR** cell wall forms around each cell; [1 mark]
- Two genetically identical daughter cells are produced; [1 mark]

[Total: 2 marks]

(2 marks)

(d) One bacterium divides five times.

Calculate how many bacteria are now present in the population?

A. 6

B. 32

C. 16

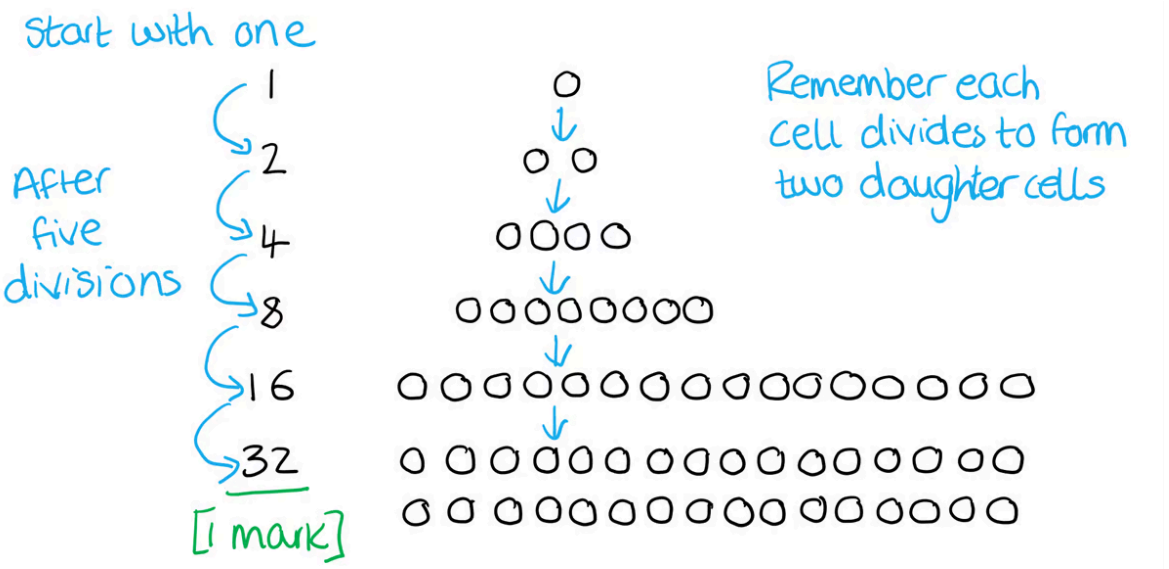
D. 64

Answer

The correct answer is B.

Calculating the number of bacteria present after a number of divisions can be done by using the 'to the power of' function. In this example, we would calculate 2^5 which gives 32.

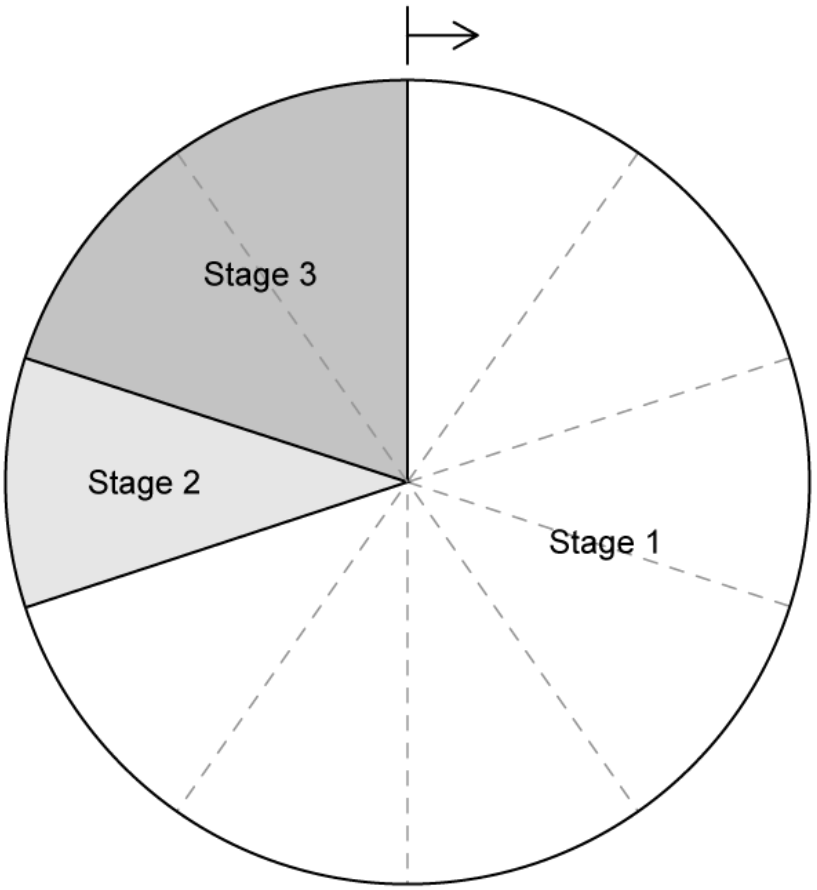
If you forget this method, a backup is to draw it out, remembering that each bacteria divides into 2 daughter cells during each division.



(1 mark)

13 (a) **Figure 5** shows the cycle of a cell which lasts 10 hours in total.

Figure 5



How long does **stage 2** last?

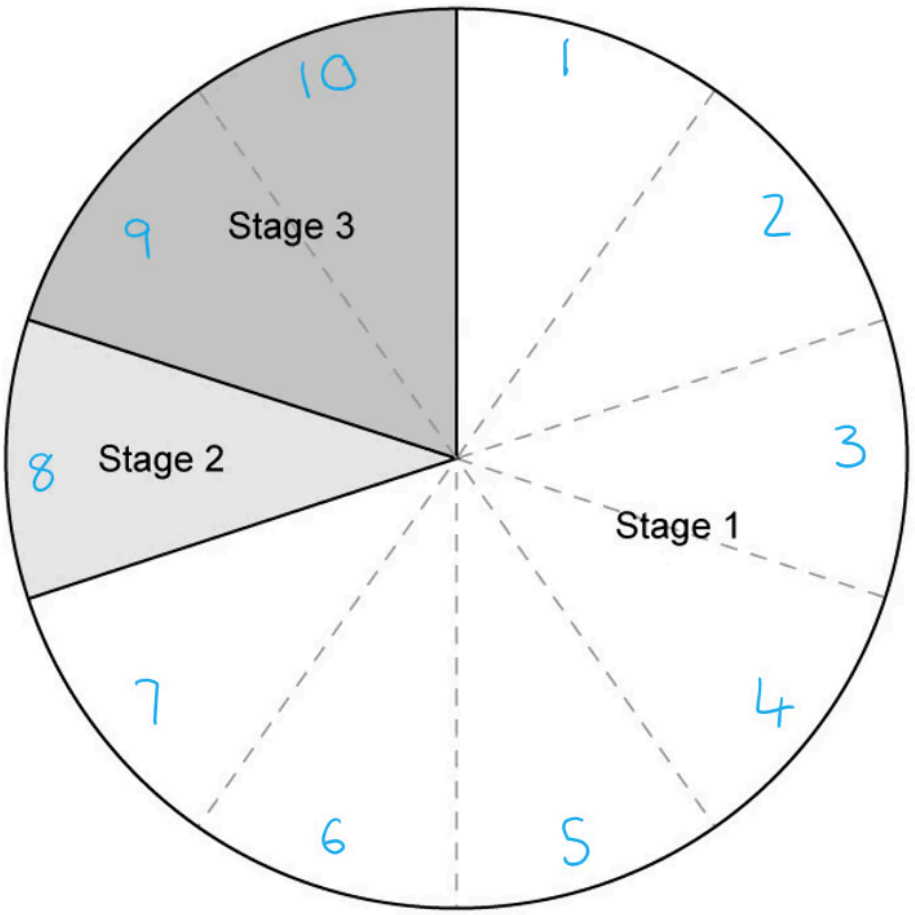
Answer

Stage 2 lasts...

- 1 hour; [1 mark]

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[Total: 1 mark]



10 segments = 10 hours
1 segment = 1 hour
stage 2 = 1 hour [1 mark]

There are 10 equal sectors in the pie chart shown here so we can assume that 1 sector = 1 hour.

(1 mark)

(b) **Stage 1** in **Figure 5** represents mitosis in the cell.

The statements in **Table 3** describe the process of mitosis.

Table 3

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Statement	Number order (1 - 4)
Two genetically identical daughter cells are produced	
Chromosomes are pulled to either end of the cell	
Cytoplasm splits	
Cell growth and DNA replication occurs	

Complete the table to place the statements in the correct order (1 = first, 4 = last).

Answer

The correct order for the statements is as follows:

Statement	Number order (1 - 4)
Two genetically identical daughter cells are produced	4
Chromosomes are pulled to either end of the cell	2
Cytoplasm splits	3
Cell growth and DNA replication occurs	1

Allow [2 marks] for all 4 correct.

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Allow [1 mark] if 3 are correct

No marks should be awarded if less than 3 are correct.

[Total: 2 marks]

(2 marks)

(c) Describe **one** use of plant stem cells.

Answer

Uses of plant could include:

- Cloning plants with pest resistance / disease resistance; [1 mark]
- Cloning rare species **OR** to increase numbers of plants at risk of extinction; [1 mark]
- Production of crop plants that give high yield; [1 mark]

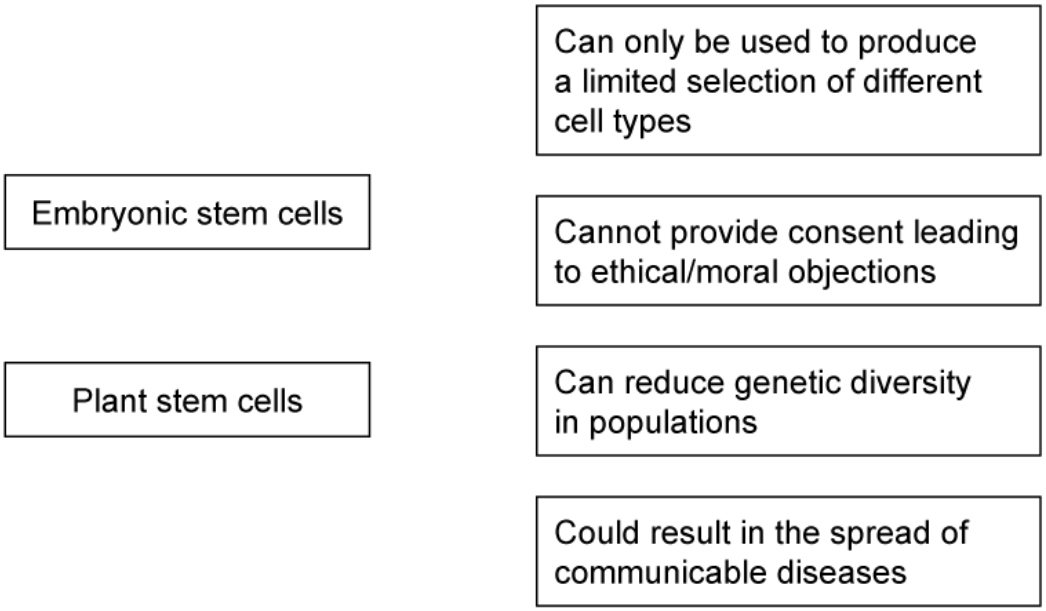
[Total: 1 mark]

(1 mark)

(d) Draw a line to link each stem cell type in **Figure 6** with the associated issue that they might involve.

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Figure 6



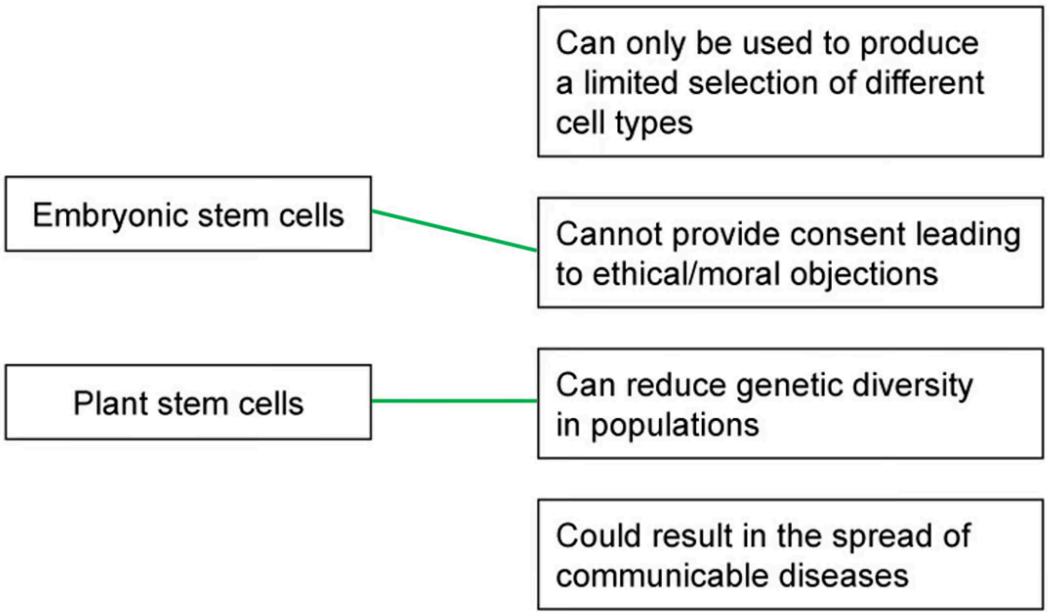
Answer

The lines should match up the cell types to the following issues:

- Embryonic stem cells - Cannot provide consent leading to ethical / moral objections; [1 mark]
- Plant stem cells - Can reduce genetic diversity in populations; [1 mark]

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[Total: 2 marks]

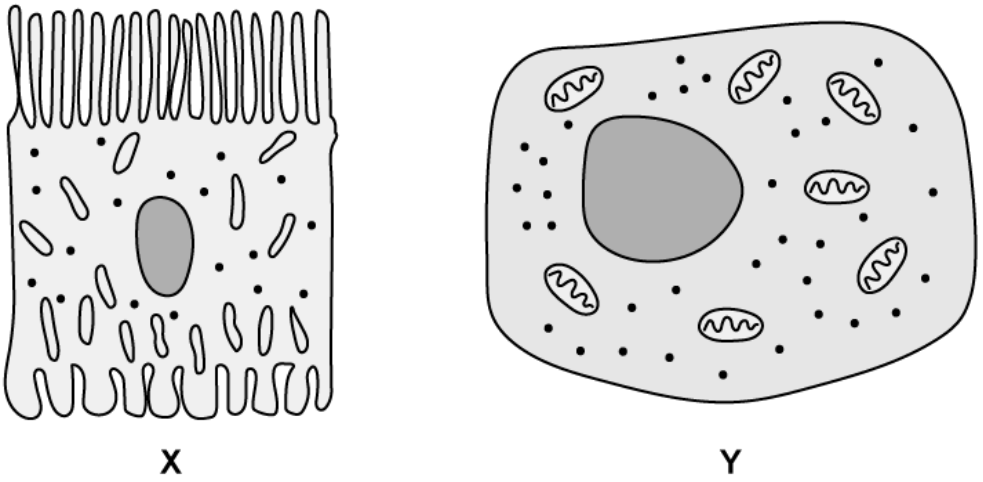


(2 marks)

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14 (a) **Figure 7** shows two cells.

Figure 7



Suggest which cell (**X** or **Y**) is better adapted to carry out diffusion and give a reason for your choice.

Answer

The cell better adapted for diffusion is...

- Cell X; [1 mark]
- (Because) it has a larger surface area to volume ratio / a folded membrane which gives a bigger surface for diffusion; [1 mark]

Allow any description of the folded membrane

Do not allow 'X has villi'

[Total: 2 marks]

(2 marks)

(b) The cells in **Figure 7** from part **(a)** also contain a high number of mitochondria.

Identify which transport process requires mitochondria to move particles across the cell membrane.

Answer

The transport process which requires mitochondria is...

- Active transport; [1 mark]

[Total: 1 mark]

Remember that the mitochondria are the site of respiration where energy is released during a chemical reaction between oxygen and glucose. This energy is used to drive the active transport of substances across the membrane against their concentration gradient.

(1 mark)

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(c) Complete the three sentences below by entering the appropriate transport process into the space provided.

_____(i)_____ is the movement of particles from a low concentration to a high concentration with the help of energy in the form of ATP.

_____(ii)_____ is the movement of particles from a high concentration to a low concentration.

_____(iii)_____ is the movement of water particles from a high water concentration to a low water concentration through a partially permeable membrane.

Answer

The sentences should be completed naming the transport processes in the following order:

- i = active transport; [1 mark]
- ii = diffusion; [1 mark]
- iii = osmosis; [1 mark]

[Total: 3 marks]

(3 marks)

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(d) Which substance is absorbed by plants during active transport?

A. Magnesium ions

B. Glucose

C. Water

D. Oxygen

Answer

The correct answer is A.

Mineral ions are moved from a low concentration in the soil to a high concentration within the root cells. This requires energy.

B is incorrect as glucose is produced during photosynthesis and moved around the plant to be used by the cells.

C is incorrect as, although water does move into root cells, water only moves by the process of osmosis.

D is incorrect because oxygen moves into the root by simple diffusion.

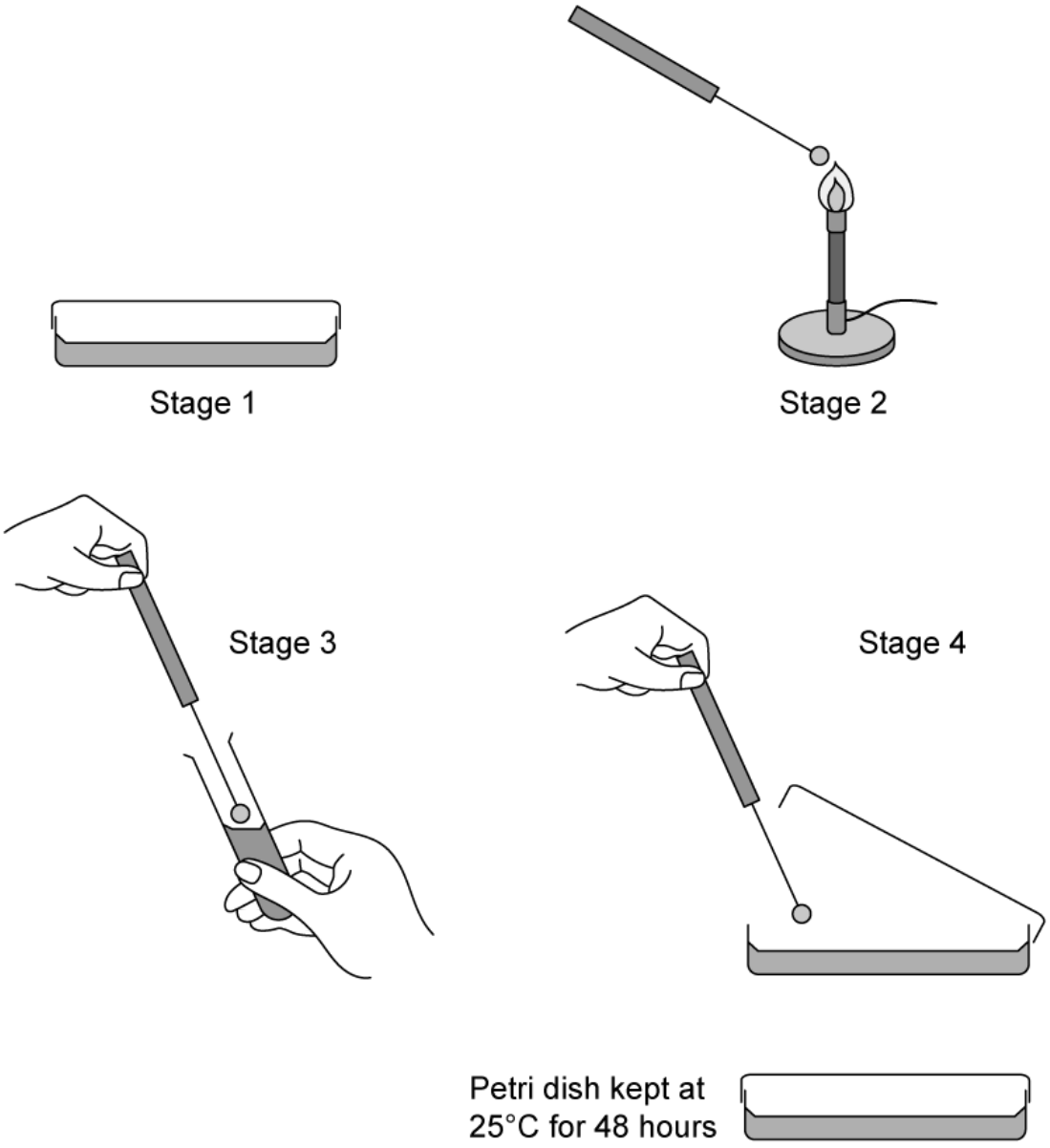
(1 mark)

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15 (a) Microorganisms can be cultured in the laboratory to investigate the effect of antibiotics and disinfectants.

Figure 8 shows the process involved in preparing the culture under aseptic conditions.

Figure 8



Describe what is happening in **stage 2.**

Answer

Stage 2 shows the following:

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- The inoculating loop is flamed / passed through a Bunsen burner to kill microorganisms; [1 mark]

[Total: 1 mark]

(1 mark)

(b) What is being spread onto the petri dish in **stage 4** shown in **Figure 8**?

Answer

In stage 4...

- Bacteria / named example of a bacterium (is being spread onto the petri dish); [1 mark]

Accept bacterial culture / innocculum.

[Total: 1 mark]

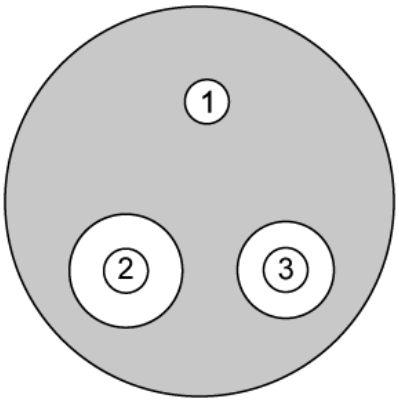
The method shown here is one which could also be used to study fungal cultures, although these are not covered by the specification.

(1 mark)

(c) Three paper disks were soaked in different antibiotics and placed on a bacterial culture to investigate how effective the antibiotics were.

The results can be seen in **Figure 9.**

Figure 9



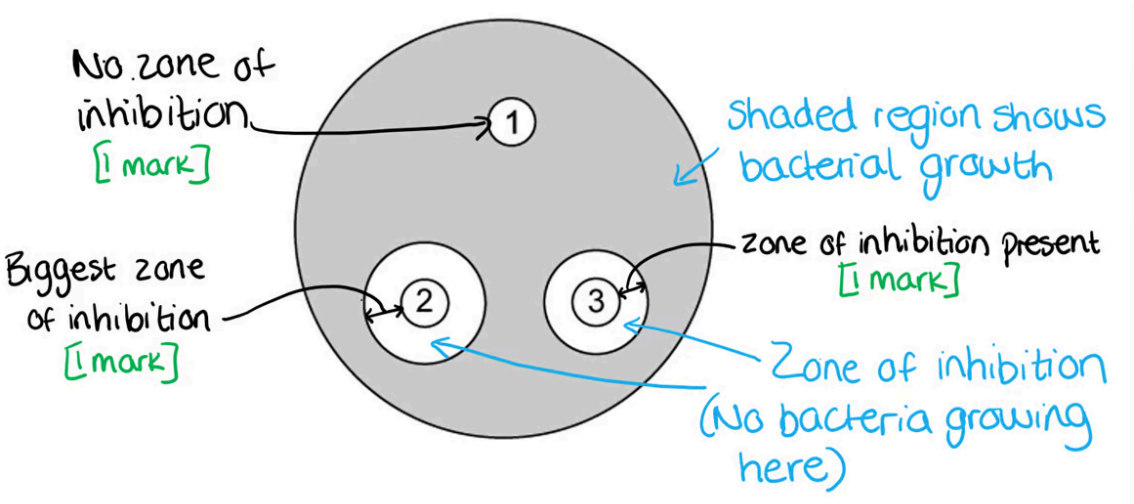
Describe what the results in **Figure 9** show.

Answer

The results in **Figure 9** show...

- Antibiotic 2 is the most effective / has the biggest zone of inhibition / kills the most bacteria; [1 mark]
- Antibiotic 1 is not at all effective / has no zone of inhibition / didn't kill any bacteria; [1 mark]
- Antibiotic 3 has a zone of inhibition / acts against the bacterial growth;[1 mark]

[Total: 3 marks]



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(3 marks)

(d) The results of the investigation can be seen in **Figure 10.**

Antibiotic disk	Mean diameter of clear zone in mm	Mean radius in mm	Zone of inhibition in mm^2
1	0	0	0
2	22	11	
3	16	8	201

The area of a circle can be calculated using the equation πr^2.

Calculate the zone of inhibition around antibiotic **2**.

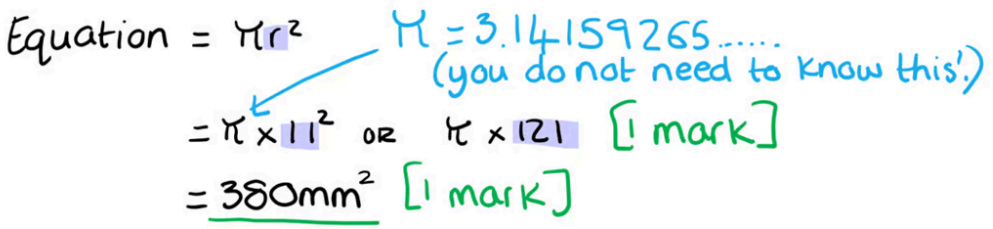
Answer

The zone of inhibition around disk number 2 is...

- π x 11^2 **OR** π x 121; [1 mark]
- 380.13 **OR** 380 $mm^{2;}$ [1 mark]

Correct answer should be awarded full marks in the absence of any calculations.

[Total: 2 marks]

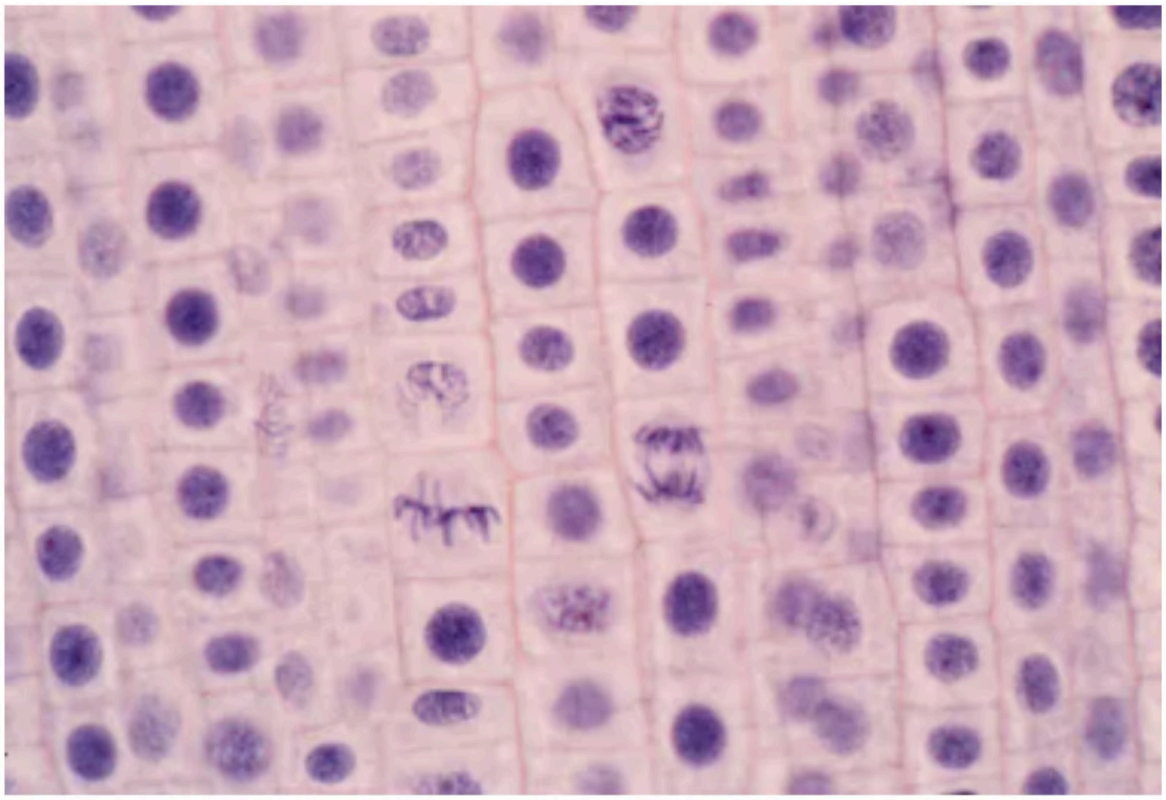


(2 marks)

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16 (a) **Figure 1** below is a photomicrograph of cells in the root of an onion.

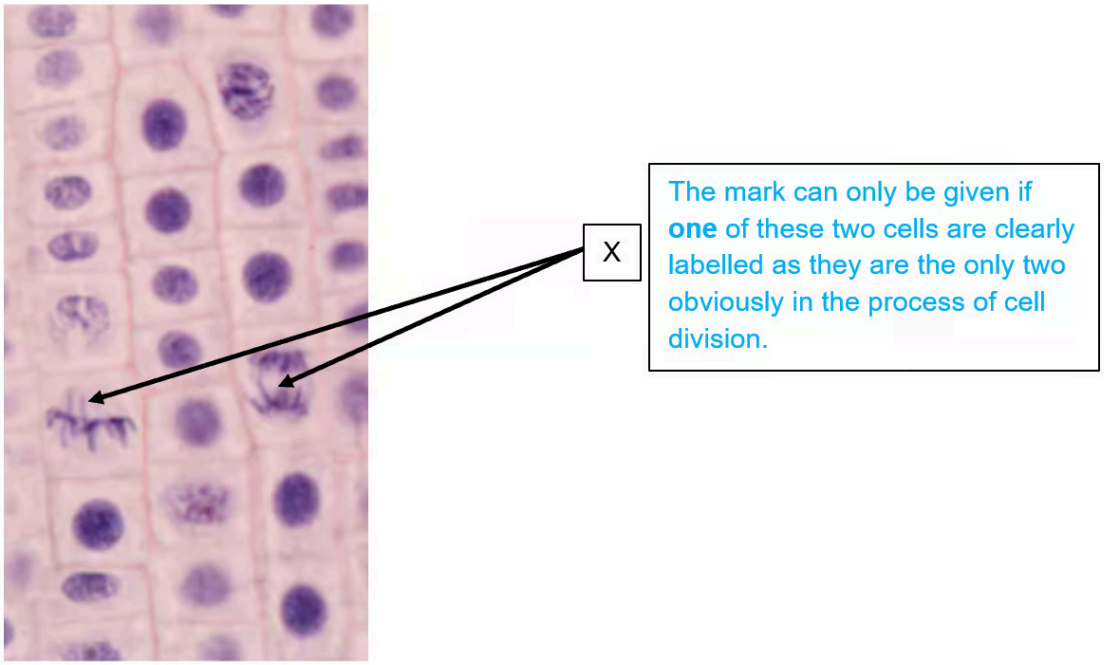
Figure 1



On the image above, label a cell that is actively dividing with the letter X.

Answer

(a)



[Total: 1 mark]

(1 mark)

(b) Name the type of cell division that occurs in the meristem of plants for growth.

Answer

The type of cell division that occurs in the meristem of plants for growth is:

- Mitosis; [1 mark]

[Total: 1 mark]

You must spell mitosis correctly to achieve the mark.

(1 mark)

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(c) Before a cell divides, what must happen to its genetic material?

Answer

Before a cell divides, its genetic material (Chromosomes) must be:

- Replicated / doubled / copied / cloned; [1 mark]

[Total: 1 mark]

Avoid using generic language such as 'chromosomes are multiplied or reproduced'.

(1 mark)

(d) A group of students decided to investigate the cell cycle.

They prepared a microscope slide of a root tip from an onion.

They then viewed the slide under a light microscope to count the number of cells in each part of the cell cycle in one field of view.

The table below shows their results.

Parts of the cell cycle

	Growth phase	Stage 1	Stage 2	Stage 3	Stage 4	Total
Number of cells	36	15	9	6	2	68

Different parts of the cell cycle take different lengths of time.

State which part of the cell cycle is the slowest. Give a reason for your answer.

Answer

The phase of the cell cycle that is the slowest is:

- Growth phase; [1 mark]
- The largest number of cells are seen in this stage; [1 mark]

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[Total: 2 marks]

(2 marks)

(e) It takes 18 hours for one complete cell cycle in a typical onion root tip cell.

Calculate the length of time **stage 3** lasts in a typical onion root tip cell.

Give your answer in minutes to 2 significant figures.

Answer

In a typical onion root tip cell **stage 3** lasts:

- (6 ÷ 68) x 18 x 60; [1 mark]
- 95.3 / 95.29; [1 mark]
- = 95 (minutes) [1 mark]

Award full marks for the correct answer in the absence of other calculations.

[Total: 3 marks]

To calculate an estimate for the length of a particular cell stage, you need to know how many cells are in that stage, the total number of cells observed and how long the complete cell cycle is. You can then use the following equation:

(observed number of cells in that stage ÷ total number of cells observed) x total length of time of cell cycle

As you were given the cell cycle length in hours, you need to multiply the answer by 60 to convert it into minutes.

(3 marks)

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17 (a) Sugar molecules are moved from the gut to the blood by active transport.

What is involved in active transport?

Answer

Active transport involves:

Any **four** of the following:

- Molecules/ions are moved through/across the cell membrane; [1 mark]
- (of intestinal epithelial cells) against a concentration gradient; [1 mark]
- Using energy supplied by respiration; [1 mark]
- Which requires oxygen; [1 mark]
- Transporter proteins/a series of chemical reactions are involved; [1 mark]
- Active transport is necessary because diffusion cannot occur; [1 mark]

[Total: 4 marks]

(4 marks)

(b) Explain two ways in which the intestine is specialised for exchanging materials.

Answer

Two ways in which the intestine is specialised for exchanging materials are:

Any **two** of the following:

- Highly folded surface / microvilli / villi to increase surface area (to volume ratio); [1 mark]
- An efficient blood supply to remove absorbed substances / maintain concentration gradients; [1 mark]
- Thin wall between lumen and capillaries/blood supply to make diffusion distance as short as possible; [1 mark]

[Total: 2 marks]

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(2 marks)

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18 (a) Both muscle and sperm cells are specialised animal cells. The nucleus of a muscle cell is different to the nucleus of a sperm cell.

Describe **one** way in which the nucleus is different between these two cells.

Answer

The nucleus of a muscle cell is different from the nucleus of a sperm cell in that...

Any **one** of the following**:**

- The nucleus of a sperm cell contains half the (number of) chromosomes in a muscle cell nucleus; [1 mark]
- The nucleus of a sperm cell contains one set of chromosomes **WHILE** the nucleus of a muscle cell contains two; [1 mark]
- A sperm cell nucleus contains 23 chromosomes **WHILE** a muscle cell contains 46 chromosomes; [1 mark]
- A sperm cell is haploid **WHILE** a muscle cell is diploid; [1 mark]

[Total: 1 mark]

Any answer that shows an indication that the nucleus of a sperm cell contains half the genetic material of a muscle (body) cell will be accepted here.

(1 mark)

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(b) All specialised cells are adapted to carry out their function.

Explain **two** adaptations of a sperm cell that enables it to carry out its function.

Answer

Two adaptations of a sperm cell that enables it to carry out its function are...

Any **two** of the following:

- Has a tail/flagellum **SO** can move/swim; [1 mark]
- Contains many mitochondria **SO** can transfer/release energy; [1 mark]
- The acrosome/head contains enzymes **SO** can enter the egg; [1 mark]
- Haploid nucleus/23 chromosome **SO** chromosome number doesn't double at fertilisation / the new cell contains 46 chromosomes after fertilisation; [1 mark]

[Total: 2 marks]

Each adaptation should be linked to an explanation as to how it helps a sperm cell fertilise an egg.

(2 marks)

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(c) Specialised cells develop from unspecialised cells by differentiation when an organism develops.

Describe what happens when a cell differentiates.

Answer

When a cell differentiates...

Any **two** of the following:

- It develops/acquires different sub-cellular structures / a different shape / makes different proteins; [1 mark]
- It becomes specialised; [1 mark]
- To enable it to carry out a specific function; [1 mark]

[Total: 2 marks]

Remember differentiation isn't just about being able to carry out a particular function, it specifically involves changes in the sub-cellular structures and shape of the cell.

(2 marks)

(d) Compare the process of differentiation in animals and plants.

Answer

The process of differentiation in animals and plants is different as follows...

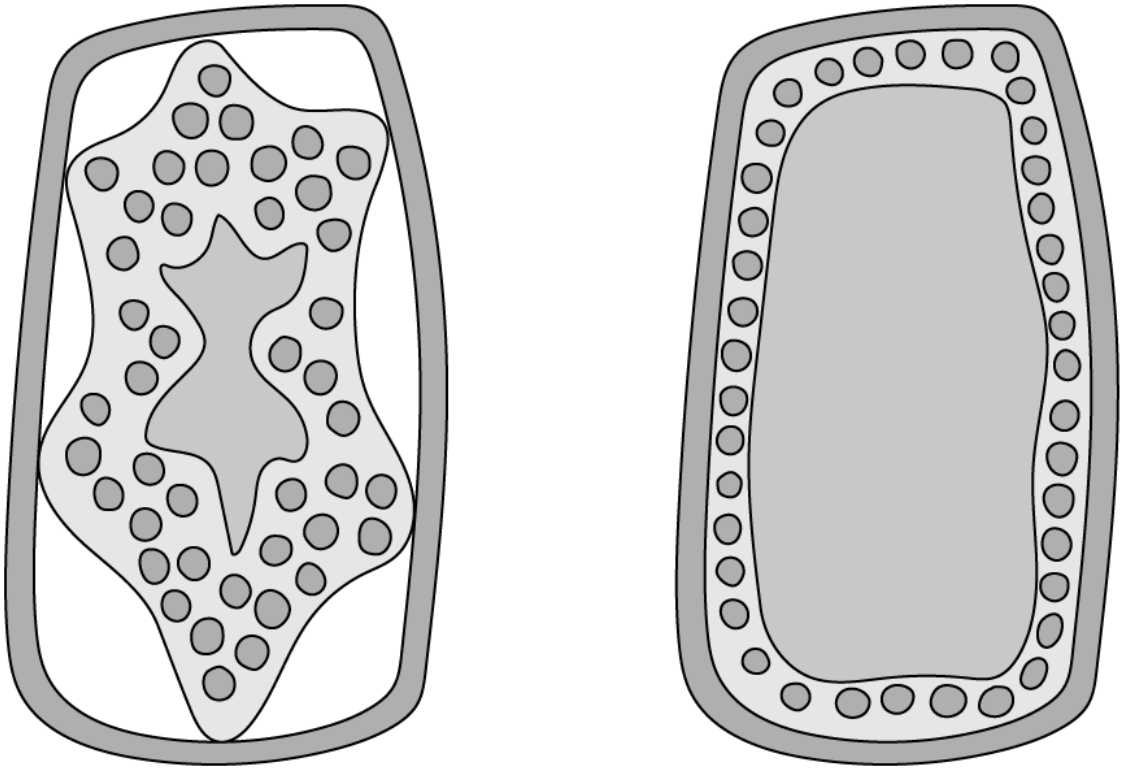
- Differentiation in animals occurs early in development/at an early stage; [1 mark]
- Plants retain the ability to differentiate / have unspecialised cells capable of forming any cell required when mature; [1 mark]

[Total: 2 marks]

(2 marks)

19 (a) **Figure 1** shows two plant cells.

Figure 1



Which of the plant cells above was placed in a solution with a lower solute concentration than the cell contents?

Answer

The cell that was placed in a solution with a lower solute concentration than the cell contents was:

- B; [1 mark]

[Total: 1 mark]

When cells are placed in a solution with a lower solute concentration than their cytoplasm, also known as a hypotonic solution, there is a net movement of water into the cell causing it to swell. The opposite happens when cells are placed in a solution with a higher solute concentration than the cell contents.

(1 mark)

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(b) Explain what has happened to the plant cell you identified in part (a).

Answer

The plant cell placed in the dilute solution has:

Any **four** of the following:

- Become turgid/swollen; [1 mark]
- Because water has entered the cell by osmosis; [1 mark]
- From a more dilute to a concentrated solution (or from a high water potential to a low water potential); [1 mark]
- Via a partially permeable membrane; [1 mark]
- The cell membrane is exerting pressure on the cell wall; [1 mark]

[Total: 4 marks]

The solution surrounding the cell has a lower solute concentration (is more dilute) than the intracellular environment of the plant cell. Water will always move from an area of a more dilute solution to an area of a more concentrated solution, therefore, there is a net movement of water into the cell which swells up becoming turgid.

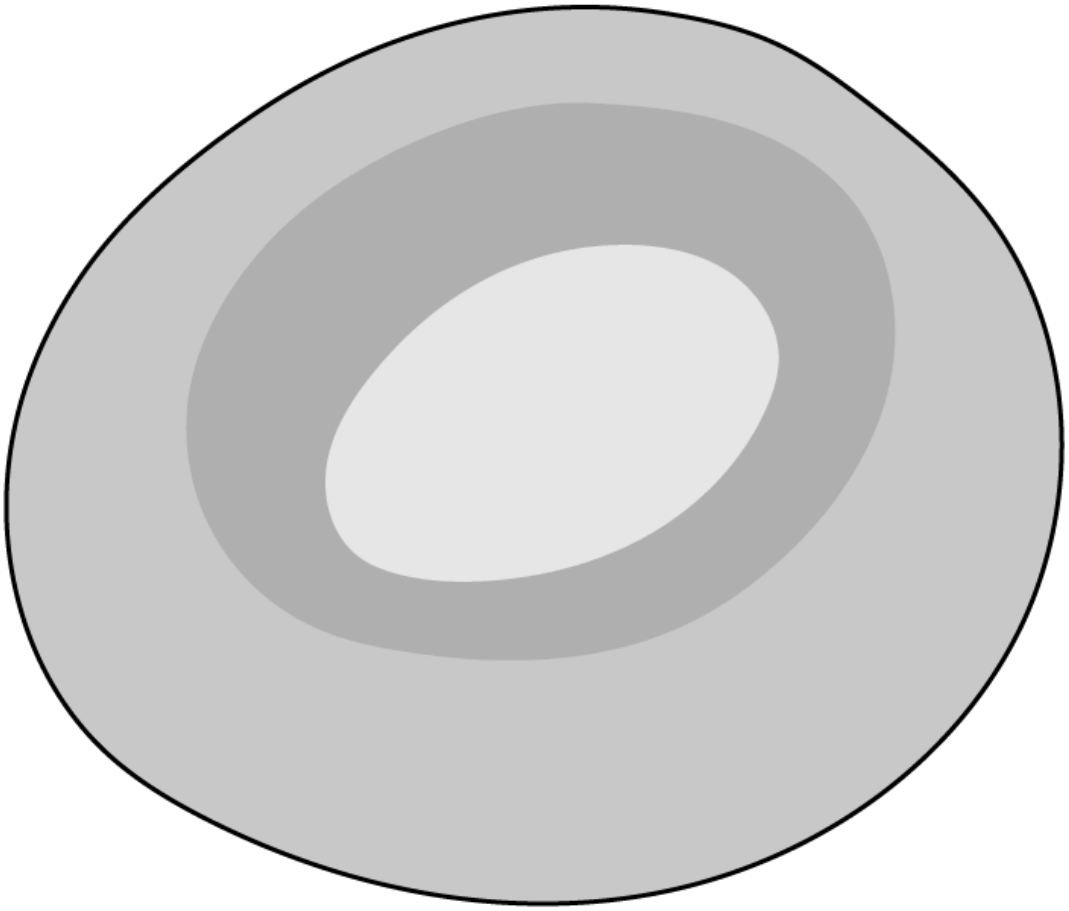
The opposite happens when the cell is placed in a concentrated solution that has a higher solute concentration than inside the cell. Consequently, water moves out of the cell which becomes plasmolysed (shrinks).

(4 marks)

(c) When placed in different solutions, animal cells will also change.

Figure 2 below shows a red blood cell.

Figure 2



Describe what would happen if a red blood cell was put into a solution with a lower solute concentration than the cell contents and explain why this would be **different** from what would happen to a plant cell.

Answer

When a red blood cell is placed in a dilute solution:

Any **three** of the following:

- The red blood cell would lyse/burst; [1 mark]
- Due to an influx of water by osmosis; [1 mark]
- Animal cells do not have a cell wall like plant cells; [1 mark]

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- Which allows plant cells to become turgid without bursting (limits how much water can enter the cell); [1 mark]

[Total: 3 marks]

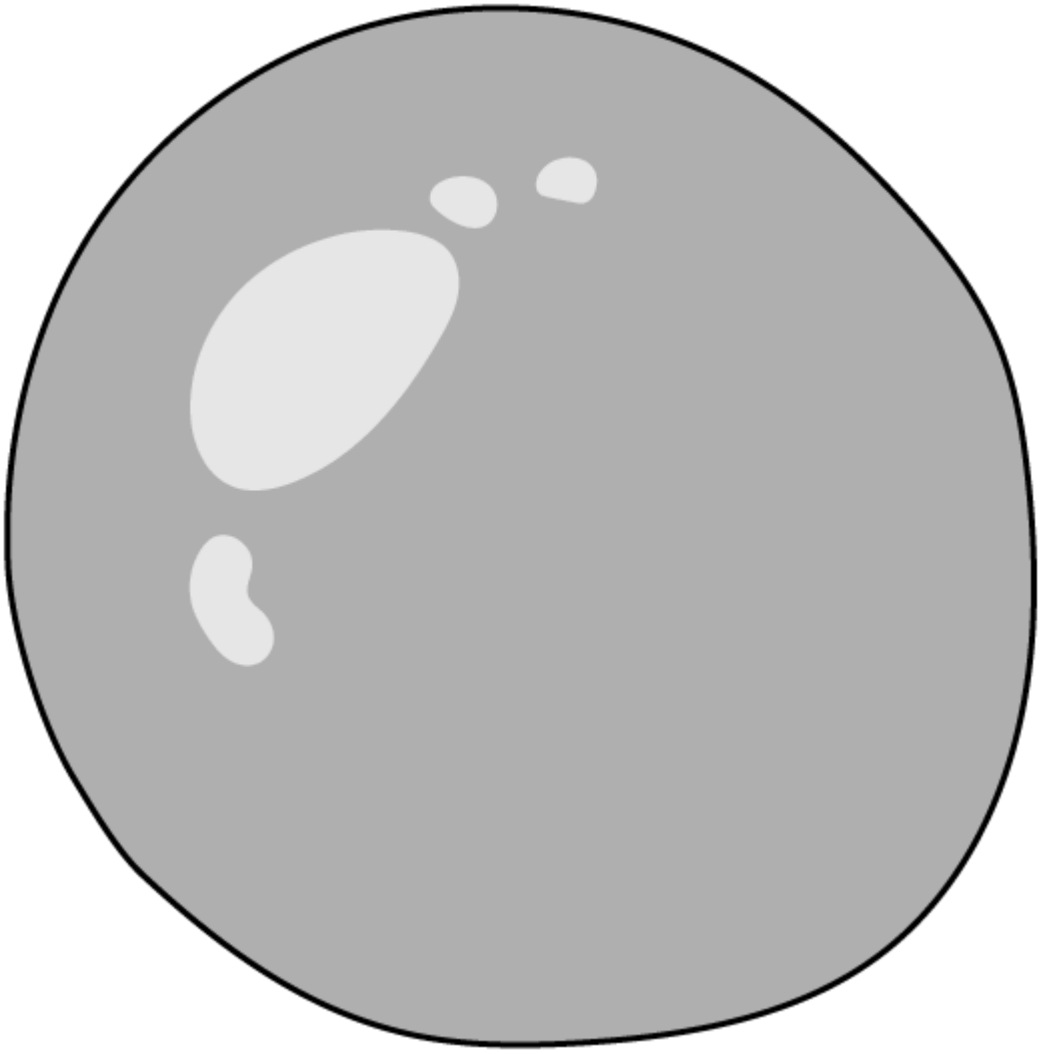
Take care to note the command words used here, you only need to describe (and not explain) what happens to the red blood cell, but you must explain how the reaction of a plant cell in the same situation would be different.

(3 marks)

(d) Hereditary spherocytosis is a rare inherited condition that produces red blood cells with an abnormal spherical shape, as shown in **Figure 3**.

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Figure 3



Suggest the possible impact of this condition on a sufferer.

Answer

The impact of Hereditary spherocytosis would be:

Any **three** of the following:

- Spherical red blood cells have reduced/decreased surface area, which reduces (the efficiency of) diffusion of oxygen from the lungs; [1 mark]
- Spherical red blood cells transport less oxygen around the body; [1 mark]

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- Less oxygen is available for respiration; [1 mark]
- Reducing the availability of energy in the cells of the sufferer; [1 mark]

[Total: 3 marks]

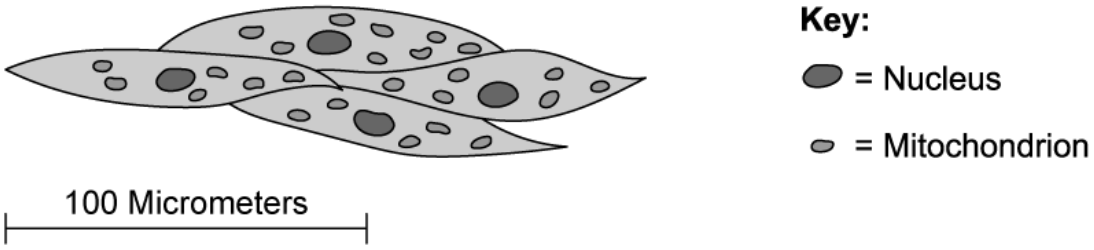
Here you are presented with an unfamiliar context, and you are expected to apply what you know about red blood cells to consider the effect that a change in the shape would have. You should know that the biconcave shape of red blood cells is vitally important in increasing surface area to volume ratio of each cell so that diffusion of oxygen (and carbon dioxide) is maximised.

(3 marks)

20 (a) Cells can be visualised with a light microscope.

Figure 1 shows some smooth muscle cells from the wall of the small intestine.

Figure 1



All cells contain ribosomes.

Explain the function of ribosomes.

Answer

The function of ribosomes is to:

- To make proteins / enzymes / where protein synthesis occurs; [1 mark]

[Total: 1 mark]

(1 mark)

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(b) Muscle cells contain many mitochondria, as seen **Figure 1**.

What is the function of mitochondria?

Answer

The function of mitochondria is to:

- To transfer energy to the cell / where energy is released / to make ATP; [1 mark]
- By (aerobic) respiration / from the breakdown of glucose; [1 mark]

[Total: 2 marks]

It's really important that you do not say that energy is 'made / produced / created' in the mitochondria. Energy is released when respiration occurs. Aerobic respiration occurs in the mitochondria, take care not to say 'anaerobic' respiration as this occurs in the cytoplasm.

(2 marks)

(c) Suggest why it is possible to visualise mitochondria using a light microscope, but not ribosomes.

Answer

It is possible to visualise mitochondria under a light microscope but not ribosomes because:

- Mitochondria are larger than ribosomes; [1 mark]
- Ribosomes are too small / very small / light microscopes do not have sufficient magnification / resolution; [1 mark]

[Total: 2 marks]

(2 marks)

(d) Identify which cell from the list below would not contain mitochondria and suggest why this type of cell does not contain this cellular structure.

- Liver cell
- Gamete
- Palisade cell
- Bacterium

Answer

The type of cell that does not contain mitochondria is:

- bacterium; [1 mark]

This is because:

- mitochondria are larger than bacterial cells / bacterial cells are small so aerobic respiration can occur in the cytoplasm/cell membrane; [1 mark]

[Total: 2 marks]

(2 marks)

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21 (a) Read the information below about stem cells:

It may be possible to treat some human diseases, such as Parkinson's and diabetes, with stem cells in the future.

Human early embryos produced *in vitro* are a source of stem cells.

The use of embryonic stem cells to treat human disease is new and patient trials have already begun.

Another source of stem cells is adult bone marrow.

The operation for collecting these cells is simple but it can be painful. It is already possible to use adult stem cells to treat certain blood diseases.

There is also hope that adult stem cells from bone marrow can also be used to treat other diseases such as heart disease; such trials have already begun.

Explain how an embryonic stem cell differs from an adult stem cell.

Answer

Embryonic stem cell differs from adult stem cells in that:

Any **three** from:

- Embryonic stem cells have not differentiated / are unspecialised / can differentiate into most types of human cell / tissue / organ; [1 mark]
- Adult stem cells can form many but not all types of cells (e.g. blood cells); [1 mark]
- Embryonic stem cells are only found in embryos / early in development; [1 mark]
- Adult stem cells are present throughout an animal/human regardless of age; [1 mark]

[Total: 3 marks]

(3 marks)

(b) Evaluate the use of embryonic and adult stem cells to treat human diseases.

Your answer should contain a conclusion.

Answer

The pros of using embryonic stem cells over adult stem cells to treat human diseases are:

Any **two** from the following:

- Embryonic stem cells can be used to treat a wide variety of diseases / conditions; [1 mark]
- Adult stem cells (due to their ability to differentiate into fewer types of specialised cell) may only be useful in treating a smaller number of diseases / conditions; [1 mark]

OR

- Embryonic stem cells are sourced from embryos made in IVF and more are usually made than are used; [1 mark]
- People may be unwilling to donate their bone marrow as the operation is painful; [1 mark]
- There is a risk of infection / there are hazards of an operation to consider; [1 mark]

The pros of using adult stem cells over embryonic stem cells to treat human diseases are:

And any **two** from the following:

- Using embryos as a source of embryonic stem cells is controversial as some consider the practice to cause harm to an embryo which cannot give consent / the embryo has 'rights' [1 mark]
- There are no ethical issues to consider if an adult consents to donating their bone marrow; [1 mark]

OR

- The long-term effects of embryonic stem cells are not known (positive or negative); [1 mark]

- Bone marrow has been used as a source of stem cells for treatment for much longer and is more tried and tested (and therefore reliable); [1 mark]

OR

- More research should be focused on adult stem cells to see if they can be used to treat more diseases / conditions so that we don't have to destroy potential life (embryos); [1 mark]

AND

One mark for a reasoned conclusion from the evidence:

- The potential benefits of being able to treat more conditions and diseases with embryonic stem cells (to prevent human suffering) outweighs the consequences, especially as many embryos produced during IVF treatment are just discarded without having a use; [1 mark]

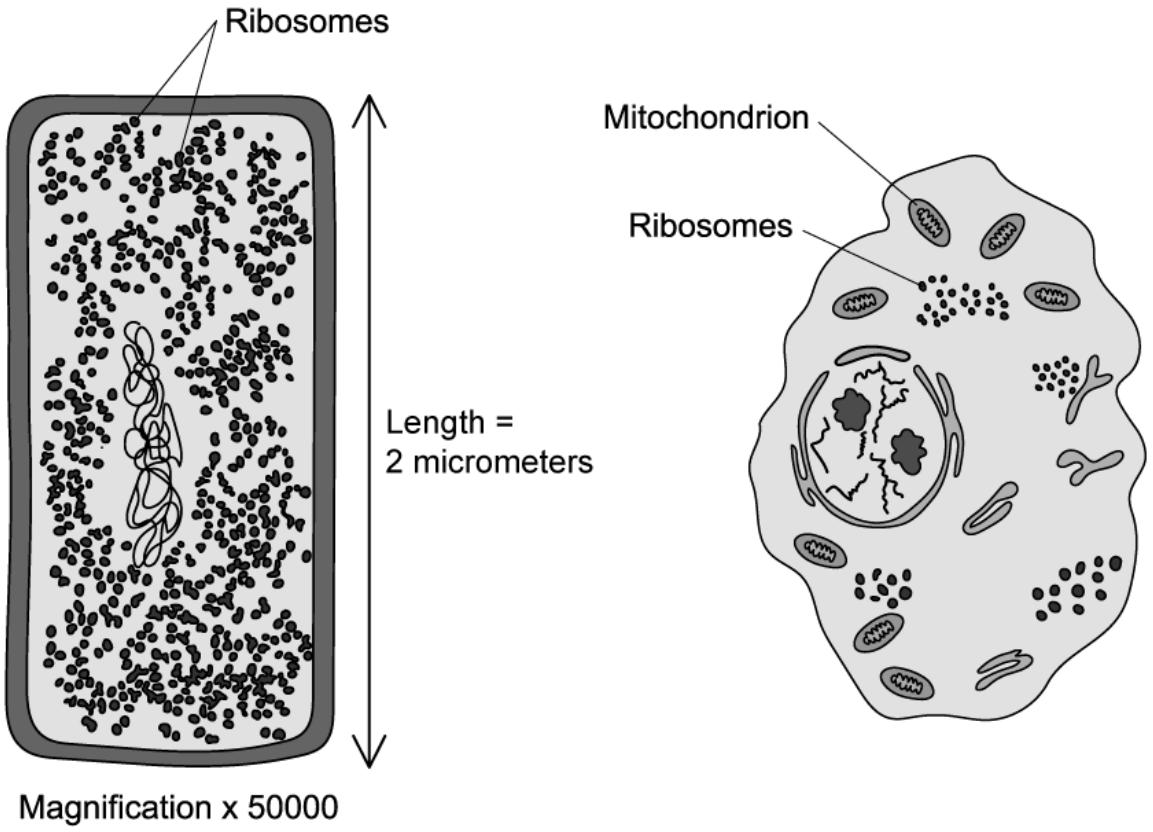
[Total: 5 marks]

(5 marks)

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22 (a) **Figure 2** shows a bacterial cell and an animal cell as seen in a student's textbook.

Figure 2



Animal cells store their genetic material in a nucleus, whereas bacterial cells do not.

Give **two** other ways in which bacterial cells differ from animal cells.

Answer

Other ways in which bacterial cells differ from animal cells include:

Any **two** of the following:

- Bacteria do not contain mitochondria / internal membranes **WHILE** animal cells do; [1 mark]
- Bacterial cells have cell walls **WHILE** animal cells do not; [1 mark]
- Bacterial cells are smaller than animal cells; [1 mark]
- Bacterial DNA is circular / a loop **WHILE** animal DNA is not / is linear; [1 mark]

- Bacterial cells have plasmids **WHILE** animal cells do not; [1 mark]

[Total: 2 marks]

(2 marks)

(b) The cells in the diagram are drawn to a length of 100 mm in the student's textbook.

The actual length of the animal cell is 60 micrometers (μm).

Calculate the magnification of the animal cell to 2 significant figures.

Show clearly how you work out your answer.

Answer

The magnification of the animal cell can be calculated as follows:

- Magnification (M) = image size (I) / actual size(A)
- Magnification (M) = 100 mm / 60 μm

Must convert measurements so that the units are the same for both I and A

- 60 μm = 0.06 mm
- Magnification (M) = 100 mm / 0.06 mm; [1 mark]
- Magnification (M) = X 1666.67
- Magnification (M) = X 1700 (2 significant figures); [1 mark]

A correct answer of x 1700 would earn **[2 marks]**

[Total: 2 marks]

It is vital that you check the units you are using, and look to see if a unit is given in the answer prompt. The same unit of measurement should be used throughout a calculation.

(2 marks)

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(c) The nucleus of an animal cell has a diameter of about 6 μm.

Suggest a reason as to why bacteria do not have a nucleus.

Answer

Bacteria do not have a nucleus because:

Any **one** of the following:

- A bacterial cell is too small / the nucleus is larger than a bacterial cell / no room; [1 mark]
- They do not need one as they have a small circular chromosome; [1 mark]
- They have no need to separate their DNA from the rest of the cytoplasm; [1 mark]

[Total: 1 mark]

Prokaryotic cells evolved long before eukaryotic cells and are much simpler in form and function. Consequently, they have a much smaller chromosome which is circular. Separating this chromosome from the rest of the cytoplasm offers no advantage to the bacterial cell so they never evolved a nucleus.

(1 mark)

23 (a) How many pairs of chromosomes are there in a body cell of a human?

Answer

A human body cell contains:

- 23; [1 mark]

[Total: 1 mark]

Take care to read the question carefully, you are asked for the number of pairs of chromosomes, not the total number, in a human body cell.

(1 mark)

(b) For any organism to grow, it must be capable of making new cells.

Describe what must happen in a cell before it can divide.

Answer

Before a cell can divide:

Any **two** of the following:

- It needs to grow; [1 mark]
- It needs to increase its number of sub-cellular structures / mitochondria / ribosomes; [1 mark]
- DNA replicates / chromosomes are copied; [1 mark]

[Total: 2 marks]

You should be able to recall from the specification that a cell must replicate its chromosomes and increase the number of sub-cellular structures it contains before it divides to produce new cells for growth or repair.

(2 marks)

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(c) Describe how a cell divides by mitosis.

Answer

When a cell divides by mitosis it must:

Any **three** of the following:

- The nuclear membrane breaks down; [1 mark]
- The chromosomes line up down the centre of the cell; [1 mark]
- The chromatids are pulled apart / chromosomes separate; [1 mark]
- The cytoplasm divides / cytokinesis occurs; [1 mark]

[Total: 3 marks]

Do not confuse chromatids and chromosomes – a chromatid is one half of a duplicated chromosome, one arm of the characteristic X shape formed when a chromosome has replicated. During mitosis, chromatids are pulled apart so that each daughter cell inherits one copy of each chromosome.

(3 marks)

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(d) Why is cell specialisation (differentiation) an important process in the development and growth of a fertilised egg into a healthy baby?

Answer

Specialisation (differentiation) is an important process in the development and growth of a fertilised egg into a healthy baby becuase:

Any **two** of the following:

- A baby has different types of cells / cells with different functions **OR** different cells are needed for different organs; [1 mark]
- Differentiation/specialisation allows specialised cells to form; [1 mark]
- Specialised cells make different tissues / organs; [1 mark]

[Total: 2 marks]

Without differentiation there is no specialisation; specialised cells carry out particular functions in multicellular organisms.

(2 marks)

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24 (a) All living organisms exchange substances with the environment. Plant roots use two different methods to absorb water and ions from the soil.

Explain why roots have two different methods to absorb water and ions.

Answer

Roots have two different methods of absorbing water and ions because:

- The concentration of ions in root cells is higher than in the soil; [1 mark]
- Ions need to be moved against their concentration gradient (requiring energy / active transport); [1 mark]
- Water potential of soil is higher than that inside a root cell; [1 mark]
- Water moves from the dilute soil to the more concentrated root cell; [1 mark]

[Total: 4 marks]

(4 marks)

(b) **Table 1** shows the concentrations of three mineral ions in the roots of a plant and in the surrounding soil.

All three mineral ions are essential to the healthy functioning of a plant.

Table 1

Mineral ion	Concentration in millimoles per gram	
	Plant root	Soil
Potassium	0.25	0.01
Magnesium	0.08	0.03
Calcium	0.12	0.02

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Explain why the plant roots can **not** absorb these mineral ions by diffusion.

Answer

Plant roots can not absorb these mineral ions by diffusion because:

- Diffusion is the movement of a substance down a concentration gradient / from a high to low concentration; [1 mark]
- To be taken up by the root the ions must be moved against the concentration gradient / if diffusion were occurring the ions would move out of the roots; [1 mark]

[Total: 2 marks]

(2 marks)

(c) Waterlogged soil has a lower oxygen concentration than non-waterlogged soil.

Suggest the impact of waterlogged soil on the activity of root cells.

Answer

The impact of waterlogged soil on the activity of root cells is:

Any **two** of the following:

- If less oxygen is available / less oxygen diffuses into the cell resulting in less respiration; [1 mark]
- Less respiration results in less energy being available for active transport; [1 mark]
- This will reduce the uptake of ions by active transport; [1 mark]

[Total: 2 marks]

In waterlogged soil, root cells may have to respire anaerobically which will generate ethanol as a by-product.

(2 marks)

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25 (a) After a baby is born, it is possible to use the umbilical cord as a source of stem cells.

What are stem cells?

Answer

Stem cells are:

Any **two** of the following:

- Stem cells are cells that are able to divide; [1 mark]
- They are undifferentiated cells / not specialised; [1 mark]
- They can form other types of cells / tissues or become specialised / differentiated / they are pluripotent; [1 mark]

[Total: 2 marks]

(2 marks)

(b) In Vitro Fertilisation can be used to produce embryos for research purposes. Stem cells can be extracted from a 3-day-old embryo made in this way.

Suggest why it may be considered more ethically acceptable to take stem cells from an umbilical cord rather than an embryo.

Answer

It may be considered more ethically acceptable to take stem cells from an umbilical cord rather than an embryo because:

Any **one** of the following:

- A 3-day-old embryo is a potential human life; [1 mark]
- Using an embryo to obtain stem cells can cause damage / would destroy a potential human life; [1 mark]
- An embryo cannot give consent; [1 mark]
- The umbilical cord would only have been thrown away / discarded / is not a potential human life; [1 mark]

[Total: 1 mark]

(1 mark)

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(c) Stem cells taken from an umbilical cord can be frozen and stored. They could be used later in that child's life to treat a condition.

Suggest a reason why it would be better to use a child's own umbilical cord stem cells instead of stem cells donated from another person.

Answer

It would be better to use a child's own umbilical cord stem cells instead of stem cells donated from another person because:

Any **one** of the following:

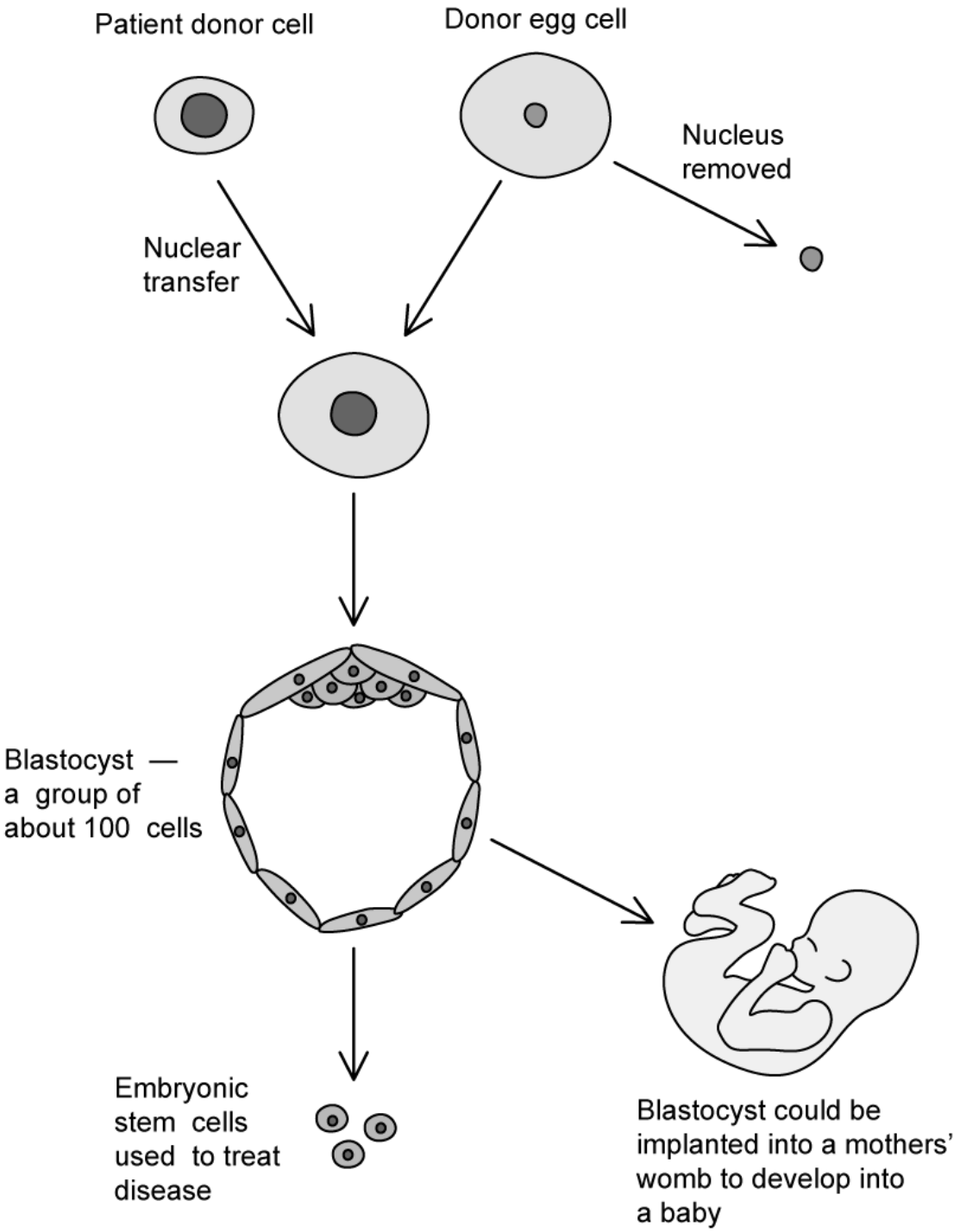
- It would be hard to find a suitable donor / perfect tissue match; [1 mark]
- There would be no danger of rejection; [1 mark]
- Any tissue created from the stem cells would have the same antigens; [1 mark]
- There would be no need to take immunosuppressant drugs (to prevent donor tissue rejection); [1 mark]

[Total: 1 mark]

(1 mark)

(d) **Figure 2** below outlines the process of therapeutic cloning.

Figure 2



This technique could be used to produce cells to treat conditions such as paralysis or diabetes, or to produce a baby.

Scientists may be allowed to use therapeutic cloning to treat disease but not to produce a baby.

Using information from the diagram and your own knowledge, suggest an explanation for this.

Answer

Scientists may be allowed to use therapeutic cloning to treat disease but not to produce a baby because:

Any **four** of the following:

- Any baby produced in this way would be a clone as the genetic material only came from one individual (no fertilisation; [1 mark]
- which is illegal; [1 mark]
- Cloning has many ethical issues; is a clone the property of the person it was cloned from or its own individual with its own rights?; [1 mark]
- The cells would be used to treat disease and not used to make a baby; [1 mark]
- Many different types of cells could be produced and used for research to help treat many diseases; [1 mark]
- Any cells produced would have the same genetic makeup as the patient; [1 mark]
- so there would be no issues of tissue rejection; [1 mark]

[Total: 4 marks]

(4 marks)

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26 (a) Animal and plant cells have some structural features in common.

Name two structures you would find in both an animal cell and a plant cell.

Answer

Structures that would be found in an animal cell and a plant cell are:

Any **two** of the following:

- Nucleus; [1 mark]
- Cell membrane; [1 mark]
- Cytoplasm; [1 mark]
- Mitochondria; [1 mark]
- Ribosomes; [1 mark]

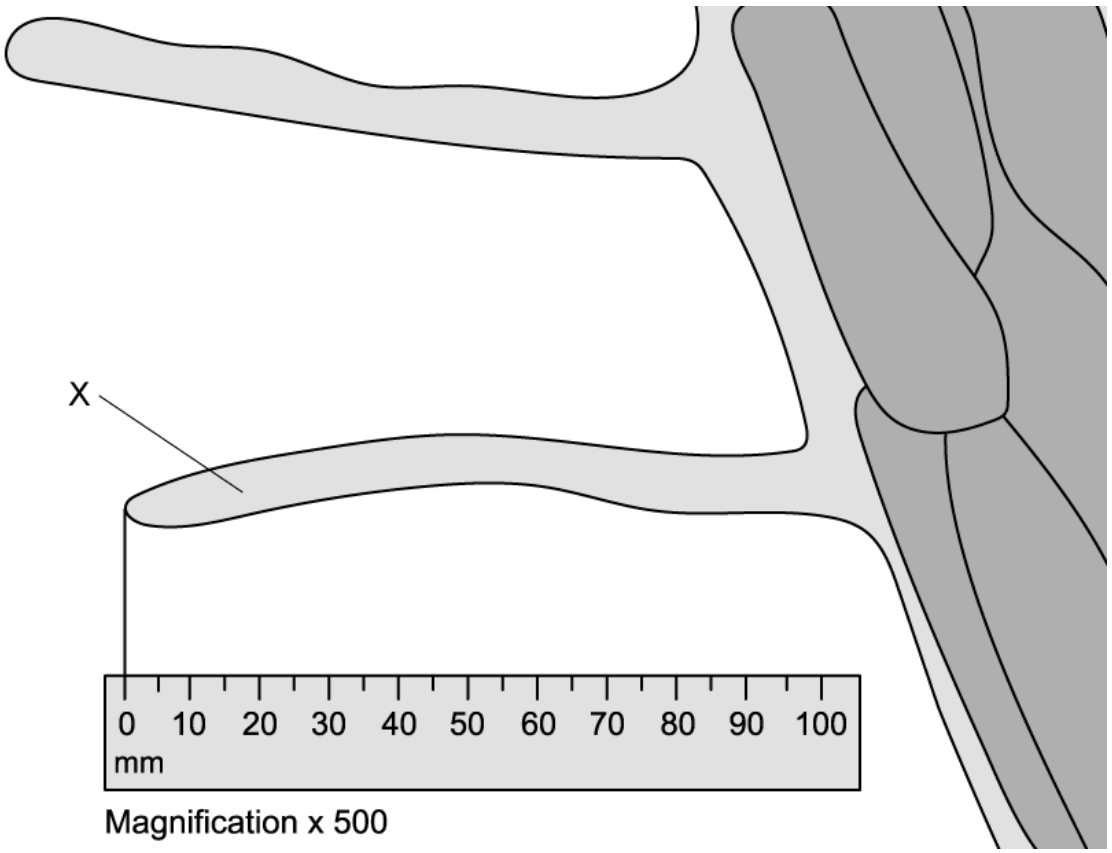
[Total: 2 marks]

(2 marks)

(b) **Figure 3** shows a photomicrograph of the surface of a plant root.

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Figure 3



Name structure **X**.

Answer

Structure X is a:

- Root hair / root hair cell; [1 mark]

[Total: 1 mark]

(1 mark)

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(c) Calculate the actual length of structure **X** in **Figure 3.**

Show your working.

Answer

The actual length of structure X is:

Correct answer gains both marks.

- Actual = image size / magnification size
- 98 to 100 mm / 500; [1 mark]
- = 0.196 mm to 0.2 mm = 196 μm to 200 μm; [1 mark]

[Total: 2 marks]

(2 marks)

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(d) Failure of structure **X** to develop properly in the cells of a plant root could be catastrophic to a plant.

Suggest an explanation as to why.

Answer

Failure of structure **X** to develop properly in the cells of a plant root could be catastrophic to a plant because...

Any **four** of the following:

- The root would have a reduced surface area; [1 mark]
- The plant would not be able to absorb enough water; [1 mark]
- The plant would not be able to absorb enough mineral ions / named mineral, e.g. magnesium ions, nitrate ions; [1 mark]
- Water is essential for photosynthesis / maintaining pressure / as a solvent; [1 mark]
- The plant may suffer from mineral deficiencies / named example of mineral deficiency described; [1 mark]

[Total: 4 marks]

(4 marks)

27 (a) A student decided to investigate the effect of different salt solutions on the mass of chicken eggs.

They used the following method:

1. 5 eggs were placed in acid for 24 hours to dissolve the eggshell.
2. The mass of each egg was measured and recorded.
3. Five beakers were set up; four with 200 cm^3 of salt solution of a particular concentration and one with water (0.0 mol dm^{-3}).
4. An egg was placed in each of the beakers.
5. After 1 hour, the eggs were removed and dried with a paper towel.
6. The mass of each egg was measured and recorded.

Their results are shown in the table in **Table 2** below:

Table 2

Concentration of salt solution (mol dm^{-3})	Mass of egg without shell in grams	Mass of egg after 1 hour in solution in grams
0.0	74.5	79.2
0.2	73.0	75.8
0.4	74.2	75.5
0.6	73.6	72.0
0.8	75.8	71.5

Calculate the percentage change of the egg placed in the 0.4 mol dm^{-3} salt solution.

Show your working.

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

Answer

The percentage change of the egg placed in the 0.4 mol dm^{-3} salt solution is:

- (1.3 / 74.2) x 100 = 1.75; [1 mark]
- = 1.8%; [1 mark]

[Total: 2 marks]

(2 marks)

(b) Explain why in some of the solutions the mass of the eggs decreased.

Answer

The mass of the eggs in some solutions decreased because:

- The mass decreased when water moved out of the egg by osmosis; [1 mark]
- Through a partially permeable membrane; [1 mark]
- Because the solution it was in was more concentrated (and the solution in the egg was more dilute); [1 mark]

[Total: 3 marks]

(3 marks)

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(c) Explain what the student would need to do to determine an estimate of the concentration of the solution inside an egg.

Answer

In order to determine an estimate of the concentration of the solution inside an egg, the student will need to:

Any **three** of the following:

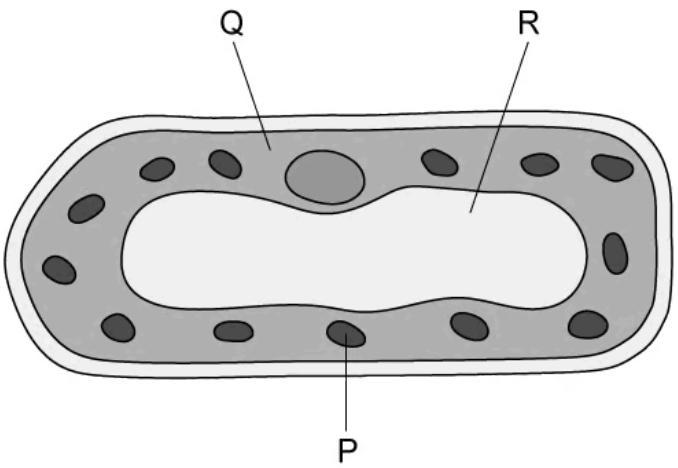
- Calculate the percentage change of each egg placed in a salt solution; [1 mark]
- Plot the percentage change in mass on a (scatter) graph; [1 mark]
- Draw a line of best fit; [1 mark]
- Determine the concentration where the line crosses the zero percentage change (in mass); [1 mark]

[Total: 3 marks]

(3 marks)

28 (a) **Figure 4** below shows a plant cell.

Figure 4



Name each labelled part of the plant cell and give its function.

Answer

Part **P** is a:

- **Name**: chloroplast; [1 mark]
- **Function**: site of photosynthesis or where sugar / carbohydrate / organic material is made; [1 mark]

The word or balanced equation for photosynthesis would be accepted here but it is better to state that photosynthesis occurs in the chloroplast.

Part **Q** is the...

- **Name**: cytoplasm; [1 mark]
- **Function**: jelly-like fluid containing the organelles of the cell and dissolved nutrients / where many chemical reactions of the cell take place; [1 mark]

Part **R** is a...

- **Name**: vacuole; [1 mark]

- **Function**: acts as a reservoir / store of water or cell / sugar sap or keeps cell turgid / allows cell to keep its shape; [1 mark]

[Total: 6 marks]

(6 marks)

(b) Identify the cell wall in **Figure 4**, label it as **S** and describe its function.

Answer

The function of the cell wall is to...

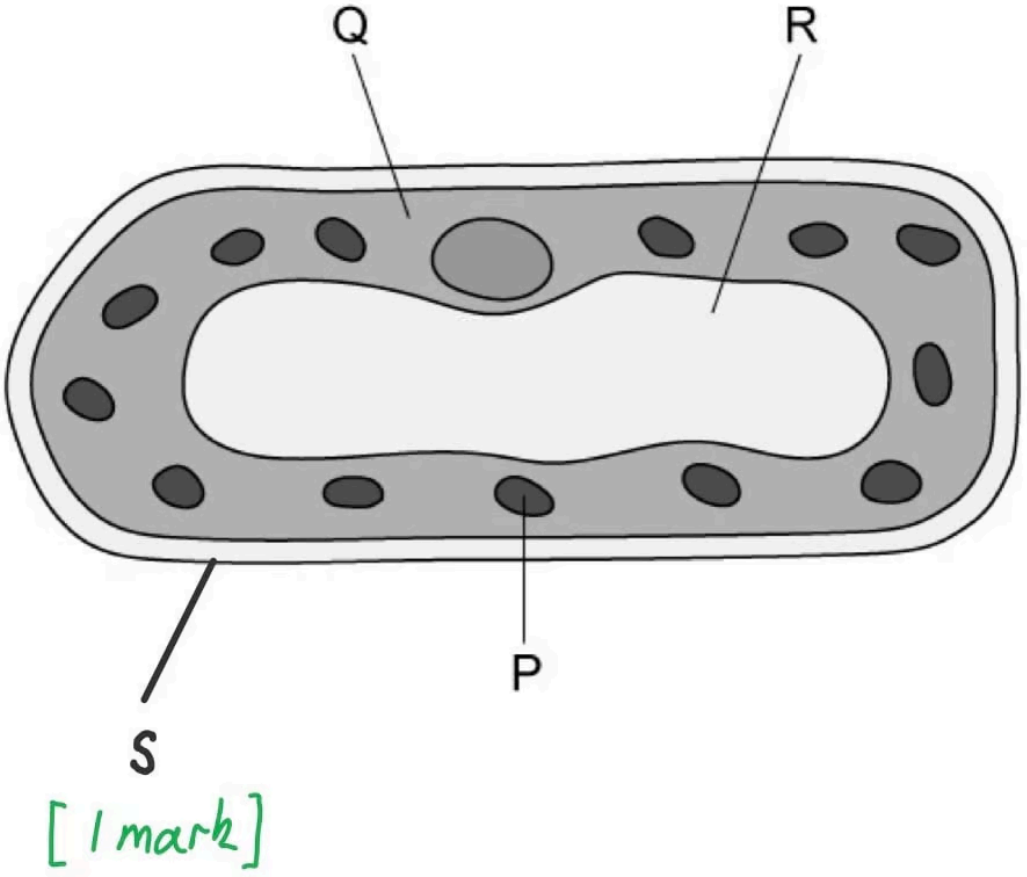
Any **one** from:

- To provide structure / support for the cell; [1 mark]
- Maintain turgor pressure; [1 mark]

and

- correctly labelled diagram; [1 mark]

[Total: 1 mark]



(2 marks)

(c) The cell wall of a plant is made from cellulose.

Name **one** type of cell, other than a plant cell, that has a cell wall made from cellulose.

Answer

Another type of cell that is made from cellulose is:

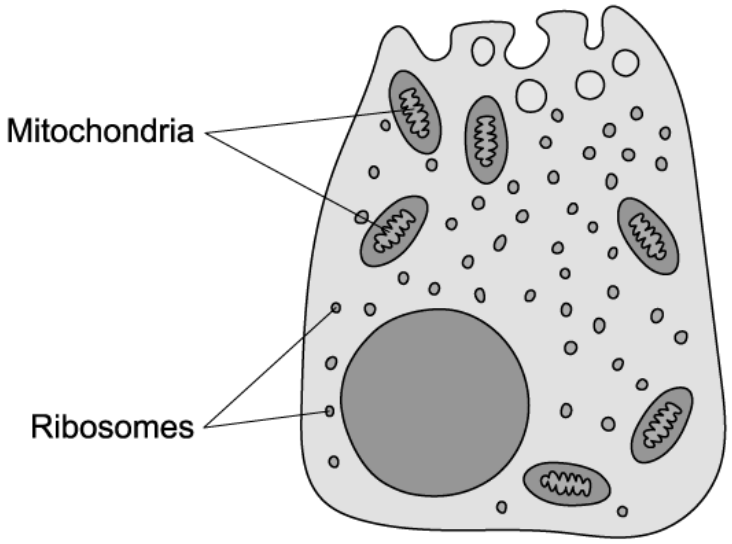
- An algal cell / algae; [1 mark]

[Total: 1 mark]

(1 mark)

(d) The cell in **Figure 5** below is a salivary gland cell.

Figure 5



Salivary gland cells are adapted to produce salivary amylase, an important enzyme in digestion.

Use the information above and your own knowledge to suggest how salivary gland cells are adapted to their function.

Answer

Salivary glands are adapted to their function in that they:

Any **three** of the following

- Contain many ribosomes; [1 mark]
- For protein synthesis / to make enzymes / to make salivary amylase; [1 mark]
- Contain many mitochondria; [1 mark]
- To provide energy (from respiration) for protein synthesis / to make enzymes; [1 mark]

Accept references to membrane vesicles [1] for secretion of enzymes [1]

[Total: 3 marks]

(3 marks)

29 (a) A group of scientists investigated the rates of absorption of different sugars using two pieces of the intestine.

One piece of the intestine was poisoned with cyanide which stops cellular respiration.

The results are shown in **Table 3** below.

Table 3

Sugar	Absorption rate (arbitrary units)	
	Healthy intestine	Intestine poisoned with cyanide
A	108	56
B	31	30
C	33	32
D	84	23

Which of the sugars in **Table 3** are absorbed by active transport?

Answer

The following sugars are absorbed by active transport:

- A and D; [1 mark]

[Total: 1 mark]

(1 mark)

(b) Explain why you chose these sugars, using evidence from **Table 3.**

Answer

The evidence that supports that sugars A and D were absorbed via active transport is:

Any **three** of the following:

- The absorption (rate) of both sugars (A and D) is reduced in the poisoned intestine; [1 mark]
- The poison prevents respiration so that there is less / no energy available; [1 mark]
- Active transport requires energy; [1 mark]
- To move substances against a concentration gradient; [1 mark]

[Total: 3 marks]

(3 marks)

(c) One of the scientists states 'All four of the sugars we investigated can be absorbed by diffusion.

Determine whether the statement is correct or incorrect. Justify your answer.

Answer

The statement "All four of the sugars we investigated can be absorbed by diffusion" is:

- Correct as all four sugars were absorbed by the intestine poisoned with cyanide, even though respiration had been stopped; [1 mark]
- Diffusion is a passive process that does not require energy from respiration; [1 mark]

[Total: 2 marks]

Initially sugars A and D most likely could be absorbed via diffusion as the sugar concentration outside the intestine (lumen) was higher. Once the concentration of sugar was lower outside the intestine it would have to be taken up via active transport (as it is against the concentration gradient) which was prevented in the intestine poisoned with cyanide.

(2 marks)

(d) One of the sugars absorbed by active transport is glucose.

Xylose is a sugar that is the same size as glucose, but it is not absorbed by active transport.

Suggest a reason why.

Answer

Xylose is not absorbed by active transport because:

Any **one** of the following:

- Active transport is selective; [1 mark]
- Transport proteins in the cell membrane can distinguish between glucose and xylose; [1 mark]
- There is no transporter protein specific for xylose; [1 mark]

[Total: 1 mark]

(1 mark)

(e) The wall of the small intestine contains smooth muscle cells.

Muscle cells convert soluble glucose into glycogen which is insoluble in water.

Suggest an explanation as to why it is essential that muscle cells store glucose as glycogen.

Answer

It is essential that muscle cells convert glucose to glycogen for storage because:

Any **three** of the following:

- Glucose is a solute, when it is present in cells it lowers the water potential; [1 mark]
- Water will move into cells containing high concentrations of glucose; [1 mark]
- Animal cells do not have a cell wall and will burst; [1 mark]
- The cells will lyse/burst if too much water moves in by osmosis; [1 mark]
- Glycogen will not affect the water potential of a cell; [1 mark]

[Total: 3 marks]

(3 marks)

30 (a) The nucleus of a typical onion cell contains **16** chromosomes.

What is a chromosome?

Answer

A chromosome is a:

Any **one** from the following:

- large DNA molecule (associated with proteins / proteins called histones); [1 mark]
- A chromosome carries a large number of genes; [1 mark]

[Total: 1 mark]

This is a simple recall question from the specification.

(1 mark)

(b) An onion cell divides by mitosis.

How many chromosomes will each of its daughter cells contain?

Answer

Each of its daughter cells will contain:

- 16 chromosomes; [1 mark]

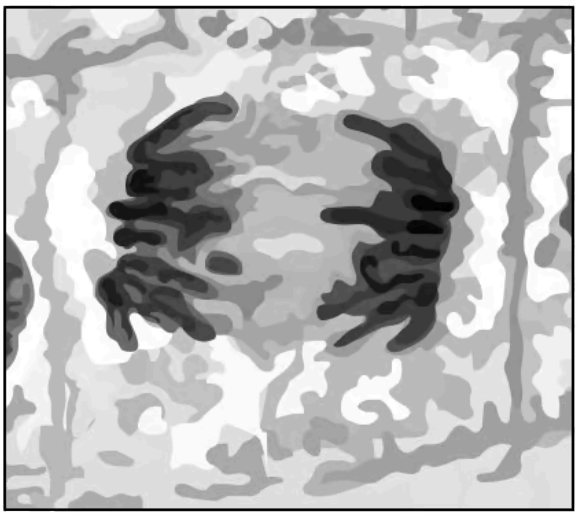
[Total: 1 mark]

The question asks for how many chromosomes, not how many pairs. Daughter cells produced by mitosis contain the same number of chromosomes as the parent cell. A typical onion cell contains 16 chromosomes, so all cells produced by mitosis from such a cell will contain the same.

(1 mark)

(c) **Figure 3** shows a photograph of an onion cell at one point during the cell cycle.

Figure 3



Describe what is happening to the cell in **Figure 3.**

Answer

Within the cell:

- The chromatids have separated or are being separated / chromosomes are being pulled apart; [1 mark]
- Mitosis is occurring; [1 mark]

[Total: 2 marks]

(2 marks)

(d) Suggest the events that would occur after those observed in the cell in **Figure 3**.

Answer

The following events would occur after those observed in the cell in **Figure 3:**

- The cell membrane and cytoplasm of the cell will divide; [1 mark]
- Two (genetically identical) daughter cells will be produced; [1 mark]

[Total: 2 marks]

(2 marks)

(e) Onion plants contain meristem tissue.

Compare the meristem tissue found in an onion plant with bone marrow tissue found in humans.

Answer

Comparing the meristem tissue found in an onion plant with bone marrow tissue found in humans:

Any **two** of the following:

- Both the meristem and bone marrow are sources of stem cells; [1 mark]
- The stem cells found in the meristem can differentiate into any type of tissue in the plant; [1 mark]
- Adult stem cells (from bone marrow) can differentiate into many but not all types of specialised cell found in a human; [1 mark]

[Total: 2 marks]

(2 marks)

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(f) Many plants are at risk of extinction as a result of human activity.

Stem cells from the meristem can be used to clone rare plant species.

Describe the advantages of cloning plants in this way.

Answer

The advantages of cloning rare plant species from meristem stem cells are:

Any **two** of the following:

- It is economical / does not require expensive equipment; [1 mark]
- Desirable traits can be preserved without the risk of variation caused by sexual reproduction; [1 mark]
- Many plants can be produced quickly from just a few individuals (reducing risk of extinction); [1 mark]

[Total: 2 marks]

(2 marks)

(g) Suggest one **other** useful application of cloning plants.

Answer

Another useful application of cloning plants is:

- Crop plants with desirable features (such as disease or drought resistance) can be cloned to produce large numbers of plants for farmers / to feed populations; [1 mark]

[Total: 1 mark]

(1 mark)

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(h) Suggest one disadvantage of producing clones of plants from meristems.

Answer

One disadvantage of producing clones of plants from meristems is:

- There is no variation in cloned plants / clones are genetically identical which makes cloned populations susceptible to environmental changes (e.g. disease); [1 mark]

[Total: 1 mark]

The biggest disadvantage with cloning is the lack of genetic variation in any cloned population. This puts the whole population at risk of not being able to adapt / cope with environmental pressures such as a change in climate or new disease.

(1 mark)

31 A student is instructed to prepare an uncontaminated culture of bacteria from a tube of liquid nutrient medium. The liquid contains one strain of bacteria.

Describe and explain the techniques the student should use to grow the bacteria on a Petri dish.

Answer

- To mark this question, you need to assign a level to your answer.
- It is only possible to achieve full marks if your response has no incorrect statements that contradict any correct response you make.
- Read your answer through, then read the level descriptors. Decide which one applies to your answer, and then allocate a mark by determining if your response fully or partially meets the level descriptor.

Level 1 [1 – 2 marks]

There is a brief description of at least one of the stages (pre-inoculation, inoculation, post-inoculation).

Level 2 [3-4 marks]

There is a simple description of at least two stages and an explanation of at least one of them.

Level 3 [5 – 6 marks]

There is a clear description of all three stages and an explanation of at least two of them.

Examples of Biology points made in the response (note that each point does not equate to 1 mark):

To kill unwanted bacteria:

- Sterilise both the Petri dish and agar before use
- Pass the inoculating loop through a flame to sterilise

Inoculation:

- Use loop/swab used to spread/streak bacterium onto agar plate

- Open the lid of the Petri dish as infrequently as possible / in direction of lit Bunsen to prevent microbes in the air from entering
- Seal Petri dish with tape to prevent contamination during incubation / tape edges but not all the way around to allow air to enter
- Incubate at a suitable temperature to allow growth of bacteria

[Total: 6 marks]

(6 marks)

32 Embryonic stem cells have the potential to be used to treat many human diseases.

Suggest how embryonic stem cells could be used to treat a person who has been paralysed.

Answer

Embryonic stem cells could be used to treat a person who has been paralysed by:

- Paralysis is caused by damage to neurones in the spinal cord (which cannot be repaired); [1 mark]
- Embryonic stem cells are unspecialised and could be manipulated to differentiate into neurones / nerve cells / their supporting cells; [1 mark]
- Which could be used to replace the cells damaged in the spine; [1 mark].

[Total: 3 marks]

The use of stem cells to treat conditions such as paralysis and diabetes is a part of the specification. You should know how stem cells could be used in each case as a potential treatment.

(3 marks)

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33 (a) The statements in **Table 1** refer to processes occurring in an organism.

Table 1

Process	**Transport mechanism**
Absorption of oxygen into the blood from the alveoli	
Movement of mineral ions into the root hair cell of a plant	
Movement of water from the kidney tubules into the blood	
Absorption of glucose into respiring cells	
Movement of urea from liver cells into the blood	
Movement of water from the cell vacuole into the xylem of a plant	

Complete **Table 1** to show which transport mechanism is being used for each of the processes described.

Answer

Table 1 should be completed as follows:

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Process	Transport mechanism
Absorption of oxygen into the blood from the alveoli	Diffusion
Movement of mineral ions into the root hair cell of a plant	Active transport
Movement of water from the kidney tubules into the blood	Osmosis
Absorption of glucose into respiring cells	Diffusion
Movement of urea from liver cells into the blood	Diffusion
Movement of water from the cell vacuole into the xylem of a plant	Osmosis

Award [1 mark] for each correct answer

[Total: 6 marks]

These are all examples of processes from the AQA GCSE Biology course which you should be familiar with.

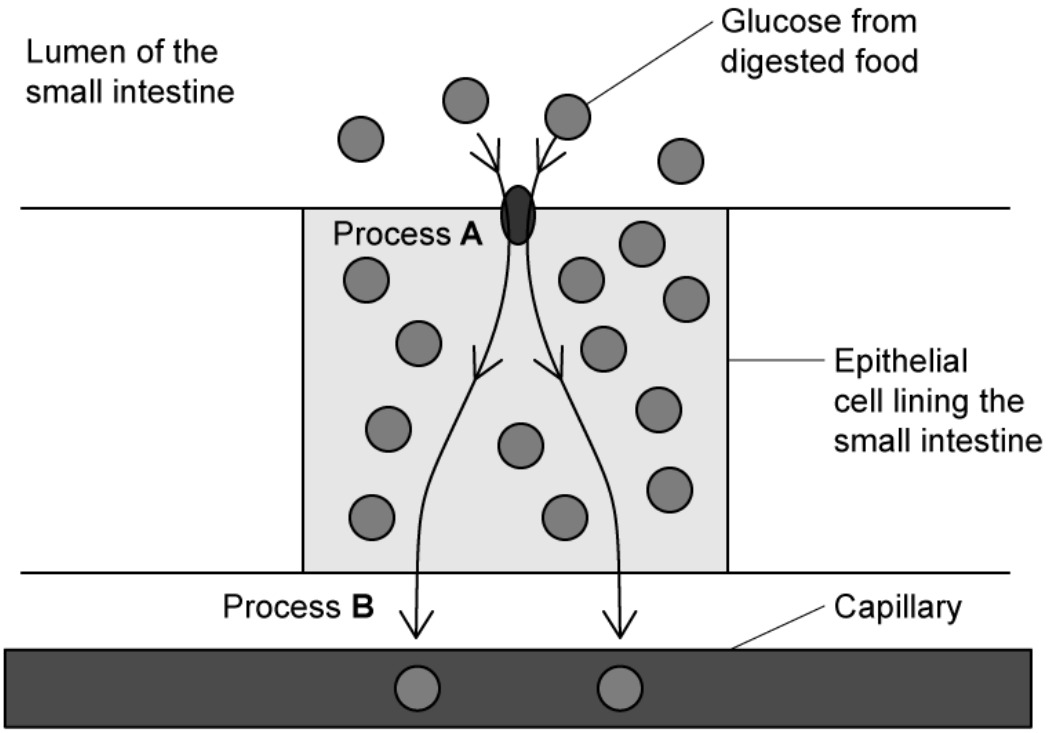
(6 marks)

(b) During digestion, glucose is absorbed from the partially-digested food in the lumen of the small intestine, across the cells lining the small intestine (the epithelial cells) and into the bloodstream.

It is a two-stage process, shown in **Figure 1**.

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Figure 1



Process **A** - glucose moves from the partially digested food in the small intestine into the epithelial cell (lining the small intestine) using energy from ATP.

Process **B** - glucose moves passively from the epithelial cell into the the bloodstream.

Use the information in **Figure 1** and your knowledge of transport across cell membranes to describe the mechanisms used in process **A** and process **B** for the absorption of glucose into the bloodstream.

Answer

The transport mechanisms used to absorb glucose is as follows:

Any **four** from the following:

- Process A occurs by active transport; [1 mark]
- Glucose concentration is high in the epithelial cell/cell lining the intestine and lower in the intestine; [1 mark]
- Glucose is moving from a lower concentration (in the intestines / lumen) to a higher concentration (in the epithelial cell) **OR** against a concentration gradient; [1 mark]

- Process B occurs by diffusion; [1 mark]
- Glucose concentration is high in the epithelial cell/cell lining the intestine and lower in the blood; [1 mark]
- Glucose is moving from a high concentration (in the epithelial cell) to a low concentration (in the blood) **OR** down a concentration gradient; [1 mark]
- Process **A** is active / requires energy whereas process **B** is passive; [1 mark]

[Total: 4 marks]

All the information that you need to answer this question can be found in the Figure provided, backed up by your knowledge from the AQA GCSE Biology specification, so don't be alarmed by the high level content that the question contains.

(4 marks)

(c) Process **B** (in **Figure 1**) relies on the presence of a concentration gradient.

Explain how a steep concentration gradient is maintained in order to continually support Process **B**.

Answer

The concentration gradient for Process **B** is maintained in the following way...

- A high(er) concentration of glucose in the epithelial cell (compared to the blood) is maintained by active transport (from the lumen); [1 mark]
- A low(er) concentration of glucose in the blood is maintained by a good blood supply / glucose is removed from the region through the constant flow of blood; [1 mark]

[Total: 2 marks]

(2 marks)

(d) Absorption of glucose may not always occur through the transport mechanism shown in Process **A** in **Figure 1.**

Suggest a situation when glucose may be absorbed into the epithelial cell through an alternative transport mechanism different to that shown in **Figure 1**.

You should refer to concentration gradients in your answer.

Answer

Glucose may be absorbed using a different transport mechanism to Process **A** if...

- The concentration of glucose in the lumen is very high / higher than inside the epithelial cell / the individual has just eaten a high carbohydrate meal; [1 mark]
- Glucose can then move down the concentration gradient into the epithelial cell by diffusion; [1 mark]

[Total: 2 marks]

(2 marks)

34 (a) Particulate matter (PM) refers to the small particles in air pollution which can irritate the airways and caused damage to the alveoli.

If concentrations of PM are high, the epithelium cells of the alveoli may be killed and replaced with unspecialised cells resulting in:

- Fewer functioning alveoli
- Thickening of alveolar walls

Explain how particulate matter could lead to reduced gas exchange in the lungs of humans.

Answer

Particulate matter can reduce gas exchange because it causes...

- A reduced surface area (due to fewer alveoli); [1 mark]
- An increased diffusion distance (due to thickened cells); [1 mark]
- Leading to a reduced rate of gas exchange; [1 mark]

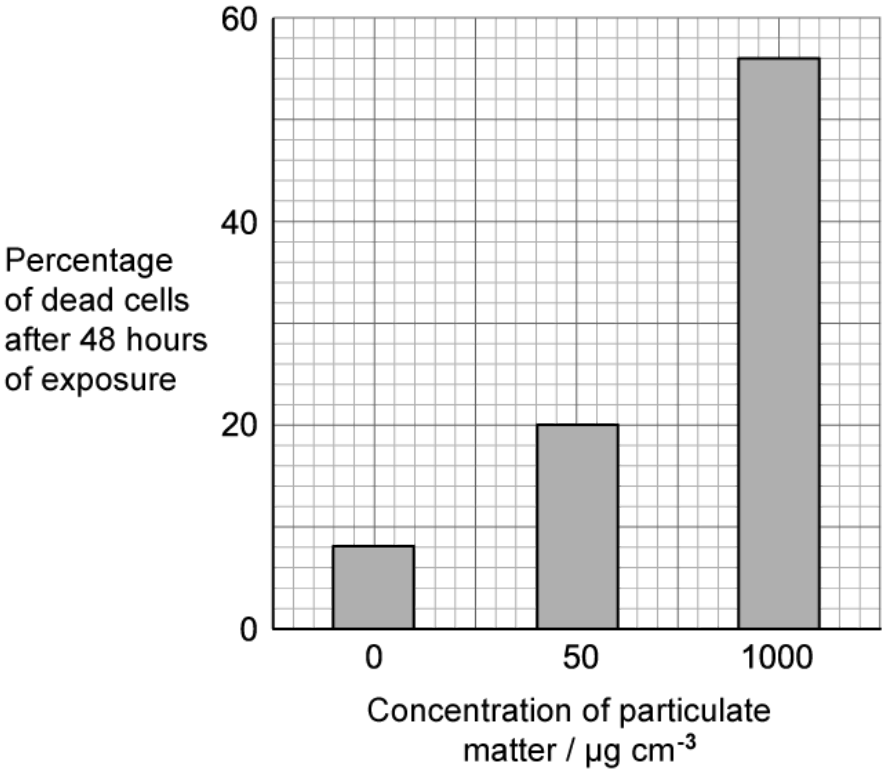
[Total: 3 marks]

This is an application based question which means you should identify your relevant knowledge from the GCSE Biology specification to answer the question about an unfamiliar scenario.

(3 marks)

(b) **Figure 2** shows the results of an investigation into the concentration of particulate matter and the percentage of dead alveolar epithelium cells after 48 of exposure.

Figure 2



Scientists studied 31 080 alveolar epithelium cells in this study.

Calculate how many more cells died after 48 hours of exposure to 1 000 µg cm^{-3} of particulate matter than after 48 hours of exposure to 50 µg cm^{-3} of particulate matter.

Answer

The calculation can be completed as follows:

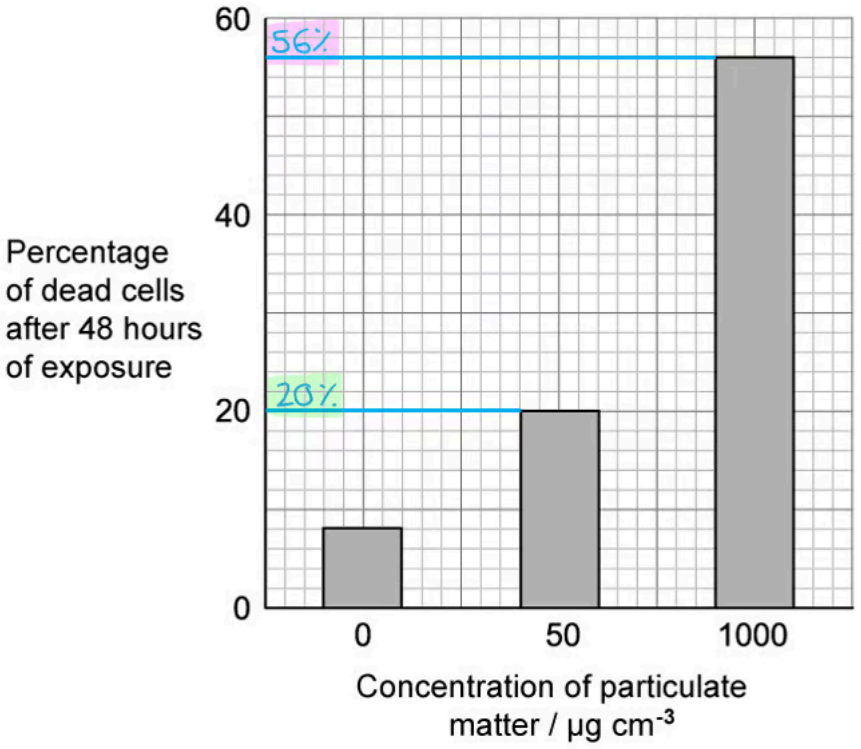
- 0.56 x 31 080 = 17 405; [1 mark]
- 0.2 x 31 080 = 6 216; [1 mark]
- 17 405 - 6 216 = 11 189; [1 mark]

OR

- 56% = 0.56 / 20% = 0.20; [1 mark]
- 0.56 - 0.20 = 0.36; [1 mark]

- 0.36 × 31 080 = 11 189; [1 mark]

[Total: 3 marks]



56% as a decimal

56 ÷ 100 = 0.56

56% of cells died at 1000µg cm^{-3}

20% of cells died at 50µg cm^{-3}

0.56 × 31 080 = 17 405 [1 mark]

0.2 × 31 080 = 6216 [1 mark]

Difference = 17 405 − 6216 = 11 189 [1 mark]

(more cells died)

(3 marks)

(c) Compare, with examples, the different transport processes involved in moving substances across the cell membrane.

Answer

The different transport processes can be compared as follows:

Indicative content:

Osmosis

- A passive process
- Movement of water molecules
- Movement is across a partially permeable membrane
- From a high water concentration / potential to a low water concentration / potential

Examples include

- Movement of water into roots of plant
- Movement of water into and out of cells / specific examples may be given
- Movement of water between the blood plasma and cells

Diffusion

- A passive process
- Molecules move from a high concentration to a low concentration

Examples include

- Oxygen into cells and carbon dioxide out of cells for respiration
- Carbon dioxide into cells and oxygen out of plant cells in photosynthesis
- Any other correct named example

Active transport

- An active process / requires energy / ATP
- Movement of molecules from a low concentration to a high concentration

Examples include

- Mineral ions move into root hair cells of plants
- Glucose moves from the lumen of the small intestine into the epithelial cell
- Any other correct names example

Level 3 [5–6 marks]:

- A thorough comparison of several key features of each of the transport processes discussed, including examples of each.
- The answer communicates ideas clearly and coherently using a range of scientific terminology accurately
- Spelling, punctuation and grammar are used with a high level of accuracy

Level 2 [3–4 marks]:

- One simple comparison is made between at least 2 of the transport processes (osmosis, active transport or diffusion) with at least 1 example.
- The answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately
- Spelling, punctuation and grammar are used with some accuracy

Level 1 [1–2 marks]:

- Some correct statements about either osmosis, diffusion or active transport but no clear comparisons made.
- The answer communicates ideas using simple language and uses limited scientific terminology
- Spelling, punctuation and grammar are used with limited accuracy

[Total: 6 marks]

This is a ‘level of response’ answer. You should decide which level your answer fits against and then consider whether it meets that level securely to achieve the higher mark, or partially to achieve the lower mark.

Examples of correct points in relation to the question are given in the mark scheme, but it is important to note that each point does not equate to a mark.

As a 'compare' question, it is important to remember that you cannot be awarded top marks without making direct comparisons.

(6 marks)

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35 (a) Compare and contrast the structures of eukaryotic and prokaryotic cells.

Include reference to the relative sizes of cellular structures in your answer.

Answer

Eukaryotic and prokaryotic cells can be compared as follows:

Structural comparisons:

- They both have cell membranes / cytoplasm / ribosomes
- Sperm cells and some prokaryotes have a tail / flagellum
- Prokaryotes can have more than one flagellum (sperm only have one)
- Eukaryotic cells have mitochondria and chloroplasts whereas prokaryotic cells do not
- Eukaryotic cells have a nucleus whereas prokaryotic cells have DNA loose in the cytoplasm
- Prokaryotic cells have plasmids whereas eukaryotic cells do not
- Eukaryotic plant cells have a cellulose cell wall, whereas a prokaryotic cell wall is made from peptidoglycan

Size comparisons:

- Prokaryotic cells are smaller than eukaryotic cells
- Prokaryotic cells are around 1 μm compared to 10-100 μm in eukaryotic cells
- Some organelles / chloroplasts / mitochondria are bigger than prokaryotic cells **OR** would not fit into a prokaryotic cell

Level 3 [5–6 marks]:

- A detailed comparison of eukaryotic and prokaryotic cells **AND** a clear understanding of how the size and scale of cellular structures can be compared.
- The answer communicates ideas clearly and coherently using a range of scientific terminology accurately.

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- Spelling, punctuation and grammar are used with a high level of accuracy.

Level 2 [3–4 marks]:

- A clear comparison of eukaryotic and prokaryotic cells **OR** a clear understanding of how the size and scale of cellular structures can be compared.
- The answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately.
- Spelling, punctuation and grammar are used with some accuracy.

Level 1 [1–2 marks]:

- Some differences or similarities between eukaryotic and prokaryotic cells are identified but direct comparisons not always made **OR** some reference to eukaryotic cells being bigger than prokaryotic cells (no mention of cellular structures).
- The answer communicates ideas using simple language and uses limited scientific terminology.
- Spelling, punctuation and grammar are used with limited accuracy.

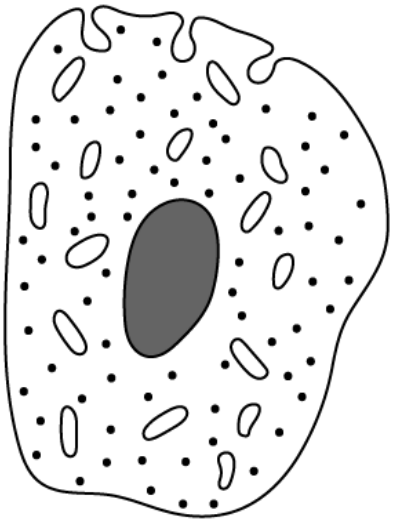
This is a 'level of response' answer. You should decide which level your answer fits against and then consider whether it meets that level securely to achieve the higher mark, or partially to achieve the lower mark.

Examples of correct points in relation to the question are given in the mark scheme, but it is important to note that each point does not equate to a mark.

(6 marks)

(b) **Figure 1** shows a cell found in the glands responsible for producing saliva in the mouth.

Figure 1



Identify the protein, produced by these cells, that is required for digestion of carbohydrates.

Answer

The protein produced by these cells for carbohydrate digestion is....

- Amylase; [1 mark]

[Total: 1 mark]

(1 mark)

(c) Suggest how the cell in **Figure 1** is adapted for its function.

Answer

The cell in **Figure 1** is adapted in the following way:

Any **four** from:

- It contains many ribosomes; [1 mark]
- Ribosomes are required for protein synthesis / to make enzymes; [1 mark]
- The cell contains many mitochondria; [1 mark]
- To provide energy from respiration; [1 mark]
- Used to build proteins / enzymes; [1 mark]

[Total: 4 marks]

(4 marks)

(d) Describe how cell specialisation results in a zygote developing into a baby.

Answer

A zygote develops into a baby through the following process:

Any **two** from:

- The single cell / fertilised egg divides by mitosis; [1 mark]
- Different cells are required to form different tissues / all the tissues of the baby; [1 mark]
- Cells (in the embryo) differentiate **OR** develop / synthesise different organelles/shapes (for their function); [1 mark]

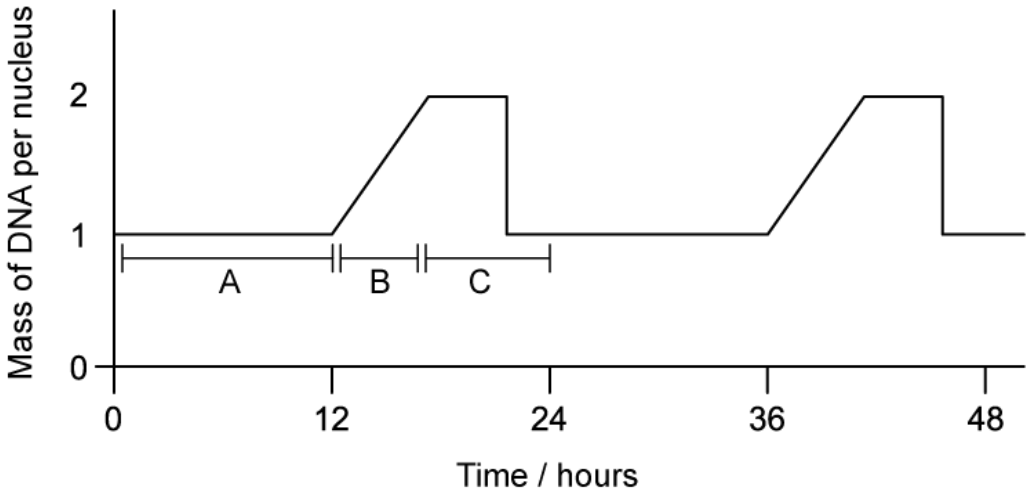
[Total: 2 marks]

(2 marks)

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36 (a) **Figure 1** shows the quantity of DNA found in the nucleus of a human cell throughout the cell cycle.

Figure 1



Identify what is happening during stage B on **Figure 1.** Explain your answer.

Answer

During stage B...

- The DNA is being replicated (ready for mitosis); [1 mark]
- (We can tell this because) the amount of DNA in the nucleus of the cell doubles from 1 to 2 units; [1 mark]

[Total: 2 marks]

To create a diploid cell which is genetically identical to the parent cell (in mitosis) the DNA needs to be replicated so that one copy can be transferred to each daughter cell.

(2 marks)

(b) **Figure 1** shows two complete cell cycles. 50% of the cell cycle is spent in stage **A** and 30% is spent moving through stage **C**.

Calculate how long the cells spend in stage **B** of the cell cycle.

Answer

The amount of time spend in stage **B** can be calculated as follows:

- One cell cycle = 24 hours; [1 marks]
- Stage B = 20% (of 24 hours); [1 marks]
- 20% of 24 hours = 4.8 hours or 288 minutes or 4 hours 48 minutes; [1 marks]

[Total: 3 marks]

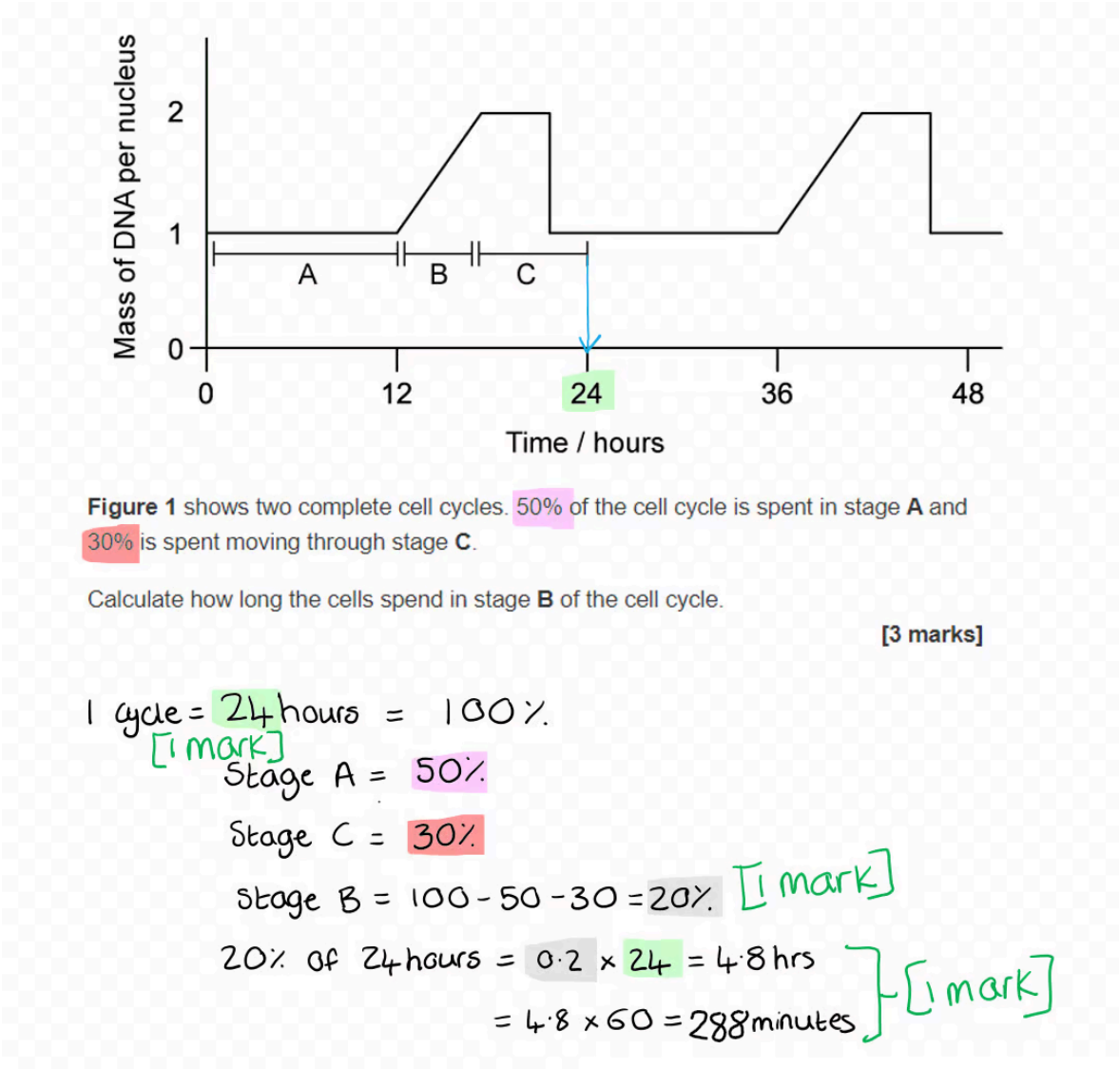


Figure 1 shows two complete cell cycles. 50% of the cell cycle is spent in stage **A** and 30% is spent moving through stage **C**.

Calculate how long the cells spend in stage **B** of the cell cycle.

[3 marks]

1 cycle = 24 hours = 100%
[1 mark]
Stage A = 50%
Stage C = 30%
Stage B = 100 - 50 - 30 = 20% [1 mark]
20% of 24 hours = 0·2 × 24 = 4·8 hrs
= 4·8 × 60 = 288 minutes [1 mark]

(3 marks)

(c) How many chromatids would be found in the nucleus of this human cell during stage **B?**

Answer

During stage B, there would be...

- 92 chromatids; [1 mark]

[Total: 1 mark]

Once the DNA has replicated, each chromosome is made of 2 sister chromatids joined together (forming an 'X' shape). This means that there are twice as many chromatids as there are chromosomes. In a human cell with 46 chromosomes, this means there are 92 individual chromatids.

(1 mark)

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(d) Describe the stages of the cell cycle.

Answer

The cell cycle can be described as follows:

Indicative content

Growth phase

- The growth phase requires the cell to grow physically in size
- DNA is replicated
- Chromosomes become 'X' shaped

Mitosis

- Chromosomes are split
- Chromosomes are pulled to either end / the poles of the cell
- A new nucleus forms
- Each nucleus contains 46 / 23 pairs of chromosomes
- Chromosomes are 'I' shaped

Cytokinesis

- The cytoplasm splits
- Cell membranes form around each cell
- Daughter cells are genetically identical to parent cells / clones of parent cells

Level 3 [5–6 marks]:

- A detailed break down of the parts of the cell cycle to include the need for DNA replication, growth phase, the process of mitosis and cytokinesis
- The answer communicates ideas clearly and coherently using a range of scientific terminology accurately

- Spelling, punctuation and grammar are used with a high level of accuracy

Level 2 [3–4 marks]:

- A description of the parts of the cell cycle with some stages absent or incorrect.
- The answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately
- Spelling, punctuation and grammar are used with some accuracy

Level 1 [1–2 marks]:

- A general description of the cell cycle with mention of DNA replication and mitosis but few / no other stages identified.
- The answer communicates ideas using simple language and uses limited scientific terminology
- Spelling, punctuation and grammar are used with limited accuracy

[Total: 6 marks]

This is a 'level of response' answer. You should decide which level your answer fits against and then consider whether it meets that level securely to achieve the higher mark, or partially to achieve the lower mark.

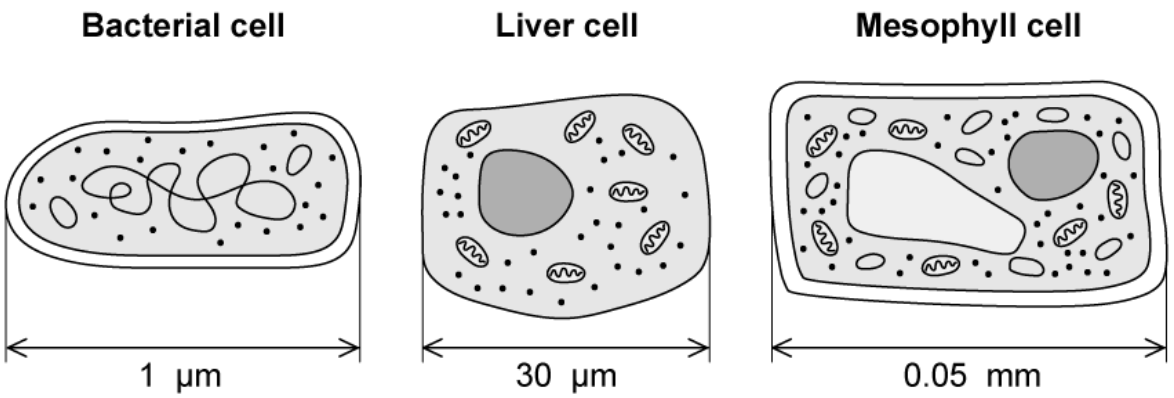
Examples of correct points in relation to the question are given in the mark scheme, but it is important to note that each point does not equate to a mark.

(6 marks)

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37 (a) **Figure 2** shows three different cells.

Figure 2



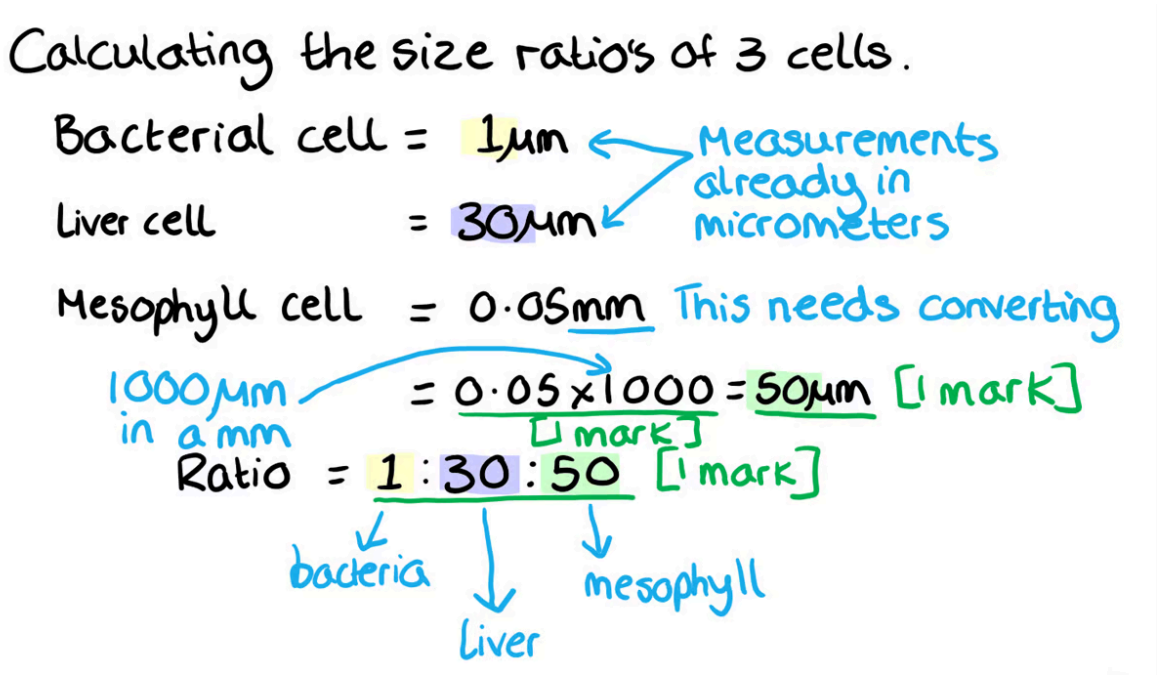
Calculate the size ratio of the bacterial cell compared to the liver cell and mesophyll cell.

Answer

The size ratio can be calculated as follows:

- 1mm = 1000 μm; [1 mark]
- 0.05 mm = 50 μm; [1 mark]
- 1 : 30 : 50; [1 mark]

[Total: 3 marks]



(3 marks)

(b) Explain the role of differentiation in the development of root hair cells which allows them to carry out their specific function in plants.

Answer

Differentiation plays the following role in producing root hair cells which allow them to carry out their function:

Any **four** from:

- Differentiation determines cell shape / development of specific organelles (to allow them to carry out a particular function); [1 mark]
- Root cells grow extensions / root hairs to give a large surface area to volume ratio this allows maximum uptake of water by osmosis; [1 mark]
- They also develop many mitochondria to provide energy for active transport of mineral ions; [1 mark]
- A large vacuole for storage of water and minerals to maintain a concentration gradient (for continuous uptake of water by osmosis); [1 mark]
- Root hair cells have no chloroplasts, as they do not photosynthesize; [1 mark]

[Total: 4 marks]

Remember that cells differentiate to become specialised. This means that the differences each cell has are required so that they are adapted to carry out a particular function.

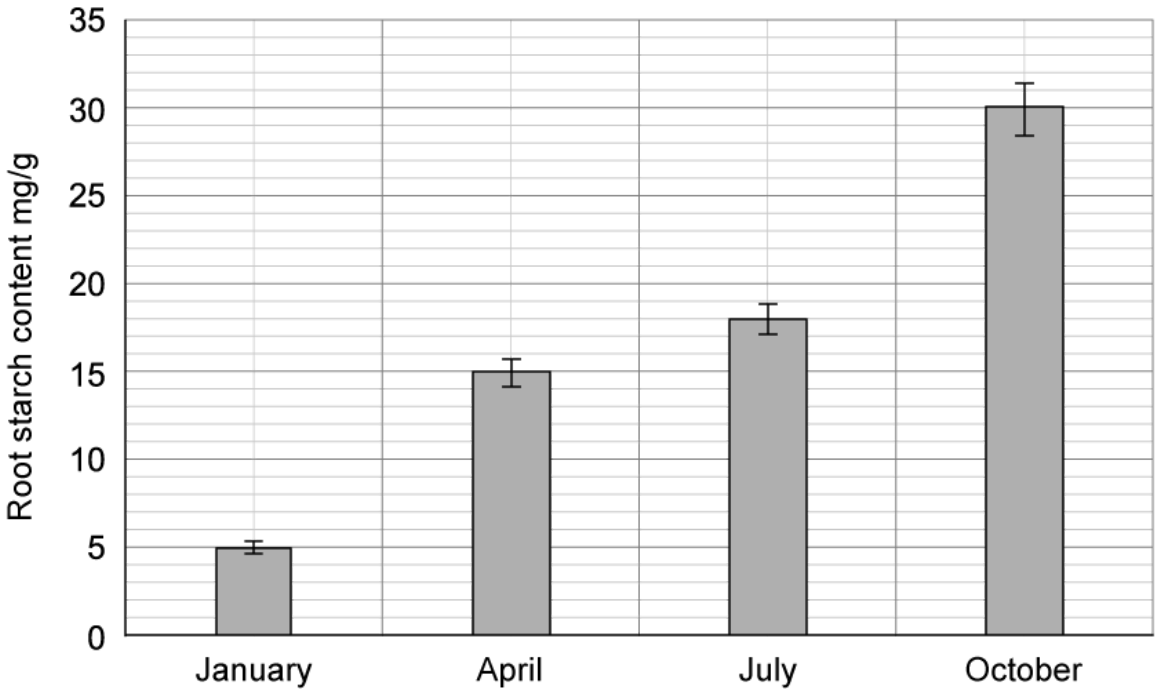
This question asks for an explanation as to how differentiation allows the root hair cell to carry out its function, so you need to ensure that you have identified the feature and then linked it to a specific function.

(4 marks)

(c) Some scientists completed a study to investigate the starch content of roots in a species of grass at four points throughout the year.

Their results can be seen in **Figure 3**.

Figure 3



Explain how the starch found in the roots of grass species helps to support growth of the grass.

Answer

Starch found in the roots of grass supports growth in the following way:

- Glucose is stored as starch in plants; [1 mark]
- Energy is released from glucose in respiration; [1 mark]
- Energy is required for growth / building of new molecules **OR** energy is required for active transport of mineral ions / nitrates into the root; [1 mark]

[Total: 3 marks]

(3 marks)

(d) Calculate the percentage change of stored starch from October to January and suggest a reason for this change.

Answer

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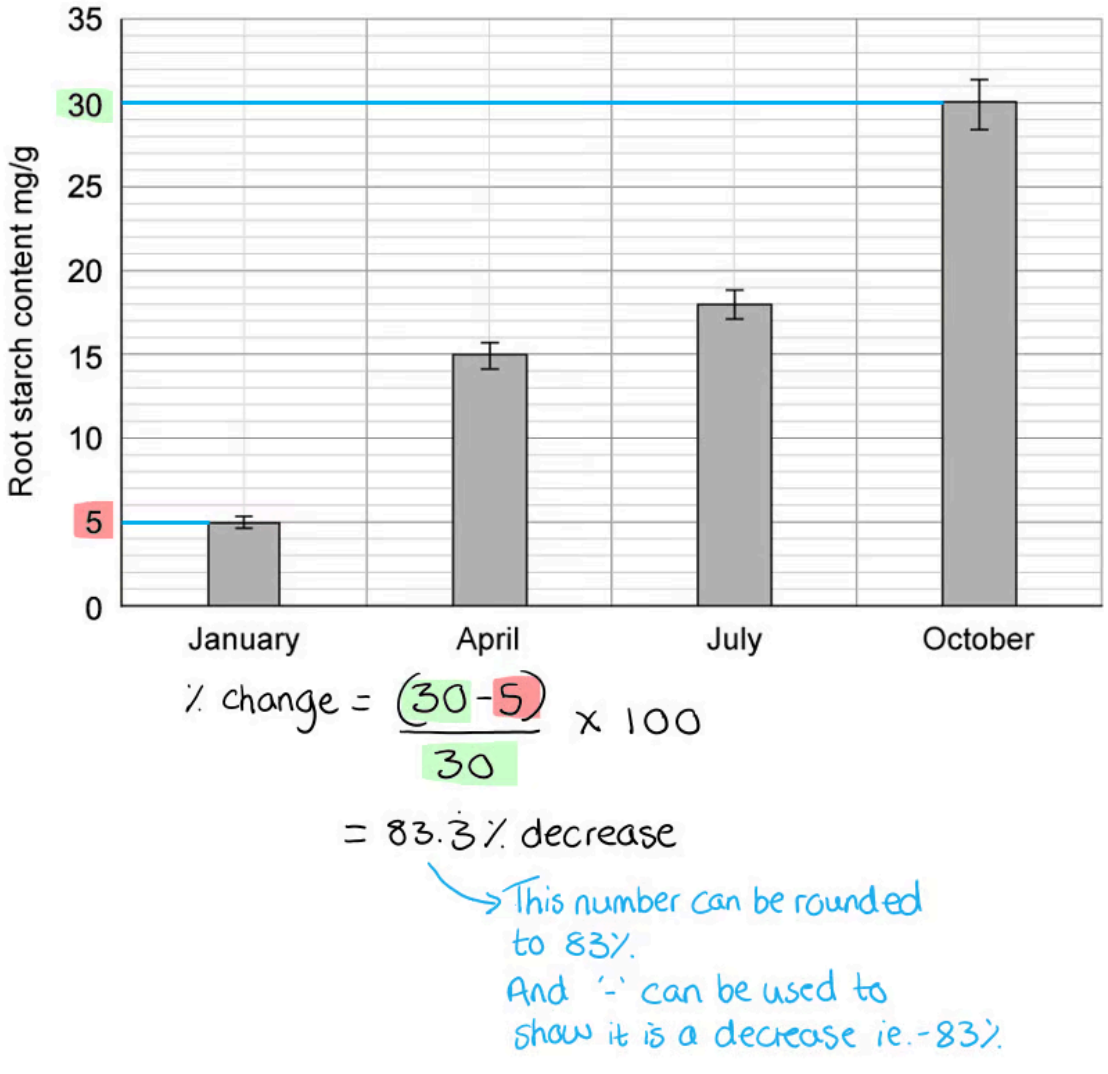
The percentage change can be calculated in the following way:

- (25 ÷ 30) x 100 = 83.3 % decrease / - 83.3 %; [1 mark]

This decrease could be because...

- Less photosynthesis occurs in winter months (so less glucose is stored as starch); [1 mark]
- Starch stores are used up / glucose is used for respiration / active transport; [1 mark]

[Total: 3 marks]



(3 marks)

38 (a) Monoglycerides are molecules made up of glycerol and one fatty acid tail. They are absorbed into the epithelial cells of the small intestine by diffusion across the cell membrane.

A scientist measured the uptake of monoglycerides in the epithelial cells of mice. In the investigation, the scientist provided the mice with different concentrations of monoglycerides and measured the uptake into the epithelial cells of the small intestine.

Complete **Table 1** to show which variables the scientist used in this investigation.

Table 1

Independent Variable	
Dependent Variable	
Control Variable	

Answer

The table should be completed as follows:

Independent Variable	The different concentrations of monoglycerides
Dependent Variable	The rate of uptake into the epithelial cells
Control Variable	The diet of the mice / the age / gender / size of the mice / the activity of the mice / any other valid control

Award [1 mark] for each correctly identified variable in the table.

[Total: 3 marks]

Remember the following:

An **independent variable** is the variable which is change in order to asses the effect of it on the dependent variable. There should only be one independent variable. e.g. the effect of light intensity on growth of shoots

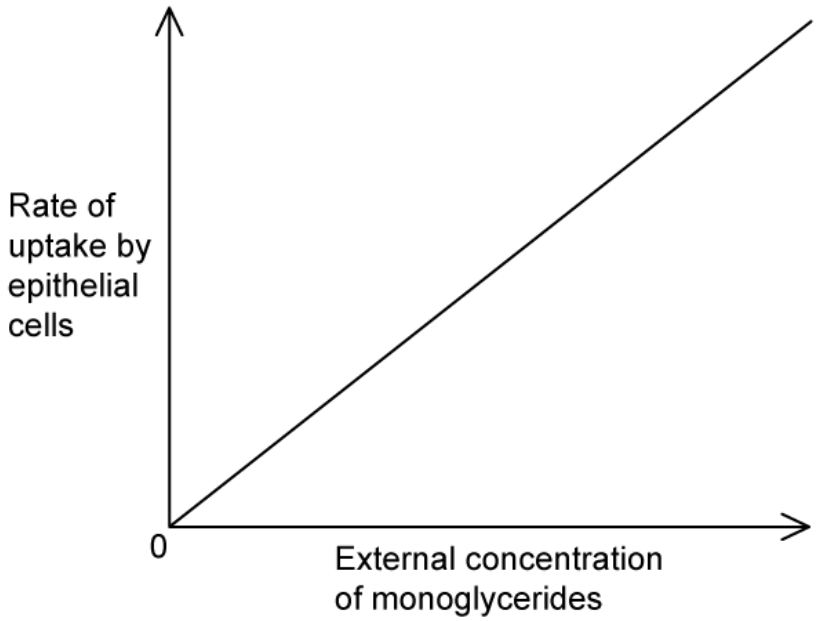
The **dependent variable** is the measurement that is being taken to establish the effect of the independent variable. There is usually just one dependent variable, but on occasion there may be more than one way of measuring the effect of the independent variable e.g. growth of a shoot and direction of growth.

The **control variables** are any variable which should be controlled to ensure that only the effect of the independent variable is being tested. This ensures a valid investigation has been carried out. There will usually be multiple control variables e.g. the species and age of seeds to be grown, the volume of water and nutrients provided to the growing shoots and the temperature and pH of the environment.

(3 marks)

(b) The graph in **Figure 3** shows the results of the investigation from part (a).

Figure 3



Describe and explain what the graph shows.

Answer

The graph shows...

- As the concentration of monoglycerides increases, the rate of uptake of epithelial cells increases; [1 mark]
- The relationship is proportional / linear; [1 mark]
- (This is because) the steeper the concentration gradient, the faster the rate of diffusion; [1 mark]

[Total: 3 marks]

(3 marks)

(c) Human body temperature is approximately 37 °C, which provides the optimum temperature for activity of protein molecules such as enzymes.

Suggest why a temperature of 37 °C helps to maximise the rate of transport of substances across the cell membrane.

Answer

A body temperature of 37 °C maximises transport because...

Any **three** from the following:

- Temperatures lower than 37 °C would result in less kinetic energy of particles (to be transported); [1 mark]
- Less kinetic energy would mean slower rate of diffusion / osmosis / active transport; [1 mark]
- Higher temperatures may result in damage to transport proteins / cell membranes; [1 mark]
- This could reduce the rate of transport across the membrane **OR** prevent transport across the membrane; [1 mark]

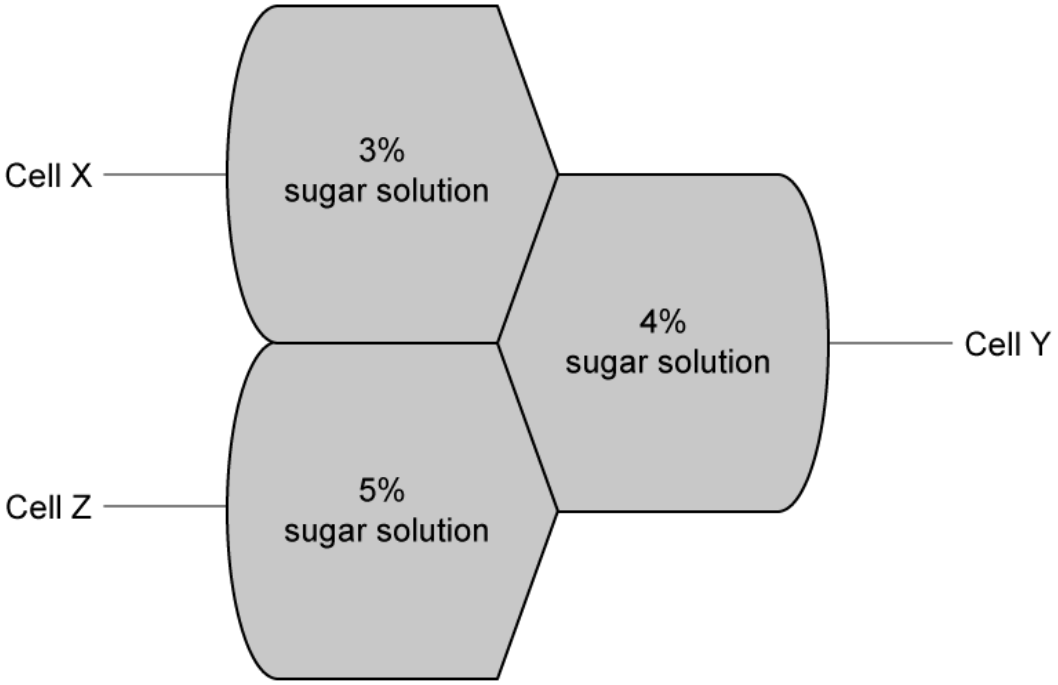
[Total: 3 marks]

(3 marks)

(d) **Figure 4** shows the concentration of sugars in three different cells; **X**, **Y** and **Z**.

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Figure 4



Which of the following statements is correct?

A. More water will move by osmosis from cell Z to cell X than from X to Z.

B. More water will move by osmosis from cell X to cell Z than from Z to X.

C. More water will move by osmosis from cell X to cell Y than from X to Z.

D. More water will move by osmosis from cell Z to cell Y than from Y to Z.

Answer

The correct answer is B.

- The net movement of water by osmosis will be from a cell with higher water concentration (and the lowest solute concentration) to a cell with lower water concentration

- Cell X has a lower solute concentration than cell Z, meaning that **X has a higher water concentration than Z**; the result of this is that the net movement of water molecules will be from cell X into cell Z.

A is incorrect because cell X has a higher water concentration than cell Z, so the net movement of water will be **from X to Z** and not the other way around.

C is incorrect because the difference in water concentration between X and Z is greater than the difference between X and Y; more water will therefore move **from X to Z** than from X to Y.

D is incorrect because cell Y has a higher water concentration than cell Z, so the net movement of water will be **from Y to Z** and not the other way around.

(1 mark)

39 (a) When a cell divides by mitosis, it produces identical daughter cells, however, when a zygote divides by mitosis, it develops into an embryo and then a fetus.

Explain how the process of mitosis can produce a whole organism from a single cell.

Answer

A foetus is formed through mitosis from a zygote because

- Mitosis increases the number of cells; [1 mark]
- Cell differentiation occurs; [1 mark]
- (To create) specialised cells / tissues / organs / named cells / tissues which carry out particular functions; [1 mark]

[Total: 3 marks]

Remember that all body cells form through the process of mitosis, only gametes form by meiosis. Differentiation is responsible for the development of specialised cells and tissues which are characteristic of multicellular organisms.

(3 marks)

(b) Compare and contrast the processes of mitosis and meiosis.

Answer

The processes of meiosis and mitosis can be compared as follows:

Indicative content

- Mitosis produces genetically identical daughter cells (clones) whereas meiosis produces genetically different daughter cells
- Mitosis produces 2 daughter cells whereas meiosis produces 4 daughter cells
- Mitosis produces diploid daughter cells (46 chromosomes) whereas meiosis produces haploid daughter cells (23 chromosomes)
- Mitosis is used for growth and repair / producing body cells whereas meiosis produces gametes
- Meiosis is a part of sexual reproduction whereas mitosis is part of asexual reproduction
- In mitosis the cell divides once whereas in meiosis the cell divides twice
- Both processes result in cell division
- DNA replication and the growth phase is required for both processes

Level 3 [5–6 marks]:

- A comprehensive comparison of meiosis and mitosis with at least 5 points taken from the indicative content.
- The answer communicates ideas clearly and coherently using a range of scientific terminology accurately
- Spelling, punctuation and grammar are used with a high level of accuracy

Level 2 [3–4 marks]:

- A clear comparison of meiosis and mitosis with at least 3 points taken from the indicative content.

- The answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately
- Spelling, punctuation and grammar are used with some accuracy

Level 1 [1–2 marks]:

- A basic description of one feature of mitosis and how it compares to meiosis.
- The answer communicates ideas using simple language and uses limited scientific terminology
- Spelling, punctuation and grammar are used with limited accuracy

[Total: 6 marks]

This is a 'level of response' answer. You should decide which level your answer fits against and then consider whether it meets that level securely to achieve the higher mark, or partially to achieve the lower mark.

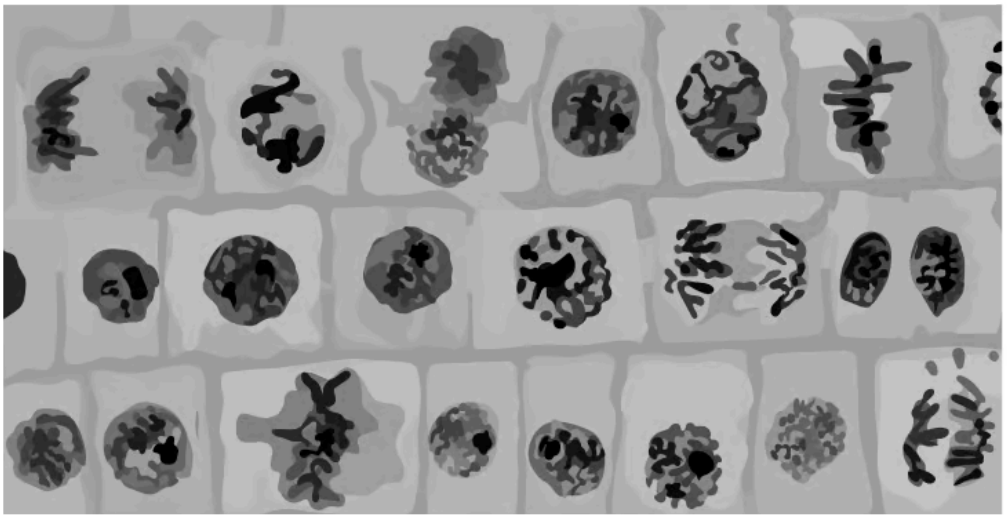
Examples of correct points in relation to the question are given in the mark scheme, but it is important to note that each point does not equate to a mark.

(6 marks)

(c) Initially, before a cell can divide, it needs to prepare for division by replicating DNA within the nucleus. During this time, there are no visible chromosomes.

Figure 2 shows a cell sample taken from plant tissue. The cell cycle in this plant tissue takes 20 hours.

Figure 2



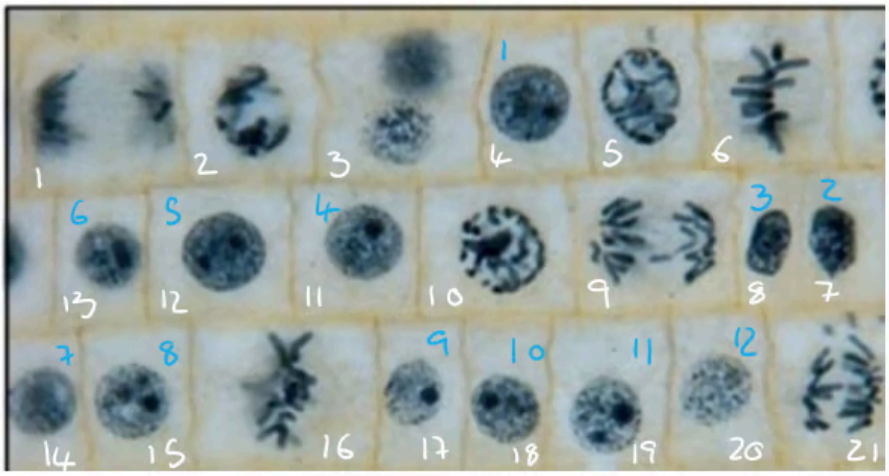
Calculate how long cells remain in the preparation stage before cell division occurs.

Answer

We can calculate the amount of time cells remain in the preparation stage in the following way:

- Number of cells preparing to divide (with no visible chromosomes) = 12; [1 mark]
- (12 ÷ 21) x 20; [1 mark]
- = 11.43 hours **OR** 11 hours 26 minutes **OR** 686 minutes; [1 mark]

[Total: 3 marks]



Cells with no visible chromosomes = 12
Total number of cells = 21
[1 mark]

Length of time in stage = (Number of cells in that stage / Total number of cells) x Length of cell cycle

Taken from the question thread.

= (12 ÷ 21) x 20 [1 mark]

= 11.43hrs OR 686 mins [1 mark]

x 60 to convert to minutes

(3 marks)

40 (a) Describe and explain **four** aseptic techniques used to prepare an uncontaminated culture.

Answer

Aseptic technique can be achieved in the following ways:

- Sterilise equipment to remove/kill unwanted microorganisms; [1 mark]
- Light Bunsen burner in work area to kill microorganisms in the air; [1 mark]
- Flame inoculating loop (in between uses) to kill any unwanted microorganisms on the loop; [1 mark]
- Keep the lid on the culture bottle when not being used to reduce/prevent bacteria escaping from the culture **OR** to prevent unwanted microorganisms getting into the culture; [1 mark]
- Replace the lid on the petri dish / tape the petri dish lid to prevent bacteria escaping from the culture **OR** to prevent unwanted microorganisms getting into the culture; [1 mark]
- Incubate at (no higher than) 25 °C to prevent growth of harmful microorganisms **OR** to prevent growth of microorganisms which thrive at human body temperature; [1 mark]

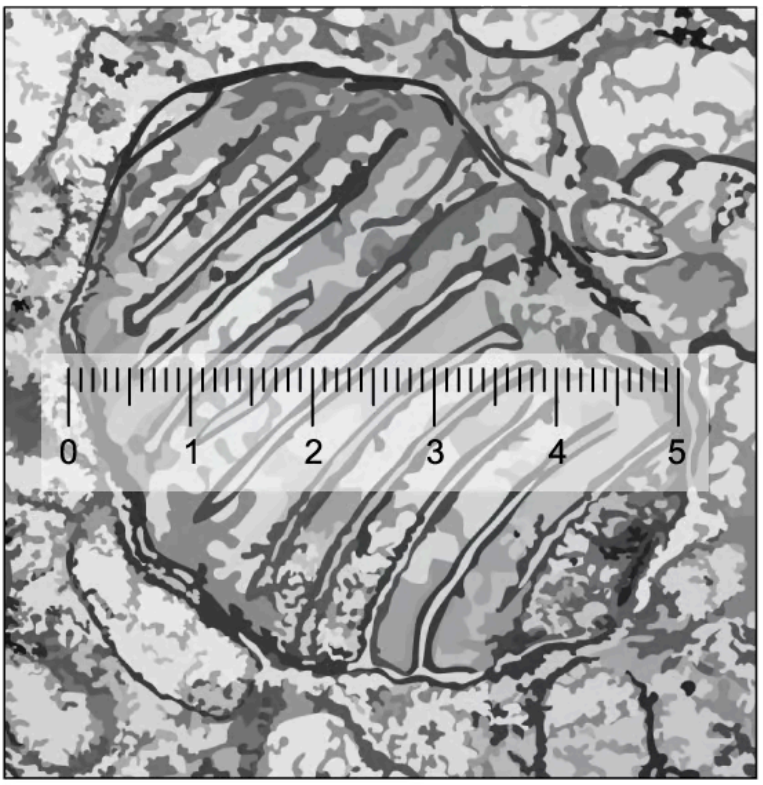
[Total: 4 marks]

Describe **and** explain are both required to gain the marks in this question.

(4 marks)

(b) The micrograph image below shows the organelle responsible for providing energy for cellular processes.

Figure 4



Name the organelle in **Figure 4**.

Answer

The organelle in the diagram is...

- A mitochondria; [1 mark]

[Total: 1 mark]

(1 mark)

(c) Higher Tier Only

The organelle in the image is viewed at a magnification of 20 000 x.

Calculate the actual size of the organelle in **Figure 4** and give your answer in mm shown as standard form.

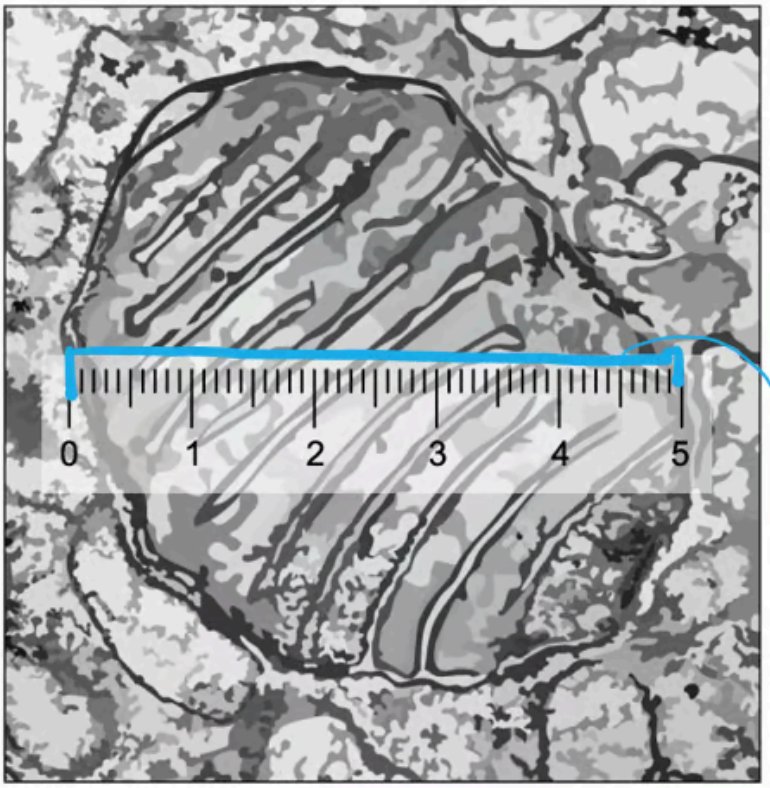
Answer

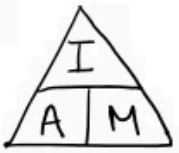
The actual size of this organelle is:

- Actual size = image size ÷ magnification
- 50 000 ÷ 20 000 = 2.5 μm; [1 mark]
- 2.5 ÷ 1000 = 0.0025 mm; [1 mark]
- 2.5×10^{-3}; [1 mark]

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[Total: 3 marks]





A = I ÷ M

Image size measures 5cm

Actual size = Image size ÷ Magnification

Image size = 5cm = 50 mm = 50 000μm

Magnification = 20 000 x

Actual size = 50 000 ÷ 20 000

= 2·5 μm [1 mark]

1000μm to a mm

Convert to mm = 2·5 ÷ 1000

= 0·0025mm [1 mark]

Standard form = 2.5×10^{-3} [1 mark]

(3 marks)

(d) Suggest whether this image was observed through a light microscope or an electron microscope.

Explain your answer.

Answer

The image was viewed...

- Using an electron microscope; [1 mark]

Plus any **two** from:

- Mitochondria / organelles that small cannot be visualised using a light microscope; [1 mark]
- The magnification is higher than a light microscope can operate at; [1 mark]
- The resolution is higher compared to a light microscope; [1 mark]

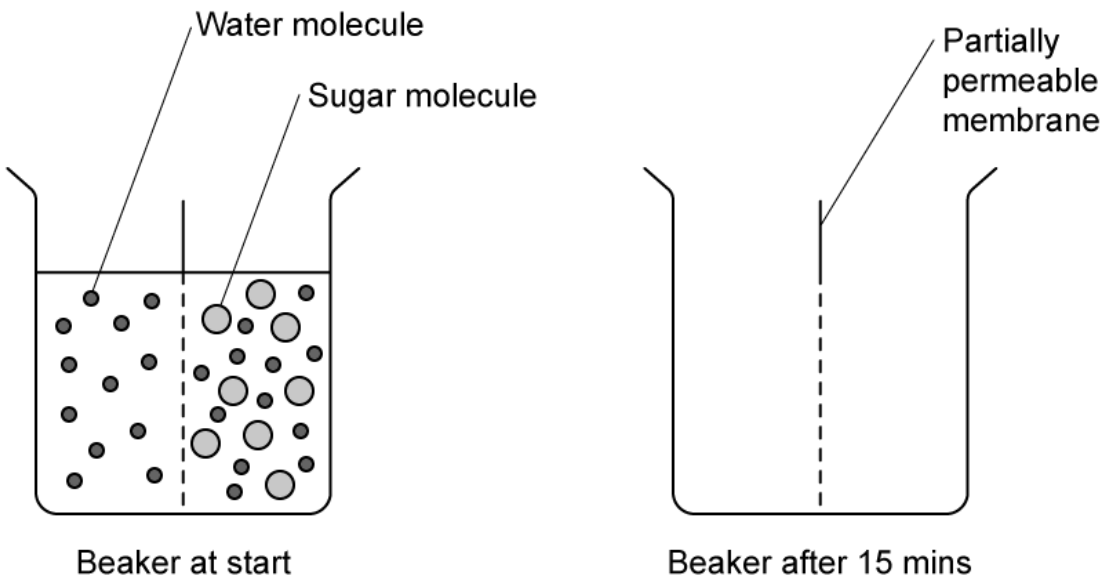
[Total: 3 marks]

(3 marks)

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41 (a) A student wanted to investigate the transport of water across a partially permeable membrane. **Figure 5** shows how the student prepared the beaker at the start of the investigation.

Figure 5



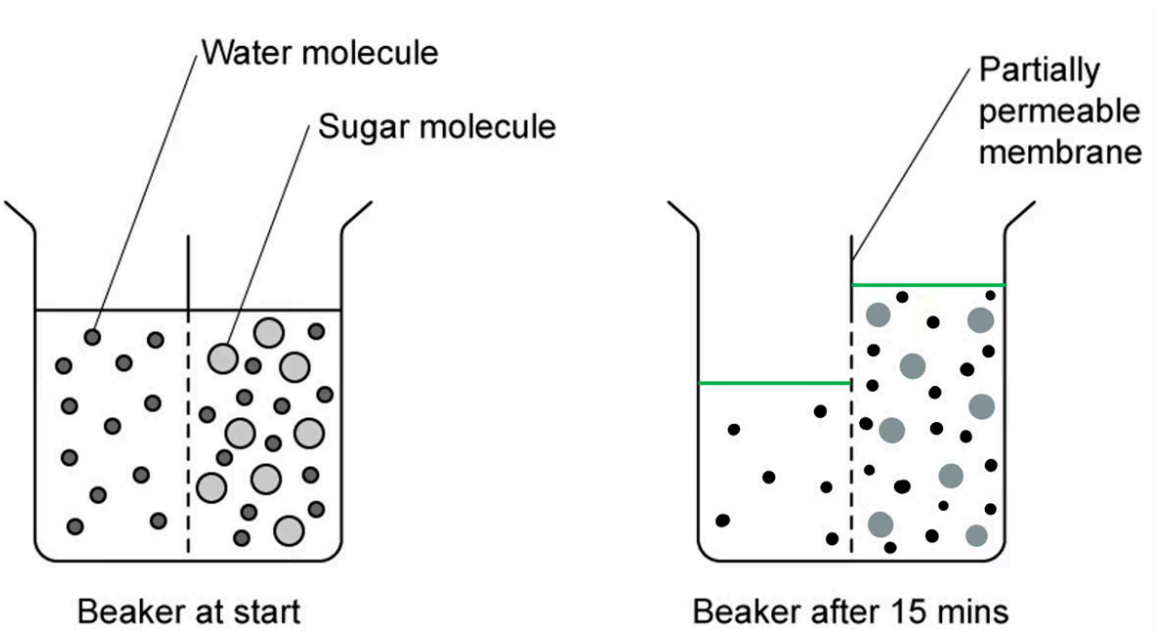
Complete **Figure 5** to show what the student would observe after 15 minutes.

Answer

The beaker after 15 minutes would look like this...

- The liquid level will be higher on the right hand side than the left; [1 mark]
- There will me more water on the right hand side than the left / fewer than 12 water molecules drawn on the left side of the membrane; [1 mark]

[Total: 2 marks]



Remember that the sugar molecules cannot move through the membrane so the water will move into the region of the beaker where the sugar concentration is higher. This will result in the volume of liquid increasing in that region of the beaker.

(2 marks)

(b) Explain your answer to part **(a).**

Answer

The reason that the beaker would look as drawn in part **(a)** is..

- The water particles move by osmosis from an area of low solute / sugar concentration to an area of high / sugar solute concentration **OR** Water particles move by osmosis from an area of high water concentration to an area of low water concentration; [1 mark]

- The sugar particles are too large to move through the small holes in the partially permeable membrane; [1 mark]

[Total: 2 marks]

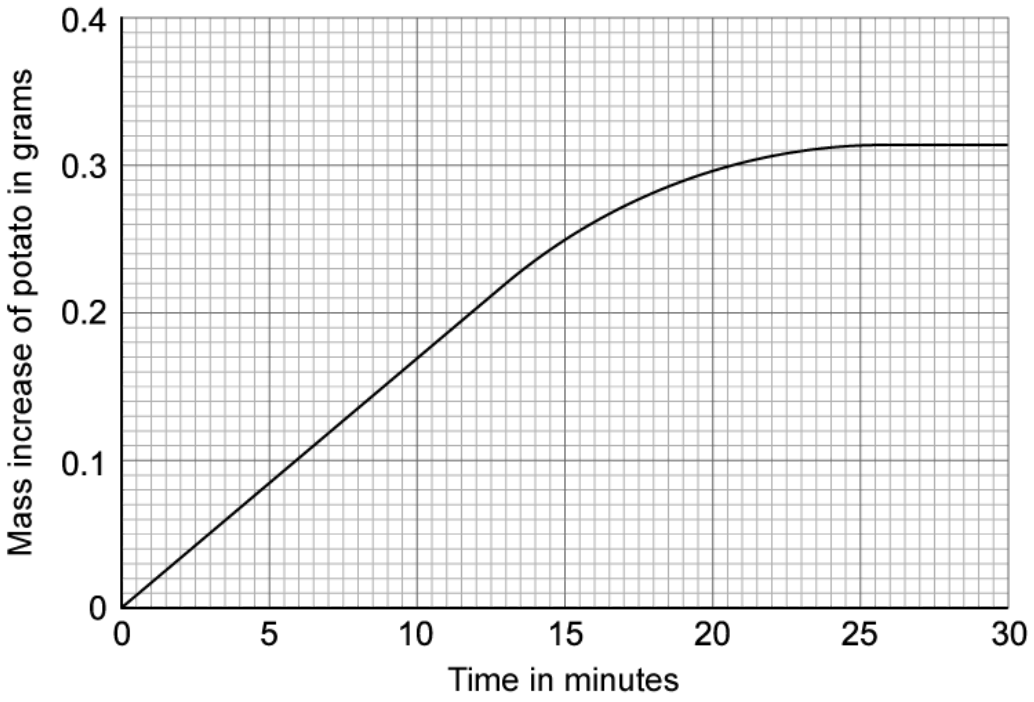
(2 marks)

(c) The student carried out a further investigation into the effect of osmosis on plant tissue.

They cut a potato into cubes and recorded the change in mass over a 30 minute period.

Figure 6 shows the results the student obtained from one cube of potato.

Figure 6



Describe and explain the trend shown on the graph.

Answer

The graph can be described as follows:

- As time increases, the mass of the potato cube increases; [1 mark]
- The increase is not proportional **OR** the increase in mass occurs more quickly in the first 15/20 minutes and then more slowly after 20 minutes / the graph levels off; [1 mark]

This is because...

A maximum of **three** from the following:

- The water concentration outside of the potato is higher than inside the potato; [1 mark]
- (So) water moves into the potato cells by osmosis; [1 mark]
- The rate occurs more quickly when the concentration gradient is steepest (between 0 and 15/20 minutes); [1 mark]
- The rate of increase slows / graph levels off because there is no longer a concentration gradient / the concentration of water inside the potato is the same as / similar to the concentration outside of the potato; [1 mark]
- The rate of increase slows / graph levels off when the cell is turgid/full / cannot absorb any more water; [1 mark]

[Total: 5 marks]

This is a 'describe and explain' question so you are required to do both parts in order to achieve full marks.

(5 marks)

(d) The potato cube from **Figure 6** had an initial mass of 2.3g.

Calculate the percentage increase that the potato cube had shown after 10 minutes.

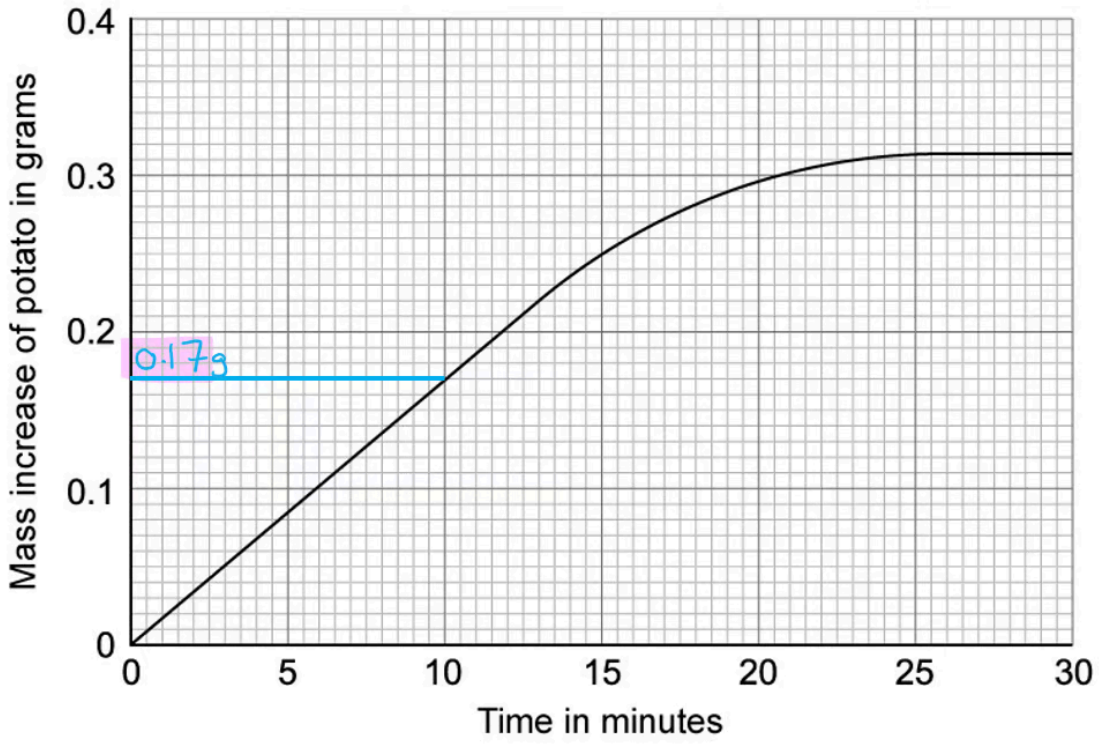
Answer

The percentage increase at 10 minutes can be calculated as follows:

- (0.17 ÷ 2.3) x 100; [1 mark]
- 7.4 % (increase); [1 mark]

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[Total: 2 marks]



After 10 minutes, mass increase = 0.17g

initial mass taken from question thread

% increase = (0.17 ÷ 2.3) x 100 [1 mark]

= 7.4% (increase) [1 mark]

(2 marks)

(e) The student repeated the investigation but with the beaker placed in a water bath at 30°C.

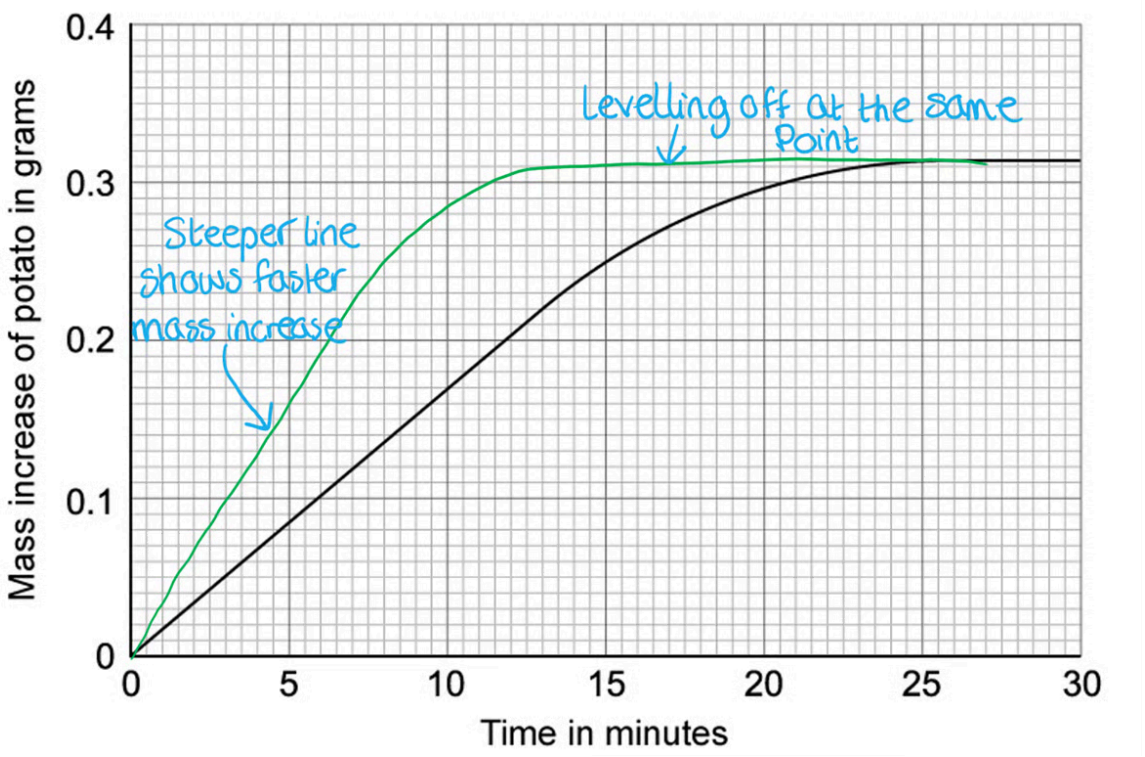
Draw a second line on the graph to show the trend expected from these results.

Answer

The line on the graph should look as follows:

- The mass of the potato would increase faster; [1 mark]
- The graph would level off at the same value of mass increase; [1 mark]

[Total: 2 marks]



(2 marks)

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(f) Explain your line drawn for part **(e)**

Answer

The trend drawn can be explained as follows:

- (The increase in mass occurs faster / rate of mass increase is faster because) a higher temperature means increased kinetic energy of particles / particles move more; [1 mark]
- Therefore the rate of osmosis is faster (into the potato); [1 mark]
- (The final mass levels off after the same mass increase) because the solute / water concentration gradient is the same in both investigations; [1 mark]
- So osmosis will continue to happen until the water concentration inside the potato is the same on the inside and the outside **OR** the same mass of water will move by osmosis into the potato until the water concentration inside the potato is the same on the inside and the outside; [1 mark]

[Total: 4 marks]

(4 marks)

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42 (a) Multiple sclerosis (MS) is a condition which affects the central nervous system caused by the immune system mistakenly attacking the brain and nerves. MS can lead to symptoms which flare up periodically, such as fatigue, vision problems, muscle spasms, mobility problems, difficulty in thinking, learning or planning, amongst others.

There are several different treatments for MS; two are considered here.

1. Stem cell treatments: Healthy cells found in the patients bone marrow can be used to rebuild the immune system. Must be used in combination with chemotherapy to remove the harmful immune cells.

2. Disease modifying therapies (DMT): Medicines that can reduce the number of relapses a patient suffers and reduce the symptoms of MS. An example of a DMT is a drug called Lemtrada.

Table 1 gives some extra information about these two treatments for MS.

Table 1

Treatment type	Side effects	Cost	Success rate
Stem Cells	Risk of developing infections, cancer or fertility issues Chemotherapy may lead to fatigue and appetite loss, hair loss 1 in 330 people may die	$550 000 per treatment	94% success rate (condition stabilised) over 4 years Can provide a cure for MS
Disease modifying therapies (e.g. Lemtrada)	Headaches, rashes, nausea, under or overactive thyroid, changes in blood pressure or kidney problems	$340 000 for 5 years of treatment	82% success rate (condition stabilised) over 4 years. Does not provide a cure.

Evaluate the use of stem cells and disease modifying therapies to treat multiple sclerosis.

Answer

The two treatments can be evaluated as follows:

Indicative content

Pros for stem cells

- Potentially provides a cure
- Has a higher success rate / 94% success rate
- Is more expensive but only needs to be carried out once
- Healthy cells from patients bone marrow so no risk of rejection
- Fewer side effects (compared to DMT)

Cons for stem cells

- No data to show success rate longer than 4 years
- A risk of death (although this is low at 1 in 330)
- Chemotherapy is also required
- Chemotherapy has associated side effects
- Side effects may also be terminal e.g. cancer
- Procedures may be difficult or painful and requires access to hospitals
- Cost is more expensive than DMT

Pros for disease modifying therapies

- No risk of death
- Symptoms are reduced / relapses reduced
- A high success rate for a cheaper cost

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- No need for chemotherapy
- Can be administered by the patient / no requirement for hospital treatment

Cons for disease modifying therapies

- Treatment is ongoing (and therefore expensive)
- It doesn't provide a cure, symptoms are just reduced
- Success rate is lower than stem cells
- No data about the success rate after 4 years

Level 3 [5–6 marks]:

- A comprehensive evaluation which communicates ideas clearly and coherently using a range of information from the Figure provided.
- Spelling, punctuation and grammar are used with a high level of accuracy

Level 2 [3–4 marks]:

- A simple evaluation which communicates ideas showing some evidence of clarity and organisation and uses information from the Figure provided.
- Spelling, punctuation and grammar are used with some accuracy

Level 1 [1–2 marks]:

- A basic comparison of the two methods with just one simple statement using the information from the Figure provided.
- Spelling, punctuation and grammar are used with limited accuracy

[Total: 6 marks]

This is a 'level of response' answer. You should decide which level your answer fits against and then consider whether it meets that level securely to achieve the higher mark, or partially to achieve the lower mark.

Examples of correct points in relation to the question are given in the mark scheme, but it is important to note that each point does not equate to a mark.

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There are many points of evaluation here, you may have covered on which is not included in the indicative content. In this situation, use your judgement as to whether your answer should be awarded the mark within the levelled criteria.

(6 marks)

(b) Heart attacks may be caused if a coronary artery becomes blocked and the flow of oxygenated blood is restricted. This can result in damage to the heart muscle tissue.

Suggest how embryonic cells could be used to treat a patient after a heart attack.

Answer

Cells from an embryo could be used to treat a patient after a heart attack in the following way:

- Stem cells removed from an early embryo; [1 mark]
- Could be stimulated to develop into heart muscle tissue; [1 mark]
- These stem cells could then be transferred / implanted into the patient; [1 mark]
- To repair the damaged tissues / cells; [1 mark]

[Total: 4 marks]

(4 marks)

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(c) A patient who has suffered a heart attack was offered treatment using stem cells from an embryo, but refused due to the use of embryonic stem cells.

Suggest a reason for this decision.

Answer

The patient's choice can be evaluated as follows:

Any **two** from the following:

- They objected on moral / ethical / religious grounds; [1 mark]
- They believe to the embryo's right to live; [1 mark]
- They prefer to consider alternative treatment; [1 mark]

[Total: 2 marks]

(2 marks)

(d) The patient mentioned in part **(c)** was offered treatment using their own healthy stem cells removed from their heart tissue.

Evaluate the decision to use these stem cells as an alternative to embryonic stem cells in the treatment of the damaged heart tissue.

Answer

The decision can be evaluated as follows:

Reasons for the use of adult stem cells:

A maximum of **two** from the following:

- No risk of rejection; [1 mark]
- Stem cells could provide a cure; [1 mark]
- The patient can consent to the donation of the stem cells; [1 mark]

Reasons against the use of adult stem cells:

A maximum of **two** from the following:

- Stem cells are partially differentiated so may be more difficult to stimulate them to develop as needed **OR** adult stem cells may have a lower success rate; [1 mark]
- These stem cells may be difficult to access / cause pain when they are being removed **OR** the patient may be too poorly to have their stem cells harvested; [1 mark]

[Total: 4 marks]

Remember that evaluate questions require a consideration of both the arguments for and the arguments against a particular idea in order to obtain all the marks.

(4 marks)

43 (a) Higher Tier Only

Complete **Table 1** to show the correct size conversions. Record your answers as ordinary numbers.

Table 1

Measurement	Unit	Conversion	Unit
15.3	cm		µm
3×10^{-6}	mm		µm
0.25	m		µm

Answer

The table should be completed as follows:

Measurement	Unit	Conversion	Unit
15.3	cm	153 000	µm
3×10^{-6}	mm	0.003	µm
0.25	m	250 000	µm

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[Total: 3 marks]

	Measurement	Unit	Conversion	Unit
1	15.3	cm	153 000	µm
2	3×10^{-6}	mm	0.003	µm
3	0.25	m	250 000	µm

1. 15·3 cm = 153mm × 1000 → 1000 µm in mm
   or 15·3 × 10 000 = 153000 [1 mark]
   ↓
   10mm in 1cm

2. 3×10^{-6} mm = 0·000 0003mm × 1000
   = 0·003µm [1 mark]

3. 0·25m = 0·25 × 1000 000 → 1000 000 µm in 1m.
   = 250 000µm [1 mark]

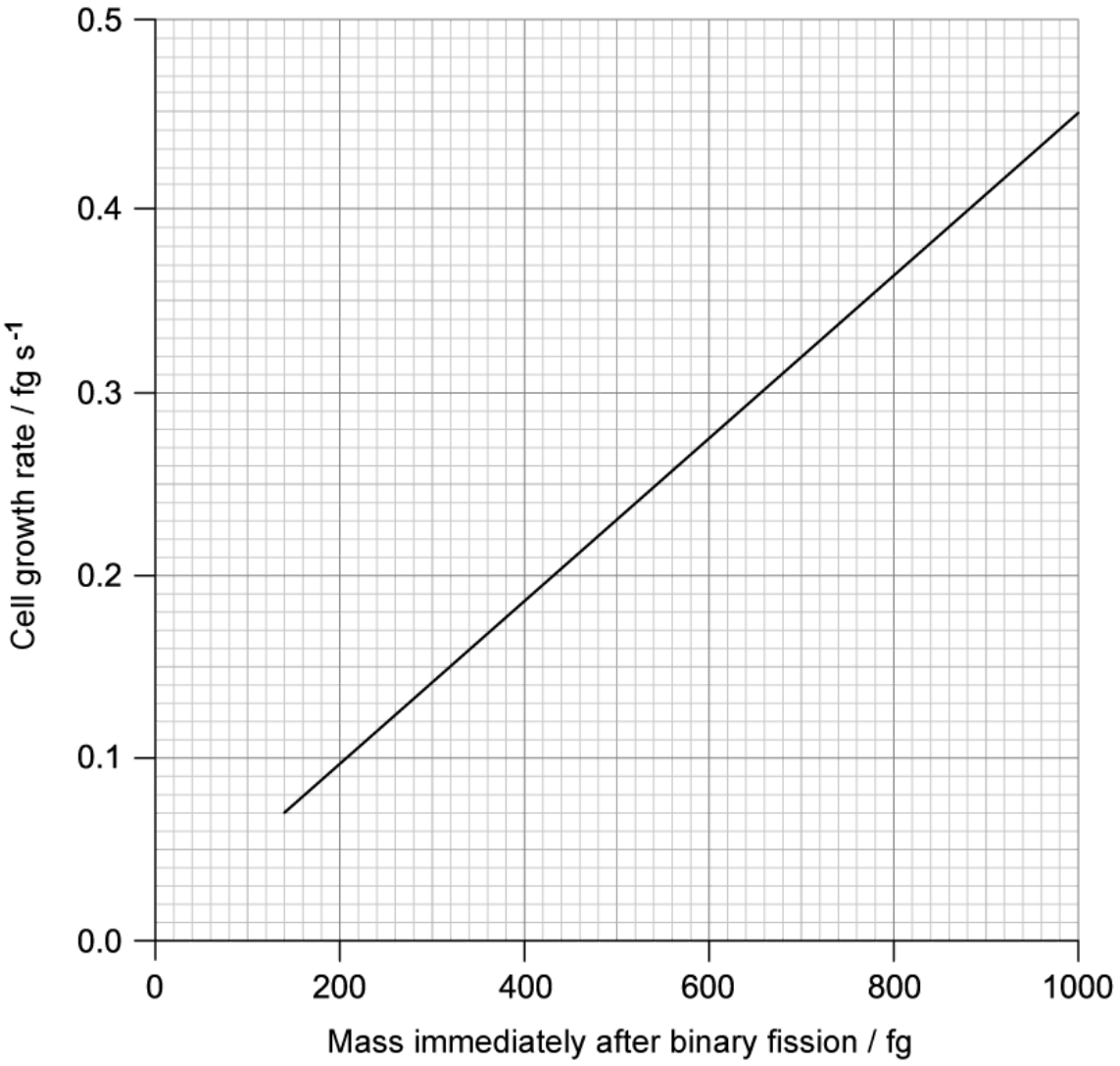
(3 marks)

(b) Higher Tier Only

The mass of bacterial cells was measured in femtograms (fg).

1 femtogram = 1×10^{-15}g

Figure 5



Calculate the mass of bacteria, in grams, immediately after binary fission when the cell growth rate was 0.1 fg s^{-1}.

Give your answer in standard form.

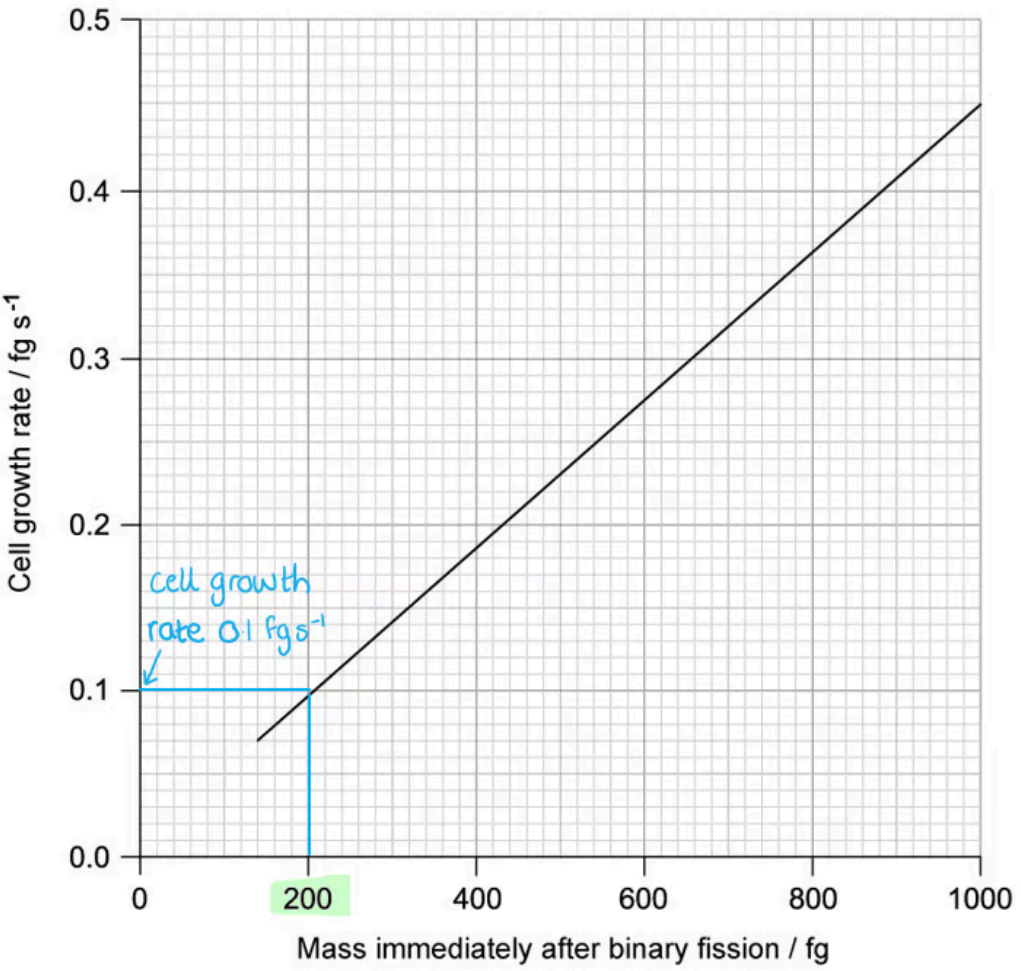
Answer

The number of grams immediately after binary fission can be calculated as follows:

- 200 x (1×10^{-15}); [1 mark]
- 2×10^{-13}; [1 mark]

[Total: 2 marks]

Any number between 2.0×10^{-13} and 2.2×10^{-13} is permitted for the mark.



Mass = 200 × (1×10^{-15}) [1 mark]

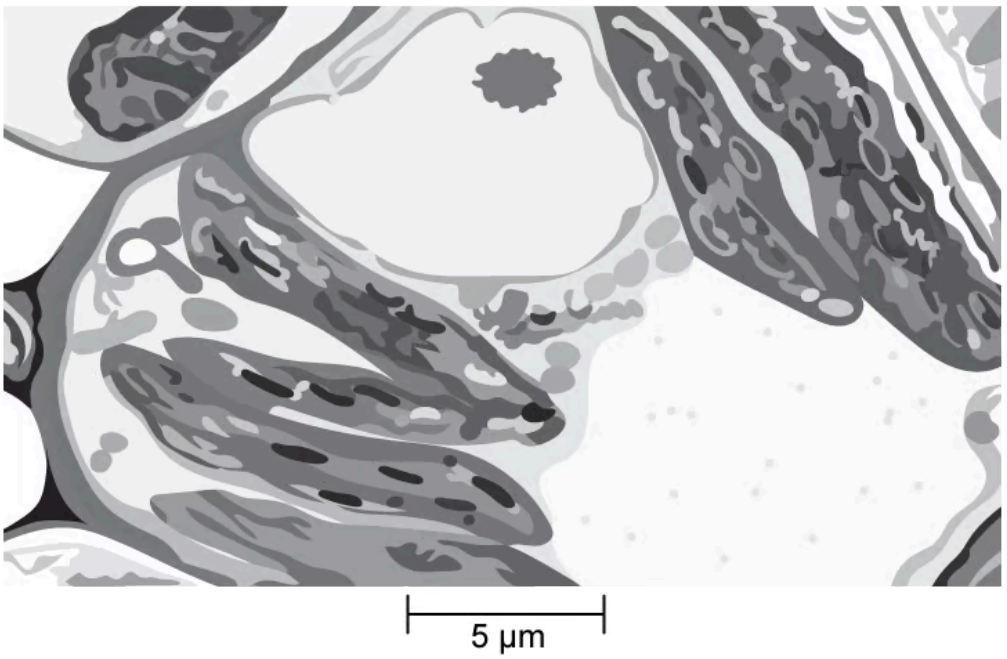
= 2×10^{-13} [1 mark]

From the question thread
1 femtogram = 1×10^{-15} g

(2 marks)

(c) The electron micrograph shows some cellular structure in a leaf. A student uses their ruler to measure the scale bar, which they find to be 1.5 cm.

Figure 6



Calculate the magnification of the image.

Answer

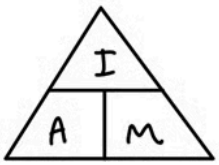
The magnification can be calculated as follows:

- 1.5 cm = 15 000 µm; [1 mark]
- 15 000 ÷ 5; [1 mark]
- 3000 x; [1 mark]

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[Total:3 marks]

Step 1: Recall formula triangle



I = image size
A = actual size
M = magnification

Step 2: Ensure units for I and A are the same

← Convert all values to smallest unit given

1.5 × 10,000 = 15,000 μm

↑ There are 10,000 micrometres in a centimetre

Step 3: Calculate magnification

M = I ÷ A
M = 15,000 μm ÷ 5 μm
M = 3,000

(3 marks)

44 (a) Glucose is a soluble sugar molecule. It can be stored in cells once it has been converted to an insoluble form.

In plants, glucose is stored as starch grains and in animals, glucose is stored as glycogen.

Cells in the roots of a clover plant contain the following specialised adaptations

- Large quantities of mitochondria
- Many stored starch grains
- Nodules on the roots which contain bacteria

Explain how these adaptations assist with the absorption of mineral ions and water from the soil into to cells of the clover root.

Answer

The adaptations help the absorption of mineral ions and water in the following way

Mitochondria

- Mitochondria are the site of respiration
- To release energy from respiration
- For active transport of mineral ions from the soil
- Against the concentration gradient **OR** from a low solute concentration to a high solute concentration

Stored starch grains

- Starch grains provide glucose for respiration / as a reactant for respiration
- To release energy for active transport of mineral ions from the soil
- Against the concentration gradient **OR** from a low solute concentration to a high solute concentration

Nodules containing bacteria

- Assist with decomposition

- Break down (organic) compounds / dead plant and animal material into usable mineral ions
- More ions are available to be taken up into the roots

Water

- Increased active uptake of minerals into the root
- Decreases the water concentration in the root hair cell
- Water moves by osmosis from the soil into the root hair cell
- Down a concentration gradient

Level 3 [5–6 marks]:

- A detailed explanation of how each adaptation supports uptake of mineral ions and water
- The answer communicates ideas clearly and coherently using a range of scientific terminology accurately
- Spelling, punctuation and grammar are used with a high level of accuracy

Level 2 [3–4 marks]:

- A simple explanation of how each of the adaptations may allow absorption of mineral ions **OR** how one of the adaptations may allow absorption of mineral ions **and** water
- The answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately
- Spelling, punctuation and grammar are used with some accuracy

Level 1 [1–2 marks]:

- One correct statement about the absorption of either mineral ions **OR** water into the root
- The answer communicates ideas using simple language and uses limited scientific terminology

- Spelling, punctuation and grammar are used with limited accuracy

[Total: 6 marks]

(6 marks)

(b) A student places an animal cell and a plant cell into distilled water and examines both under a microscope.

Explain the differences in observations that the student would have made of the animal cell and plant cell.

Answer

The student would have observed the following:

- The animal cell would burst / lyse; [1 mark]
- The plant cell would swell; [1 mark]

This is because...

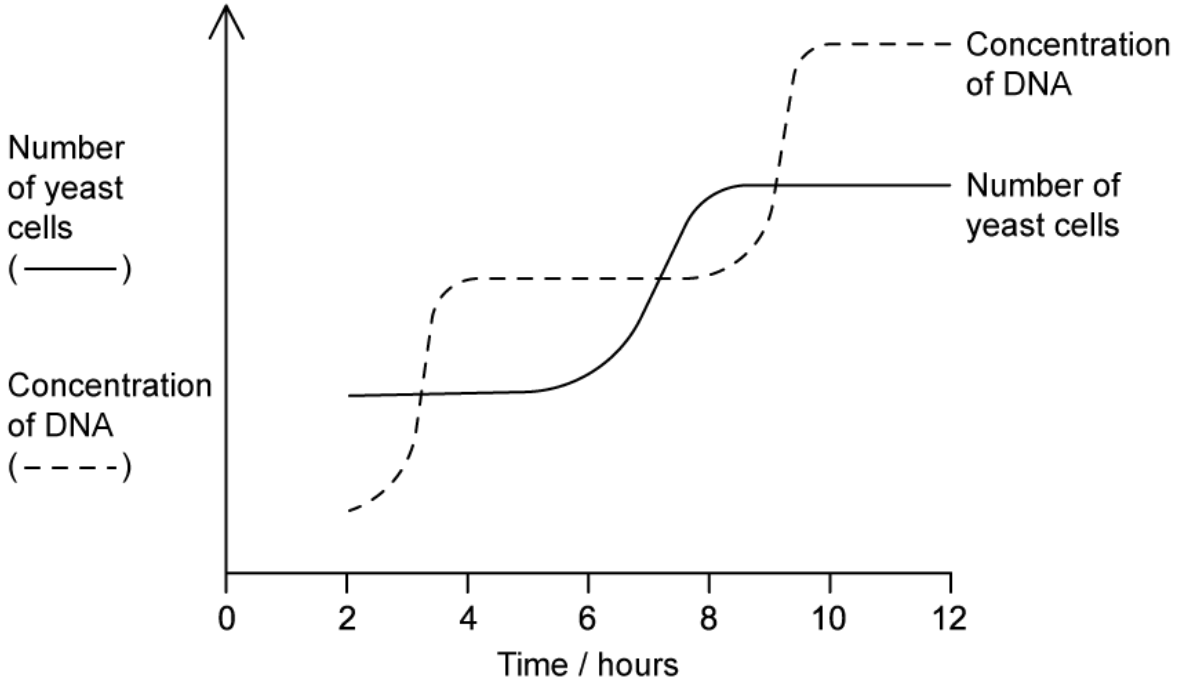
- Water moves into the cells by osmosis; [1 mark]
- The plant cell has a cell wall whereas the animal cell doesn't; [1 mark]

[Total: 4 marks]

(4 marks)

45 (a) Some scientists studied mitosis in yeast cells. **Figure 3** shows the concentration of DNA and the number of yeast cells over a 12 hour period.

Figure 3



Describe and explain the shape of the curve for the number of yeast cells between 2 and 8 hours.

Answer

The shape of the curve can be explained in the following way:

Any **four** from the following:

- Between 2 and 6 hours the number of (yeast) cells remains constant; [1 mark]
- Cells are in the growth and DNA replication stage of the cell cycle; [1 mark]
- This means that DNA increases but the number of cells remains the same; [1 mark]
- Between 6 and 8 hours the number of (yeast) cells increases; [1 mark]
- Cells are going through mitosis; [1 mark]

- This means that the number of cells increases **OR** each cell divides into 2 new daughter cells; [1 mark]

[Total: 4 marks]

(4 marks)

(b) One cell cycle in **Figure 3** from part **(a)** takes 6 hours.

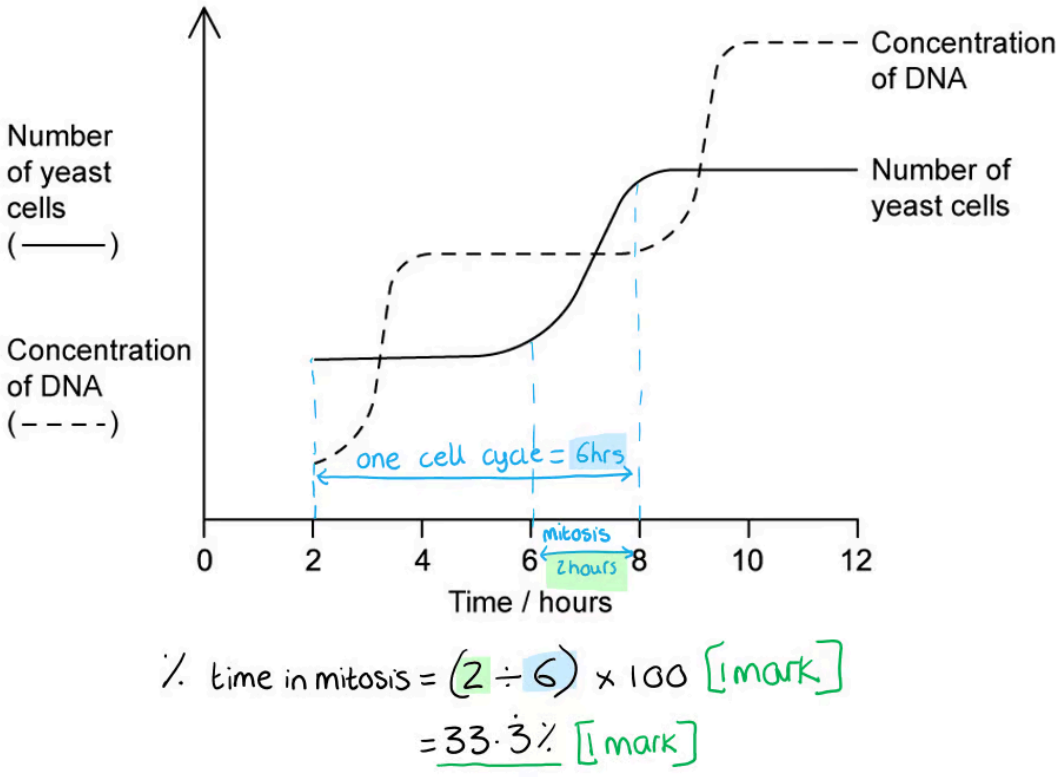
Calculate the percentage of time taken by mitosis in one cell cycle.

Answer

The percentage of time taken in mitosis is:

- 2 ÷ 6 x 100; [1 mark]
- 33% / 33.3% / 33.33%; [1 mark]

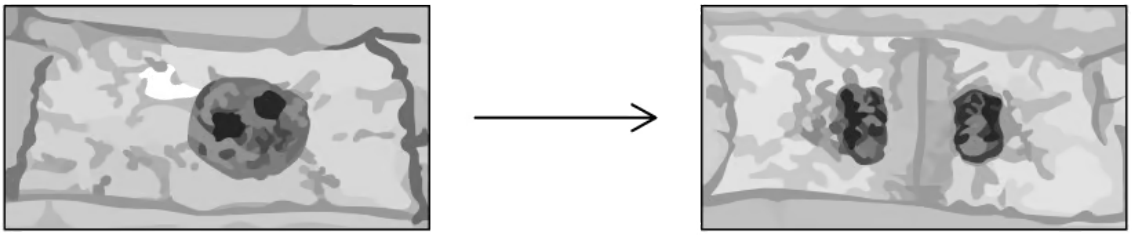
[Total: 2 marks]



(2 marks)

(c) **Figure 4** shows cells in two stages of division.

Figure 4



Describe the changes that occur in the cell between image **X** and image **Y**.

Answer

The changes that occur between image X and image Y are as follows:

Any **four** of the following:

- DNA and organelles / named organelles / mitochondria / ribosomes are replicated; [1 mark]
- Cell grows in size; [1 mark]
- Chromosomes become visible / condense; [1 mark]
- Chromosomes are pulled to either end of the cell; [1 mark]
- A nucleus forms around the chromosomes; [1 mark]
- Cytoplasm splits / cell membrane forms around each cell / cytokinesis occurs; [1 mark]

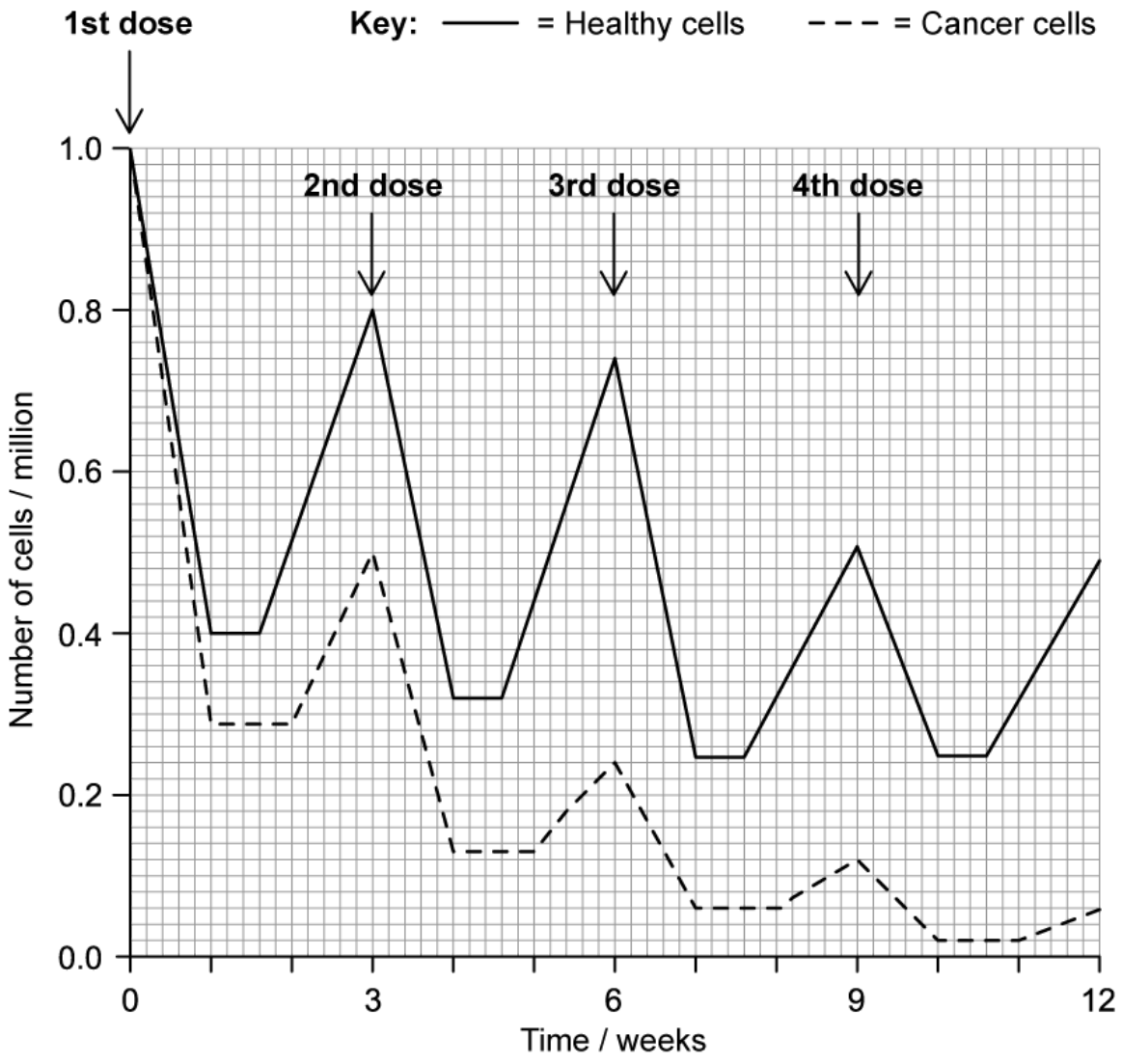
[Total: 4 marks]

(4 marks)

46 (a) Cancer cells originate from healthy cells where the cell cycle is not being controlled normally. This can lead to uncontrolled cell division and the formation of tumours. Drugs used to destroy cancer cells also cause damage to healthy cells, although are more effective against the cancer cells.

Figure 5 shows the effect of a chemotherapy cancer treatment on the number of healthy and cancerous cells over a 12-week time period.

Figure 5



Calculate how many more cancer cells than healthy cells were destroyed after the first treatment.

Give your answer in standard form.

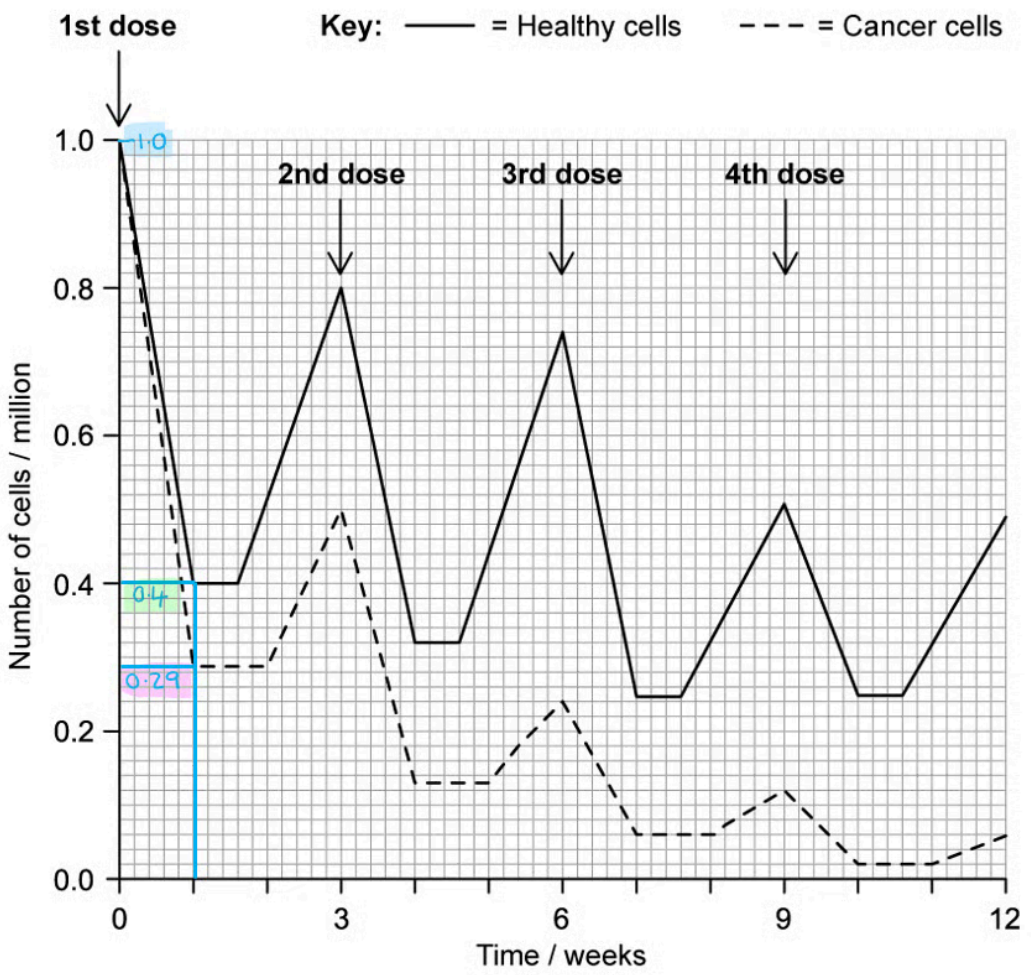
Answer

The number of cancer cells killed compared to healthy cells can be calculated as follows:

- 1 - 0.29 = 0.71 million cancer cells killed; [1 mark]
- 1 - 0.4 = 0.6 million healthy cells killed; [1 mark]
- 0.71 - 0.6 = 0.11 million or 110 000; [1 mark]
- 1.1×10^5; [1 mark]

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[Total: 4 marks]



(4 marks)

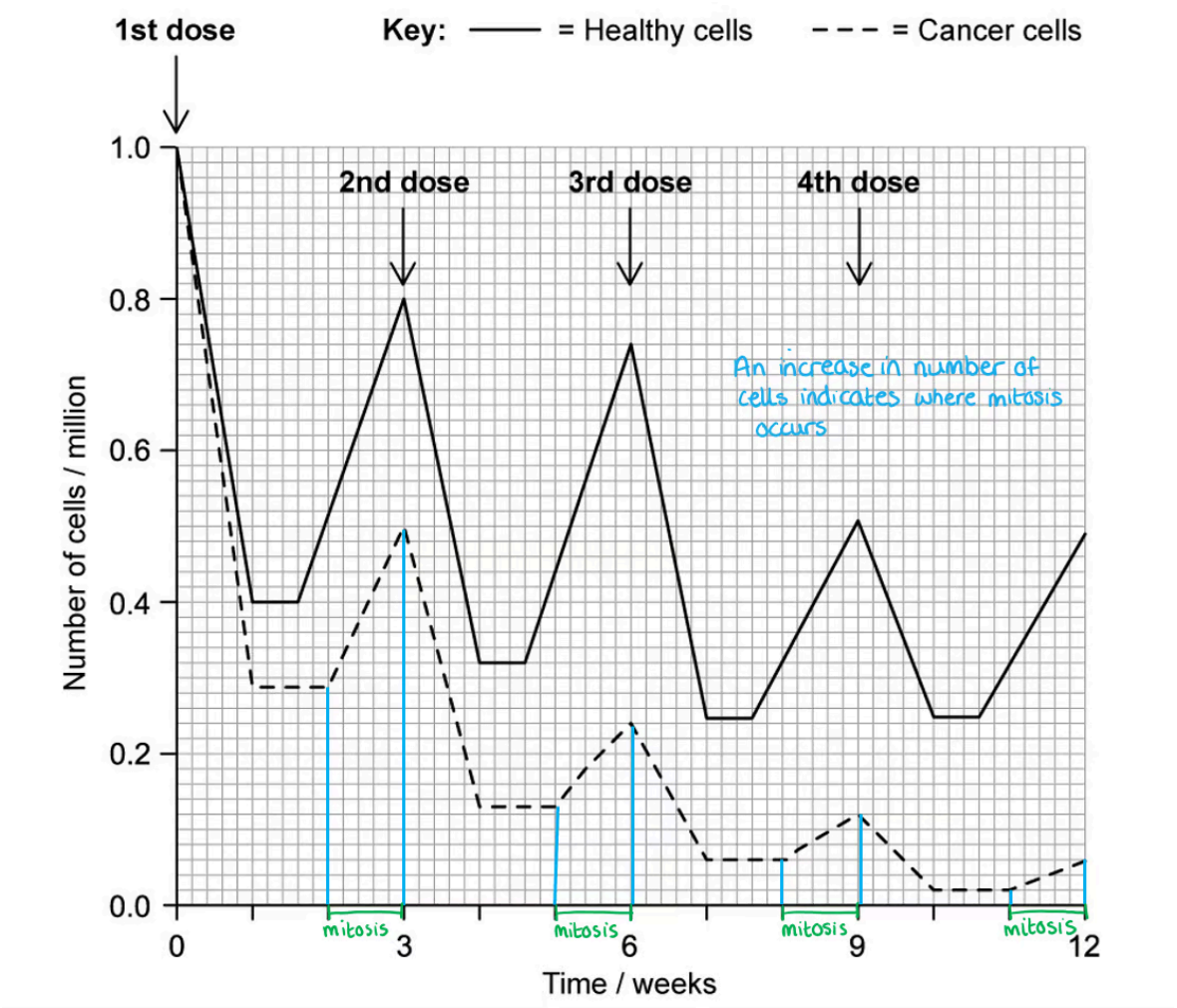
(b) With reference to the data in **Figure 5,** identify a time period in which the cancer cells were dividing by mitosis.

Answer

The cancer cells were dividing by mitosis...

- Between days 2 and 3 / days 5 and 6 / days 8 and 9 / days 11 and 12; [1 mark]

[Total: 1 mark]



(1 mark)

(c) Another treatment for cancer patients is to receive a stem cell transplant from a donor. The process includes the following steps:

1. The patient is given a high dose of chemotherapy
2. Stem cells are taken from the bone marrow of a closely-related individual (with similar tissue type and genotype)
3. Stem cells are introduced into the patient
4. The patient is monitored for after-effects of the transplant

With reference to the data in **Figure 5** and the information provided here, suggest why a high dose of chemotherapy might be necessary.

Answer

A high dose of chemotherapy may be necessary because..

- Chemotherapy kills cancer cells (more than healthy cells) **OR** to remove all cancer cells; [1 mark]
- Healthy stem cells can then divide to produce more healthy cells / replace cancer cells; [1 mark]

[Total: 2 marks]

This is a suggest question, as such, you are not expected to know the reason for requiring chemotherapy. However, you have been given information in the question and are expected to use your own reasoning to come up with a logical answer.

(2 marks)

(d) With reference to the process described in part **(c),** suggest an issue that might be associated with receiving a stem cell transplant which requires careful monitoring of the patient after the procedure (stage 4).

Answer

The patient should be carefully monitored because...

- Their immune system may reject the transplant / rejection of the transplant might occur; [1 mark]

[Total: 1 mark]

(1 mark)

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Related to the following questions:

1. Organisms must transport substances to and from the exte...
2. Complete the sentence using the correct words from the b...
3. Figure 1 shows an image of a plant cell. Identify structures ...
4. Figure 3 shows some muscle cells. Identify the function of a...
5. Complete each row of Table 1 with a tick (✓) or a cross (✕)...
6. State why mitosis is important in multicellular organisms.
7. Figure 5 shows liver cell which measures 60 mm. Calculate t...
8. Describe how the root hair cell in Figure 3 is adapted for ab...
9. Give the definition of a stem cell.
10. Pre-cut potato chips can be stored in salt solution before ...
11. Below is a list of statements regarding use of stem cells fr...
12. Describe the method used to prepare an onion cell speci...
13. Figure 5 shows the cycle of a cell which lasts 10 hours in to...
14. Figure 7 shows two cells. Suggest which cell (X or Y) is bett...
16. Figure 1 below is a photomicrograph of cells in the root of ...
17. Sugar molecules are moved from the gut to the blood by a...
18. Both muscle and sperm cells are specialised animal cells. ...
19. Figure 1 shows two plant cells. Which of the plant cells ab...
20. Cells can be visualised with a light microscope. Figure 1 sh...
21. Read the information below about stem cells: It may be po...
22. Figure 2 shows a bacterial cell and an animal cell as seen i...
23. How many pairs of chromosomes are there in a body cell ...
24. All living organisms exchange substances with the environ...
25. After a baby is born, it is possible to use the umbilical cord...
26. Animal and plant cells have some structural features in co...
27. A student decided to investigate the effect of different salt...
28. Figure 4 below shows a plant cell. Name each labelled part...
29. A group of scientists investigated the rates of absorption o...
30. The nucleus of a typical onion cell contains 16 chromosom...
32. Embryonic stem cells have the potential to be used to trea...
33. The statements in Table 1 refer to processes occurring in ...
34. Particulate matter (PM) refers to the small particles in air ...

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35. Compare and contrast the structures of eukaryotic and pr...
36. Figure 1 shows the quantity of DNA found in the nucleus o...
37. Figure 2 shows three different cells. Calculate the size rati...
38. Monoglycerides are molecules made up of glycerol and on...
39. When a cell divides by mitosis, it produces identical daugh...
40. Describe and explain four aseptic techniques used to prep...
41. A student wanted to investigate the transport of water acr...
42. Multiple sclerosis (MS) is a condition which affects the cen...
43. Complete Table 1 to show the correct size conversions. Re...
44. Glucose is a soluble sugar molecule. It can be stored in cel...
45. Some scientists studied mitosis in yeast cells. Figure 3 sho...
46. Cancer cells originate from healthy cells where the cell cyc...

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Related to the following questions:

12. Describe the method used to prepare an onion cell speci...
15. Microorganisms can be cultured in the laboratory to inves...
31. A student is instructed to prepare an uncontaminated cult...
40. Describe and explain four aseptic techniques used to prep...

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Related to the following questions:

15. Microorganisms can be cultured in the laboratory to inves...
40. Describe and explain four aseptic techniques used to prep...

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