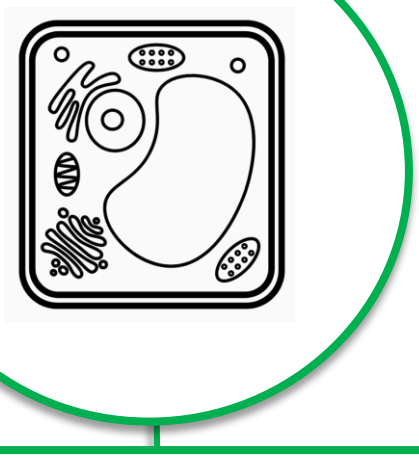
BIOLOGY UNIT 1 FOUNDATION – CELLS



<u>In this topic, you will learn</u> how structural differences between types of cells enables them to perform specific functions within the organism. You will learn how cells must divide by mitosis producing two new identical cells, in order for an organism to grow. You will also learn how cells can grow into a range of different types of cells, which has led to the development of stem cell technology.

<u>This will build up on</u> the work you did in year 7, 8 and 9 on cells, tissues and organs.

<u>This will help you to</u> prepare for the work you will do in years 10 and 11 when you will learn about cells, differentiation and organisation of organisms.

Name:

Set:

Teacher:

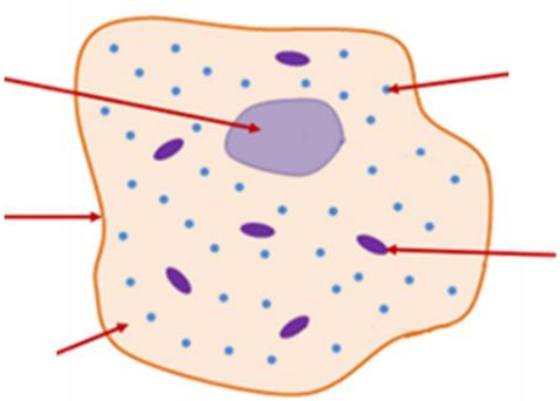
Target:

Date: _____

ACTIVATE KNOWLEDGE

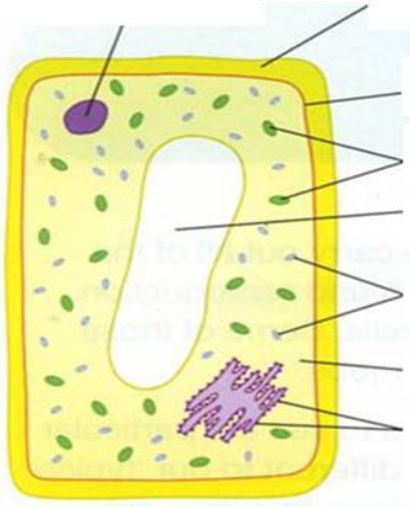
Animal Cell:

- Nucleus
- Cytoplasm
- Cell membrane
- Mitochondria
- Ribosome

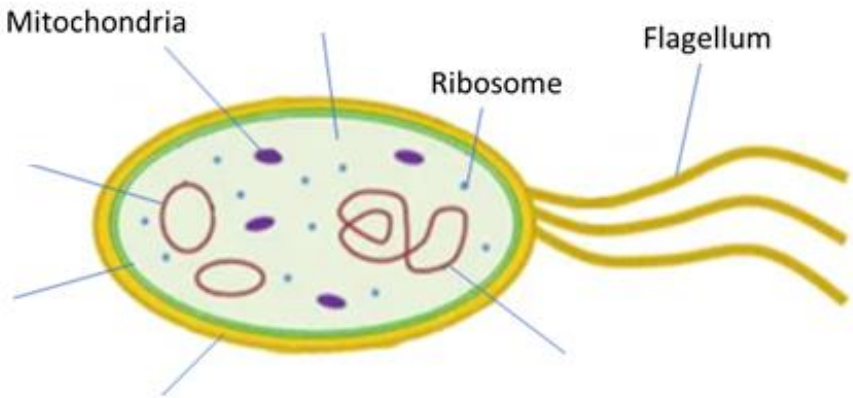


Plant cell

- Nucleus
- Cytoplasm
- Cell membrane
- Cell wall
- Vacuole
- Mitochondria
- Ribosome
- Chloroplast

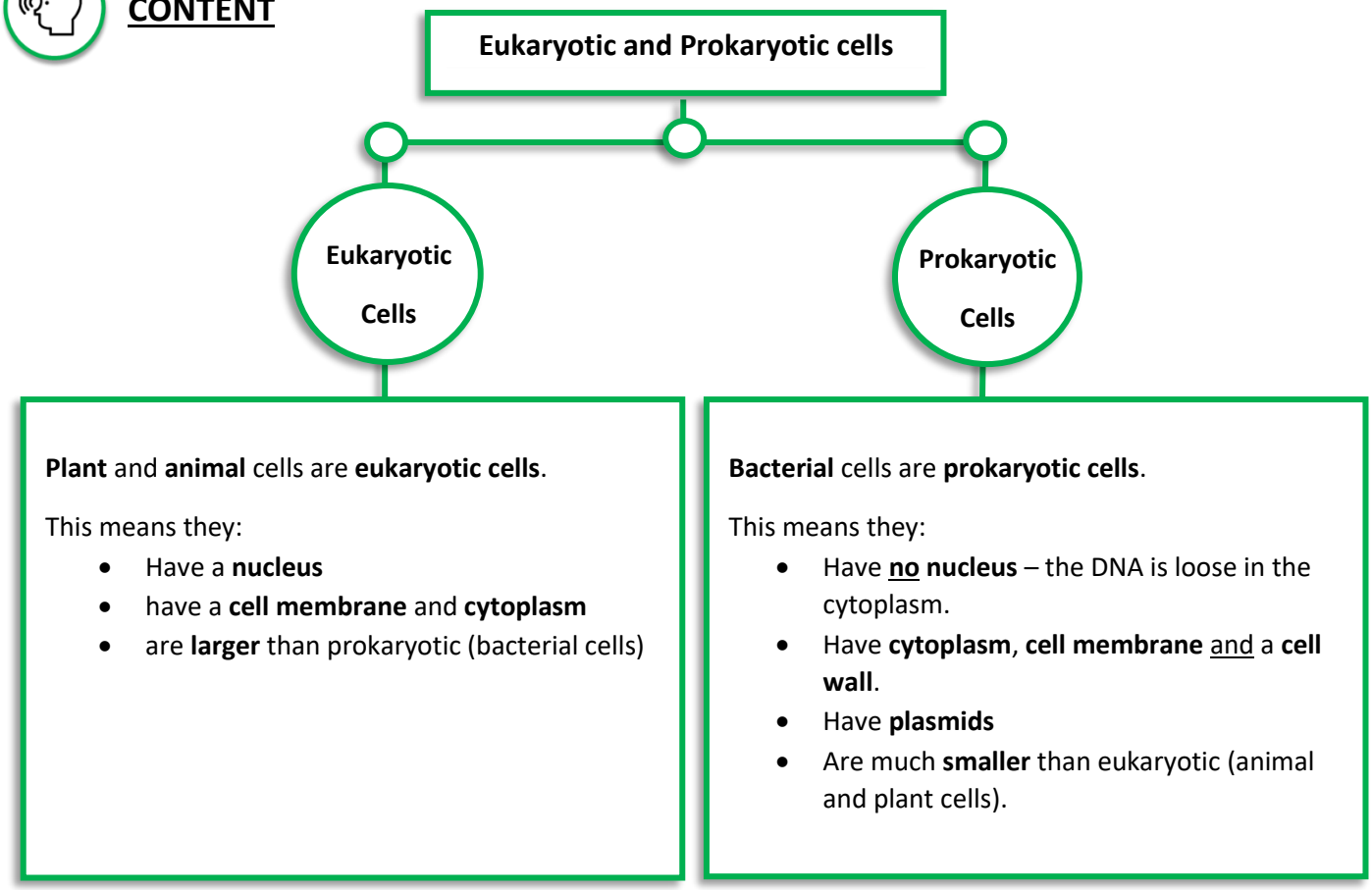


Bacterial cell



- Cytoplasm
- Cell membrane
- Cell wall
- Plasmid
- Loop of DNA

CONTENT



Cell structure and function

Complete the table to identify which cell structure carries out which function:

Cell structure	Function
	Where respiration takes place, and energy is released
	Contain chlorophyll to absorb light for photosynthesis
	Filled with cell sap, important for keeping the cells rigid to support the plant.
	Controls all the cell activities. Contains genetic information.
	Made of cellulose that strengthens the cell and provides support
	Where protein synthesis takes place. All proteins needed in the cell are made here from amino acids.
	Where most chemical reactions take place
	Controls what enters and leaves the cell.

Specialised cells

A **specialised cell** is one that performs a specific function.

Most cells in an organism are specialised.

A cell's structure (e.g. its shape and the parts it contains) helps it to carry out its function — so depending on what job it does, a specialised cell can look very different to general animal and plant cells.

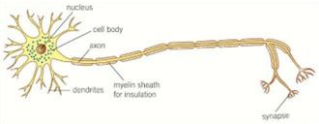
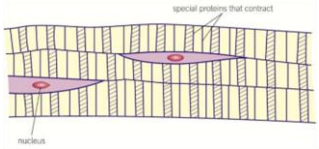
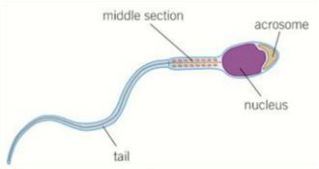
Differentiation is the process by which a cell becomes …… for its job.

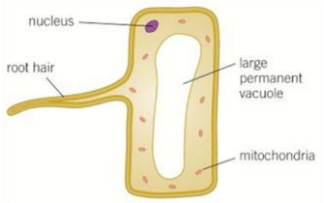
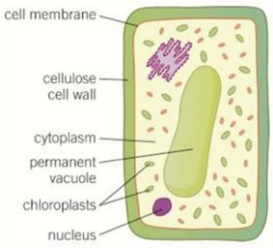
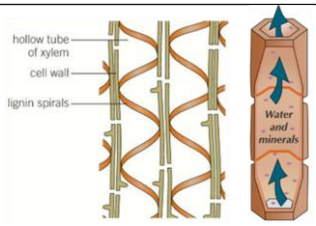
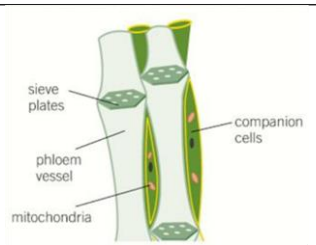
In most animal cells, the ability to differentiate is lost at an …….. …… of development.

But many types of plant cells have the ability to differentiate …… their life.

In animal embryos, cells divide to produce new cell types, but in mature animals, cells divide mainly to replace …… cells.

As a cell differentiates it acquires different sub-cellular …… to enable it to carry out a particular …… .

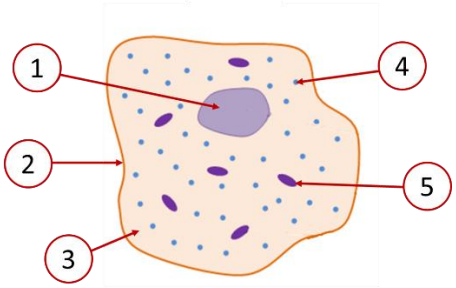
Name of Cell	Diagram	Job of the Cell	Adaptations (what features does it have to help it do its job)
Nerve Cell (Animal Cell)		Carry electrical impulses around the body.	Lots of dendrites – to make connections to other nerve cells. An axon – carries the nerve impulse and can be up to 25m long! The nerve endings (synapses) are adapted to pass the impulses to another cell or between a nerve cell and a muscle using chemical transmitters.
Muscle Cell (Animal Cell)		Specialised to contract and relax.	**<u>Many</u> mitochondria** to transfer the energy needed. Can **store glycogen** that can be broken down for use in respiration by mitochondria. Special protein that slide over each other making the fibres contract.
Sperm Cell (Animal Cell)		Contain genetic information	**Long tail** – to help move the sperm through water or the female reproductive system to the egg. Middle section full of **mitochondria**, to release the energy needed for the tail to work. **Acrosome** – stores digestive **enzymes** to penetrate the egg. Large nucleus – contains the genetic information.

Name of Cell	Diagram	Job of the Cell	Adaptations (what features does it have to help it do its job)
Root Hair Cell (Plant Cell)		Found in the roots of plants, they absorb water and minerals	**Large surface area** available for water to move into the cell. Large permanent vacuole that speeds up the movement of water by osmosis from the soil across the root hair cell. **<u>Many</u> mitochondria** to release the energy needed for active transport of mineral ions into the root hair cells.
Palisade Cell (Plant Cell)		Carry out photosynthesis	Many **chloroplasts** which contain **chlorophyll** to trap the light needed for photosynthesis. Usually positioned in layers in leaves and outer layers of stems to absorb as much light as possible. Large permanent vacuole – helps to keep the cell rigid Cellulose cell wall – to provide structure.
Xylem Cell (Plant Cell)		Transports water and minerals ions **up** the plant from the roots. It is also important in supporting the plant.	A chemical called **lignin** builds up in spirals in the cell walls and the cells die forming long **hollow tubes**. The spirals and rings of lignin in the xylem make them very strong and help them withstand the pressure of water moving up the plant.
Phloem Cell (Plant Cell)		Transporting food (glucose) made in photosynthesis around the plant. They form tubes	Special sieve plates allow water carrying dissolved food to move freely up and down the tubes to where it is needed. Companion cells help to keep them alive, since most of their internal structures are lost. The mitochondria of the companion cells transfer the energy needed to move food up and down the plant.

Cells, Tissues and Organs

Date: _____

RETRIEVAL ACTIVITY

	Question	Answer	Mark
1	What is label 1? 		
2	What is label 2?		
3	What is label 4?		
4	What is label 5?		
5	What type of cell are animal and plant cells?		
6	What type of cell is a bacterial cell?		
7	What is the function of ribosomes?		
8	What is the function of mitochondria?		
9	What controls what enters and leaves a cell?		
10	Which organelle is the site of photosynthesis?		
		Score:	**/10**

ACTIVATE KNOWLEDGE

What structure does a plant cell have but an animal cell does not have?

In plants, what are shoots and roots examples of?

☐ Organs ☐ Organ systems ☐ Tissues

In plants, what are leaves examples of?

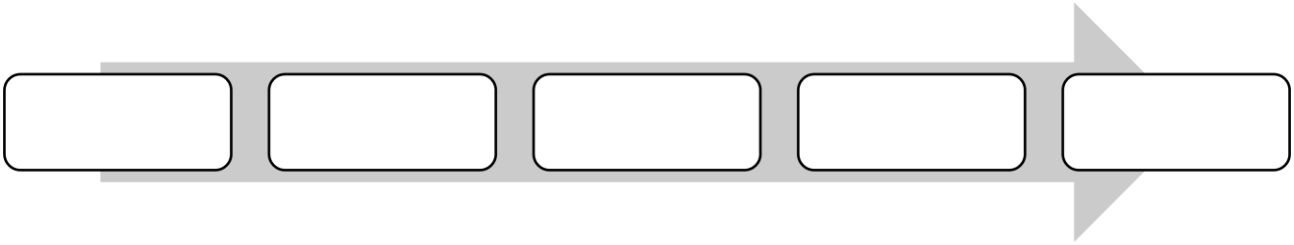
☐ Organs ☐ Organ systems ☐ Tissues

CONTENT

Cells, Tissues and Organs

How are cells, tissues and organs organised?

Using the words below complete the flow chart to illustrate organisation:



Organism; tissue; cell; organ; organ system

Tissues

Tissue	Description
Muscle tissue	Muscle tissue can contract and relax to bring about movement.
Glandular tissue	Glandular tissue release (secrete) substances such as enzymes and hormones.
Epithelial tissue	Epithelial tissue covers the outside of your body, as well as your internal organs, or acting as a lining.

Animals such as humans are …….. . Their cells do not work alone.

Cells are organised together as a …… .

A tissue is a group of cells with a similar structure and function, working together.

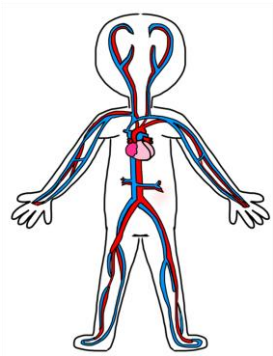
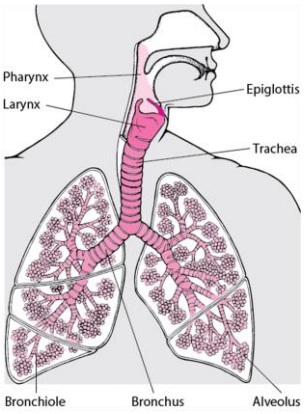
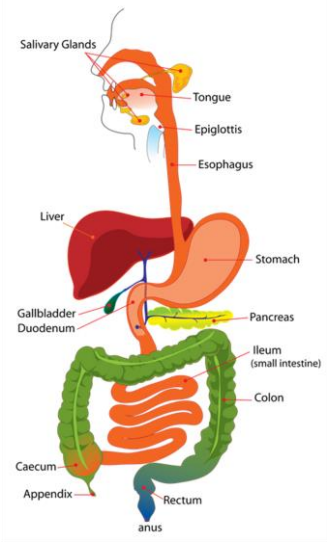
Tissues are grouped together to form …….. .

Organs are usually made of several different types of …….. .

The tissues of an organ work together to perform one major task.

Organ systems

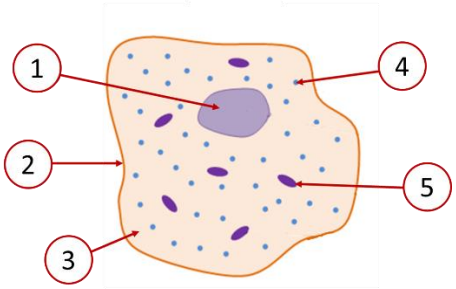
Organ systems are a group of organs that work together to perform a major function.

Organ system	What is is made up of:	Tissues it contains
Circulatory system 	Heart, blood vessels – arteries, veins, capillaries	Muscular tissue in the heart causes it to contract and relax and constantly keep pumping the blood around the body; and in the arteries it allows the blood to be pumped under high pressure. Epithelial tissue – provides a covering.
Respiratory system 	Lungs, trachea, bronchi, alveoli, diaphragm, ribs, intercostal muscles.	Muscle tissue – the diaphragm is a sheet of muscle involved in breathing along with the intercostal muscles between the ribs. Epithelial tissue – provides a covering. Glandular tissue – in the nose and trachea to produce mucus which traps bacteria and dirt.
Digestive system 	Mouth, oesophagus, stomach, pancreas, liver, small intestine, large intestine, rectum and anus	Muscular tissue – in the mouth (tongue) allows chewing; oesophagus squeezes the food down to the stomach by peristalsis; stomach to mix and churn the food with digestive juices; small intestine to move the food through. Epithelial tissue – provides a covering. Glandular tissue – in the mouth salivary glands secrete saliva and enzymes; the stomach secretes hydrochloric acid and enzymes; the pancreas and small intestine secrete enzymes to digest food; the liver secretes bile to neutralise the stomach acid and emulsify (break down) fats into smaller droplets.

Microscopes

Date: _____

RETRIEVAL ACTIVITY

	Question	Answer	Mark
1	What is label 1?  		
2	What is label 2?		
3	What is label 4?		
4	What is label 5?		
5	What type of cell are animal and plant cells?		
6	What type of cell is a bacterial cell?		
7	What is the function of ribosomes?		
8	What is the function of mitochondria?		
9	What controls what enters and leaves a cell?		
10	Which organelle is the site of photosynthesis?		
		Score:	**/10**

ACTIVATE KNOWLEDGE

Which image has the higher resolution?

CONTENT

Microscopes

Microscopes are used to study cells and their subcellular structures.

Microscopy techniques have improved over the years as technology and knowledge have improved.

Two common types of microscope are **the light microscope** and the **electron microscope**.

Label the microscope:

Magnification and resolving power

Resolution is the ability to distinguish between two separate points.

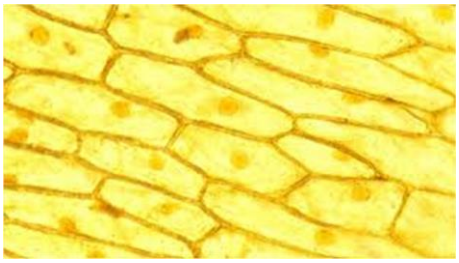
The **resolution** of the microscope affects how much detail it can show and how clear it is.

Magnification is the ability to make small objects seem larger – i.e. how big the image is.

Comparing light microscope and electron microscope

Light microscope

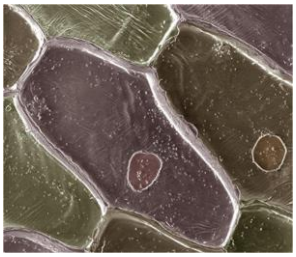
Onion cell under a light microscope



Modern **light microscopes** can magnify images about 1500 times and have a **low resolution**.

Electron microscope

Onion cell under an electron microscope



Electron microscopes can magnify images about two million times, so have a **higher magnification** than a light microscope as well as a **higher resolution**.

Magnification

The magnified image is produced by two lenses, the **eyepiece lens** and the **objective lens**.

Total magnification = magnification of eyepiece lens x magnification of objective lens

Using the equation above calculate the following:

1. If a microscope has an eyepiece with a magnification of x10 and an objective lens with a magnification of x40. What would the total magnification be?

   Total magnification = magnification of eyepiece x magnification of objective lens

   =

   =

2. If a microscope has an eyepiece with a magnification of x15 and an objective lens with a magnification of x20. What would the total magnification be?

   Total magnification = magnification of eyepiece x magnification of objective lens

   =

   =

CONTENT

Calculating the size of an object

You will need to calculate the size of objects under the microscope using the following formula:

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

The triangle helps you to rearrange the equation:

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

Image size = Actual size x Magnification

Worked example:

1. If the magnification is x40 and the image of the cell you are looking at measures 1mm, you can work out the actual diameter of the cell:

Size of the actual object = $\frac{\text{image size}}{\text{magnification}}$

= $\frac{1}{40}$

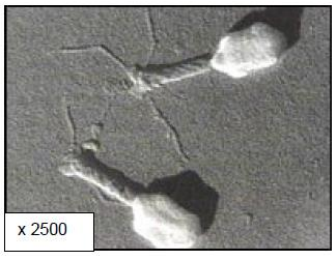
= 0.025mm

Or, converted to μm 0.025 x 1000 = 25 μm

Remember:

1mm = 1000μm

2. What is the actual size of the head of this virus?



a) Measure the length of the head (image size)

b) What is the magnification? *(it is usually given in the question or on the diagram)*

c) Rearrange the equation:

d) Convert mm into μm

Working out:

Length of head =

Magnification =

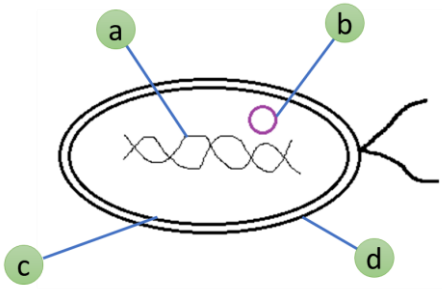
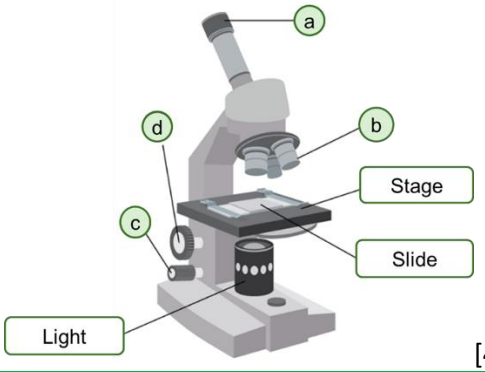
Equation and working out:

Actual size converted to μm =

Date: _____

Microscopes Required Practical

RETRIEVAL ACTIVITY

	Question	Answer	Mark
1	Complete the labels for the bacterial cell:  [4]	a = b = c = d =	
2	Complete the missing labels of the microscope:  [4]	a = b = c = d =	
3	What do we call the ability to distinguish between two points, that affects how clear the image is using a microscope? [1]		
4	Which type of microscope has the higher magnification and resolving power – a light microscope or an electron microscope? [1]		
		Score:	**/10**

ACTIVATE KNOWLEDGE

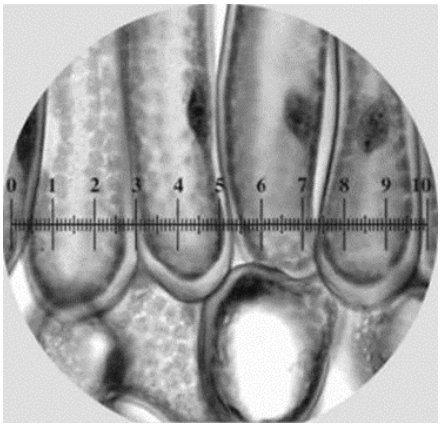
Number the following statements to explain how a microscope is used. The first one has been done for you.

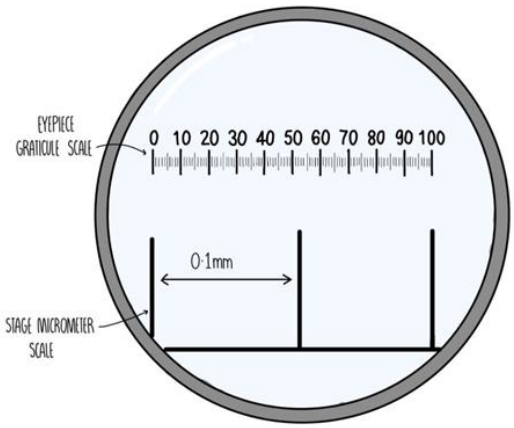
1	Place the slide on the stage and switch the light on to make sure that light is able to pass through the slide.
	While looking through the eyepiece lens turn the coarse focusing wheel until the image comes into focus
	Change the objective lens to a higher power lens of x10 to increase the magnification.
	Change to the lowest power objective lens (x4) so that you will have the widest field of view.
	Turn the fine focussing wheel to get a clearer image.
	Refocus the slide using the coarse and then the fine focussing wheel.

CONTENT

Using an eyepiece graticule to measure cells

The graticule in the eyepiece lens is a scale (it does not have units)



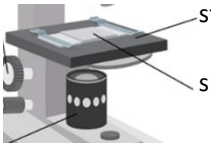


The graticule needs to be calibrated so that you can work out what each division is equal to for different magnifications.

Microscopes Required Practical

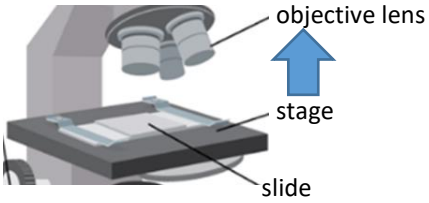
1. Place a thin layer of **epidermal tissue** onto a slide and add two drops of iodine solution. Cover with a cover slip.

2. Place the slide on the stage and switch the light on to make sure that light is able to pass through the slide.

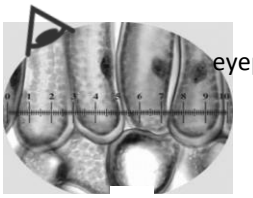


3. Change to the lowest power objective lens (x4) so that you will have the widest field of view.

4. Move the stage as close to the objective lens as possible – the slide must not touch the lens.



5. While looking through the eyepiece lens turn the **coarse focusing wheel** so the stage moves away from the lens.



coarse focusing wheel

6. Turn the **coarse focusing wheel** until the image comes into focus.

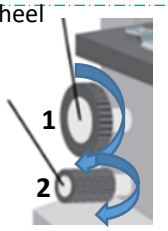
fine focusing wheel

7. Turn the **fine focussing wheel** to get a clearer image.

8. Change the objective lens to a higher power lens of x10 to increase the magnification.

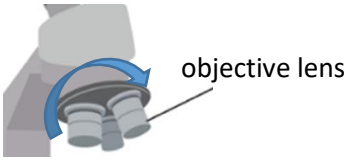
coarse focusing wheel

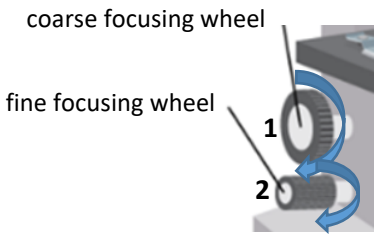
fine focusing wheel



9. **Refocus** the slide using the **coarse** and then the **fine** focussing wheel.

10. Change the objective lens to a higher power lens of x40 to increase the magnification even further.





11 — **Refocus** the slide using the **coarse** and then the **fine** focussing wheel.

Using the graticule to calculate the size of a single cell

12 — Rotate the nosepiece to use the medium power (x10) objective lens.

13 — Place a ruler onto the stage to see that the full length of the graticule measures 1mm = 1000µm
This is how you would calibrate the eyepiece graticule.

14 — Place the onion slide back onto the stage and see if you can use the graticule to measure the length of one of your onion cells.

Date: _____

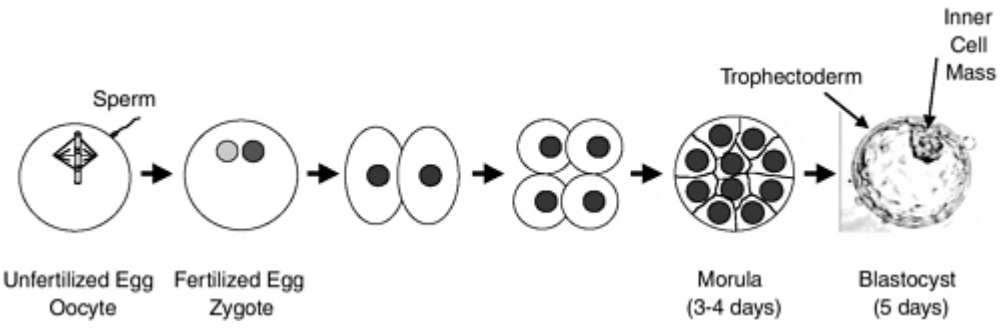
Stem Cells

RETRIEVAL ACTIVITY

	Question	Answer	Mark
1	Are animal and plant cells prokaryotic cells or eukaryotic cells?		
2	Are bacterial cell prokaryotic cells or eukaryotic cells?		
3	What is the function of ribosomes?		
4	What is the function of mitochondria?		
5	What controls what enters and leaves a cell?		
6	Which organelle is the site of photosynthesis?		
7	Which type of cell has plasmids – eukaryotic or prokaryotic?		
8	Prokaryotic cells have a nucleus – True or False?		
9	What is it called when a cell becomes specialised?		
10	What does a sperm cell have to enable it to move to the egg cell?		
		Score:	**/10**

ACTIVATE KNOWLEDGE

This diagram shows the development of an embryo from the sperm and egg.



How do these cells make all the cells of our body?

CONTENT

Cell Differentiation

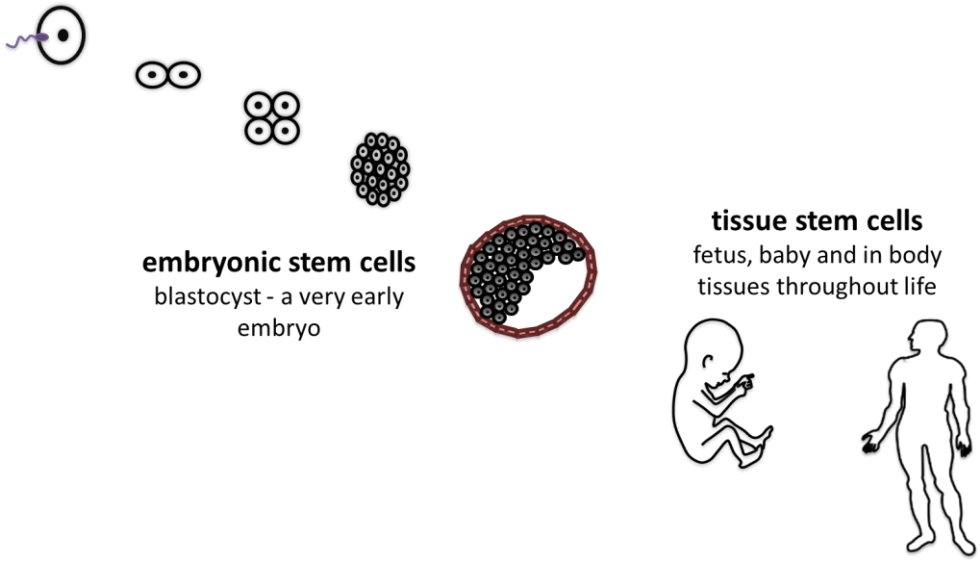
Differentiation is the process by which a cell becomes **specialised** for its job.

In most animal cells, the ability to differentiate is lost at an early stage of development, many types of plant cells have the ability to differentiate throughout their life.

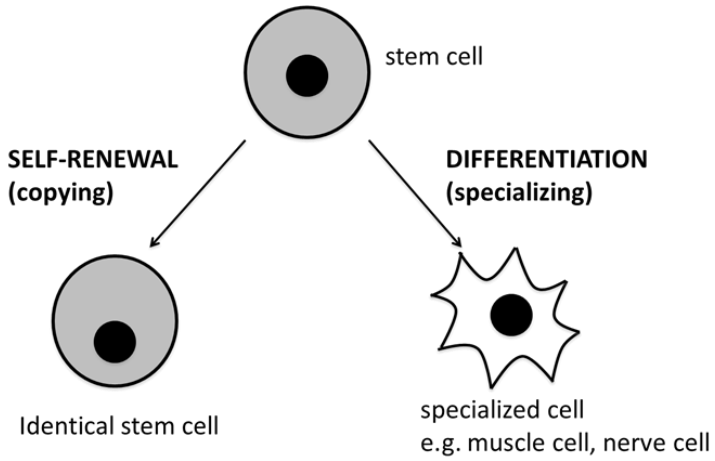
In animal embryos, cells divide to produce new cell types, but in mature animals, cells divide mainly to replace damaged cells.

What are stem cells?

Stem cells are **undifferentiated** (unspecialised) cells. They can develop into different types of cell depending on what instructions they're given.



Stem cells can self-renew and differentiate



Self renewal is needed because if the stem cells didn't copy themselves, you would quickly run out. It is important for the body to maintain a pool of stem cells to use throughout your life.

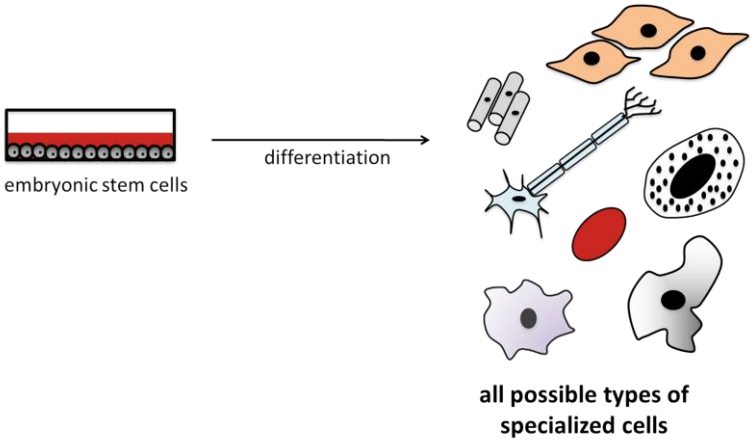
Differentiation is important because specialized cells are used up, damaged or die all the time during your life. Specialised cells cannot divide and make copies of themselves, but they need to be replaced for your body to carry on working.

Where do we find stem cells?

Human Stem cells

1. **Embryonic stem cells**

   Stem cells are found in early human embryos. They have the potential to differentiate into **any type of cell**.



   This makes sense because all the different types of cell found in a human being have to come from those few cells in the early embryo.

2. **Adult stem cells (tissue stem cells)**

   Adults also have stem cells, but they're only found in certain places, like **bone marrow**. These cells aren't as versatile as embryonic stem cells, because they can only turn into **certain types** of cells.

   Adult stem cells can only differentiate into related cell types, for example, bone marrow cells can differentiate into blood cells and cells of the immune system but not other cell types.

Plant stem cells

Cell division in plants occurs in regions called **meristems**.

Cells of the meristem can differentiate to produce **all types** of plant cells at any time during the life of the plant.

The main meristems are close to the tip of the shoot, and the tip of the root.

These growth regions contain stem cells that can be used to produce clones cheaply and quickly. Meristems can be used for producing large numbers of disease resistant crops and for growing and preserving rare varieties of plants to protect them from extinction.

Stem cells in Medicine

Adult stem cells in medicine

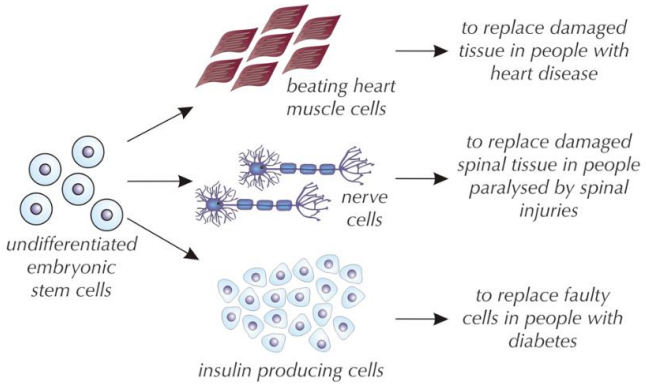
Medicine already uses **adult stem cells** to cure disease. People with some blood diseases (e.g. sickle cell anaemia — a disease which affects the shape of the red blood cells) can be treated by bone marrow transplants.

Bone marrow is the tissue found inside bone. It contains stem cells that can turn into new blood cells to replace the faulty old ones.

Embryonic stem cells in medicine

Scientists can also extract stem cells from very early human embryos and grow them.

These embryonic stem cells could be used to replace faulty cells in sick people in the future. For example, they could be used to make insulin-producing cells for people with diabetes, nerve cell for people paralysed by spinal injuries etc.



Issues involved in stem cell research

Embryonic stem cell research has exciting possibilities, but it's also pretty controversial.

Therapeutic cloning

An embryo can be made to have the same genetic information as the patient. This means that the stem cells produced from it would also contain the same genes and so wouldn't be rejected by the patient's body if used to replace faulty cells.

Therapeutic cloning can be used to treat diabetes. Embryonic stem cells (that can specialise in any type of cell) are produced with the same genes as the person who needs the treatment, when these cells are put into the body they are not usually rejected.

However, there are risks involved in using stem cells in medicine. Stem cell grown in the lab may become contaminated with a virus which could be passed on to the patient and so make them ill.

The benefits of using stem cells

- Stem cells left over from IVF treatment (that would otherwise be destroyed) can be used to treat serious conditions.
- Stem cells are useful in studying how cell division goes wrong (such as cancers).
- Stem cells could be used to grow new organs for transplantation in the future.

The risks and objections of using stem cells

- There is a risk of transferring viral infections by using stem cells.
- Stem cells might act as a reservoir of cancer cells and spread to other parts of the body when used in an operation.
- Some people believe that an embryo of any age is a human being and so should not be used to grow cells or be experimented on.

Date: _____

Diffusion

RETRIEVAL ACTIVITY

	Question	Answer	Mark
1	What is cell differentiation?		
2	What are stem cells?		
3	Why do stem cells self-renew (make copies)?		
4	Why are stem cells needed?		
5	Give one place that human stem cells be found?		
6	Give another place that human stem cells be found?		
7	Where can plant stem cells be found?		
8	What type of cell can embryonic stem cells differentiate into?		
9	What type of cells can adult stem cells differentiate into?		
10	True or false? The ability to differentiate in animal cells is lost at an early stage of development.		
		Score	**/10**

ACTIVATE KNOWLEDGE

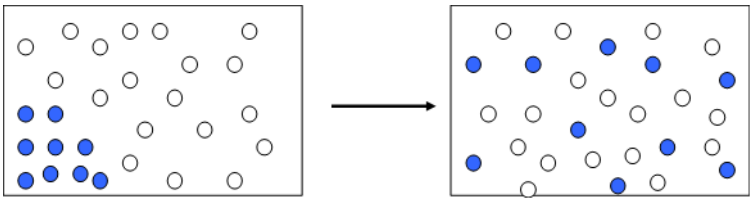
A can of air freshener is sprayed at the front of a room. Explain how the smell gets from one side of the room to the other.

Some words you may want to include: Particles, diffusion, diffuse, spread, concentration

CONTENT

Diffusion is the spreading out of particles from an area of high concentration to an area of low concentration.

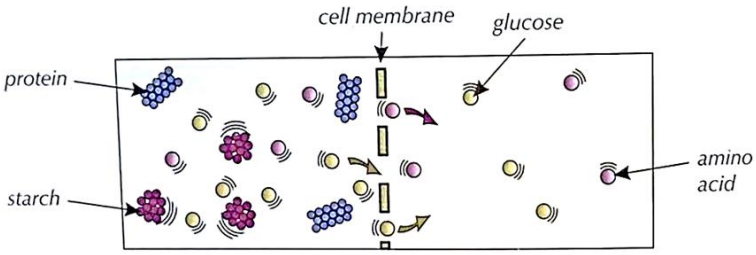
Diffusion happens in both solutions and gases.



Diffusion in cells

Dissolved substances can move in and out of cells by **diffusion**.

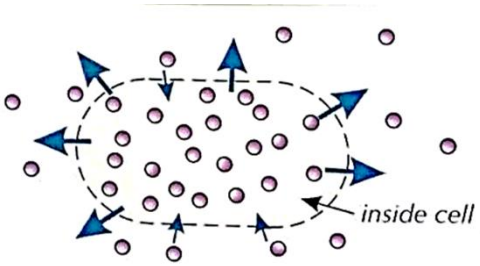
Only very small molecules can diffuse through cell membranes though — things like oxygen (needed for respiration), glucose, amino acids and water.



Big molecules like starch and proteins can't fit through the membrane

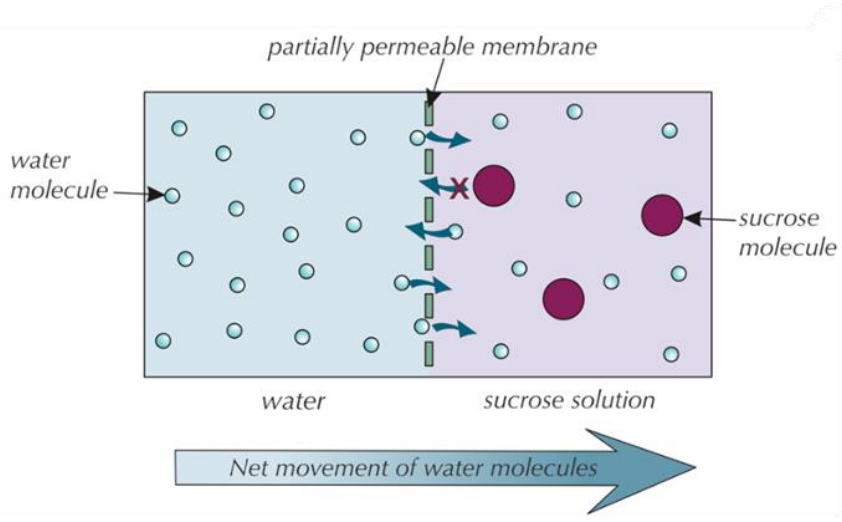
Example:

Particles are diffusing both in and out of this cell. However, the concentration of particles is higher inside the cell than outside, so the **net movement** of particles is out of the cell.



Partially permeable membranes

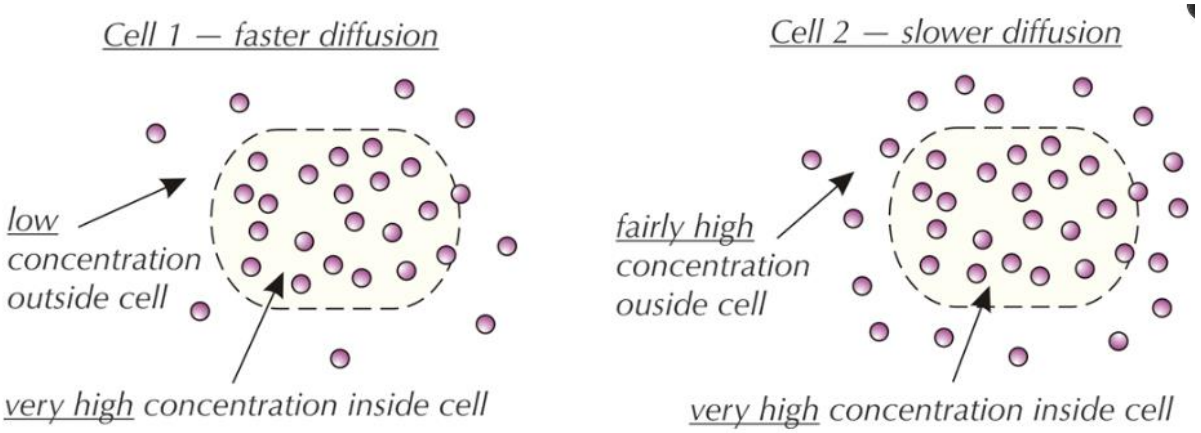
A **partially permeable membrane** is just one with very small holes in it. So small, in fact, only tiny molecules (like water) can pass through them, and bigger molecules (e.g. sucrose, a sugar) can't.



Rate of diffusion

The rate of diffusion can be affected by:

1. The **difference in concentration** of the particles — the bigger the difference in concentration, the faster the diffusion rate.



2. **Temperature** - the higher the temperature the faster the diffusion rate, because the particles have more energy, so move around faster.
3. **Larger surface area** of the membrane, the faster the diffusion rate, because more particles can pass through at once.

Diffusion in animals

Diffusion is important in the exchange of substances in animals.

In the **alveoli**, oxygen diffuses into the blood from an area of high concentration inside the alveoli to a low concentration in the blood.

In the **villi** of the small intestine, digested food e.g. glucose, amino acids, glycerol and fatty acids diffuse from a high concentration in the small intestine to a low concentration in the blood.

Diffusion in plants

During **photosynthesis** carbon dioxide diffuses into the stomata of a leaf from a high concentration in the air to a low concentration in the leaf. Oxygen diffuses from a high concentration in the leaf to a lower concentration in the air through the stomata.

During **respiration** the reverse happens.

Mineral ions diffuse from a high concentration in the soil to a low concentration in the root cells.

Osmosis

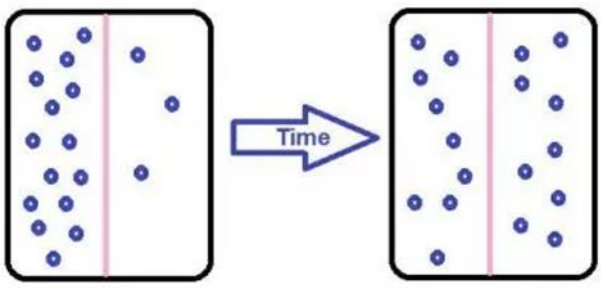
Date: _____

RETRIEVAL ACTIVITY

	Question	Answer	Mark
1	Name the part of a cell where respiration takes place.		
2	Name the part of a cell where protein synthesis takes place		
3	What is it called when a cell becomes specialised?		
4	When particles move from a high to a low concentration, what is it called?		
5	True or false? Large molecules can move through cell membranes.		
6	How does an increase in temperature affect the rate of diffusion?		
7	True or False? Having a large surface area increases the rate of diffusion.		
8	If the concentration outside a cell is greater than the concentration inside the cell. Which direction will particles move in? Into or out of the cell?		
9	Give an example of where diffusion takes place in humans		
10	Give an example of where diffusion takes place in plants.		
		Score	**/10**

ACTIVATE KNOWLEDGE

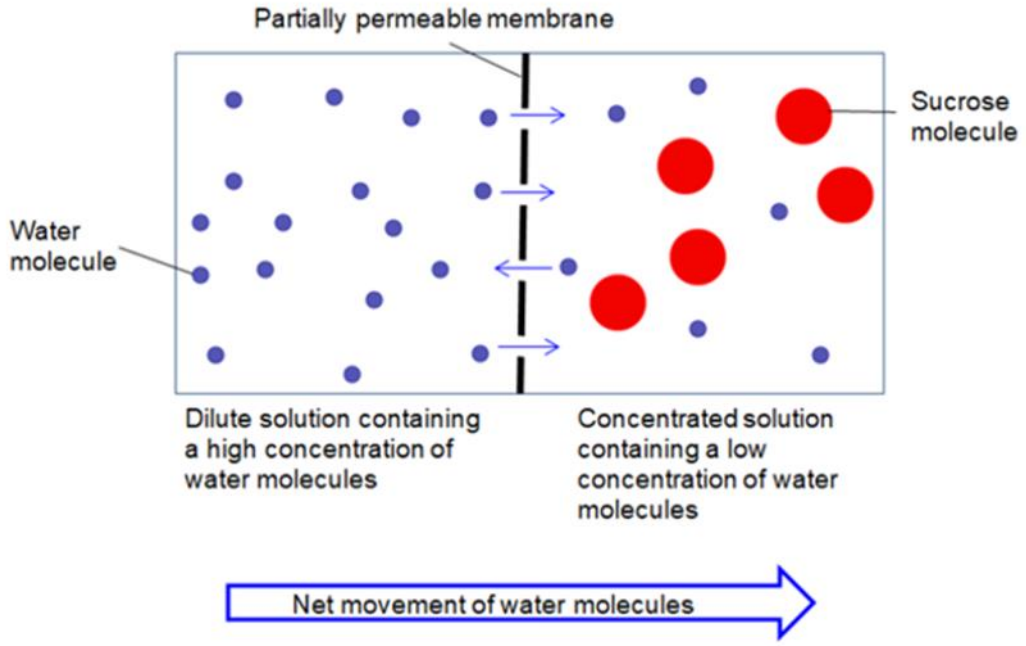
What does this diagram show?



CONTENT

What is Osmosis?

Osmosis is the movement of water molecules across a semi-permeable membrane from a region of high water concentration (dilute solution) to a region of low water concentration (concentrated solution).

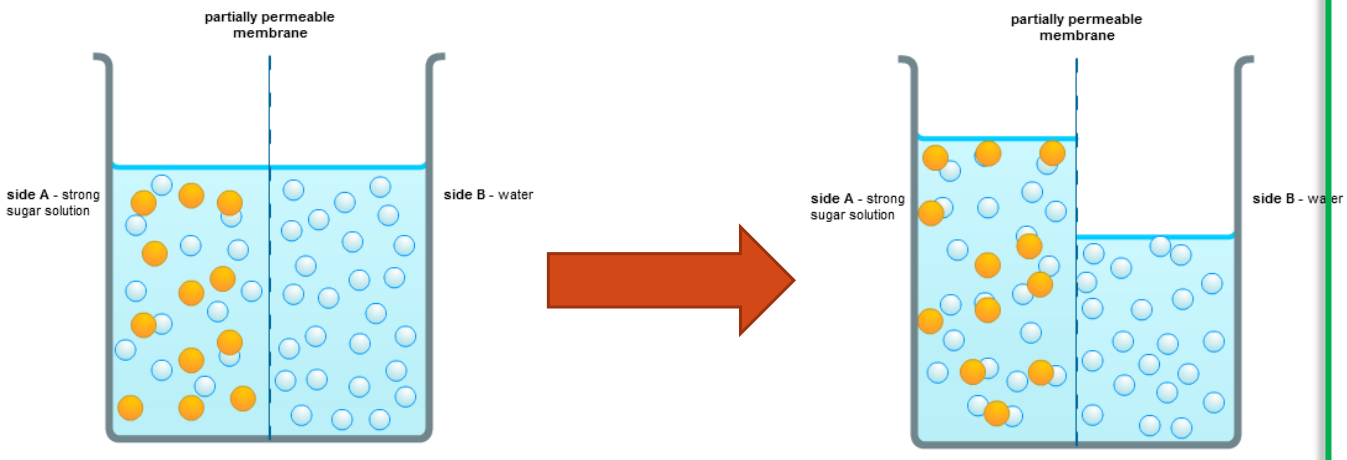


The water molecules actually pass <u>both ways</u> through the membrane during osmosis.

This happens because water molecules move about randomly.

But because there are more water molecules on one side than on the other, there's a steady **net** flow of water into the region with fewer water molecules, i.e. into the stronger sugar solution.

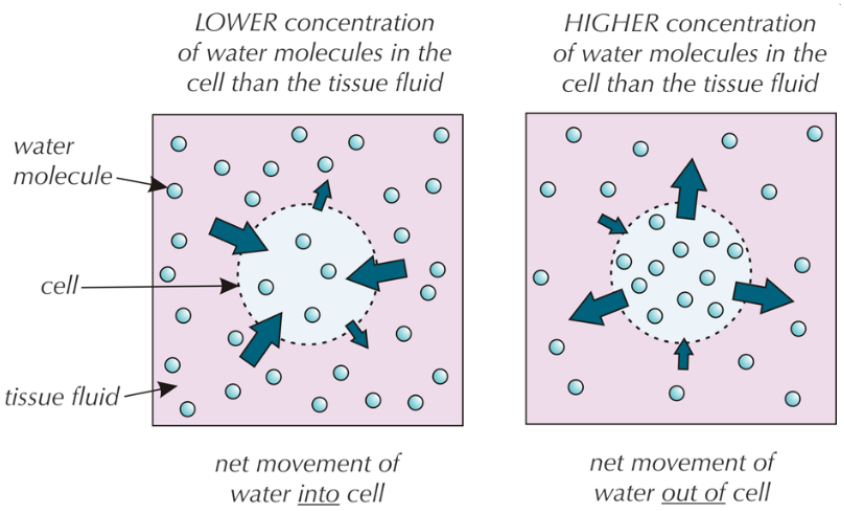
This means the strong sugar solution gets more dilute. The water acts like it's trying to "even up" the concentration either side of the membrane.



The movement of water into and out of cells

The solution surrounding a cell will usually have a different concentration to the fluid inside the cell. This means that water will either move into the cell from the surrounding solution, or out of the cell, by osmosis.

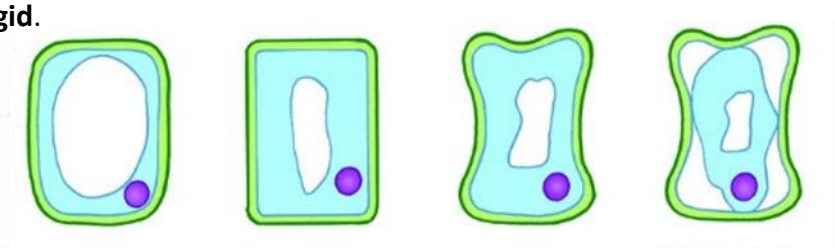
If a cell is short of water, the solution inside it will become quite concentrated (i.e. there'll be a low concentration of water molecules). This usually means the solution outside the cell is more dilute (there's a higher concentration of water molecules), and so water will move into the cell by osmosis. If a cell has lots of water, the solution inside it will be more dilute, and water will be drawn out of the cell and into the fluid outside by osmosis.



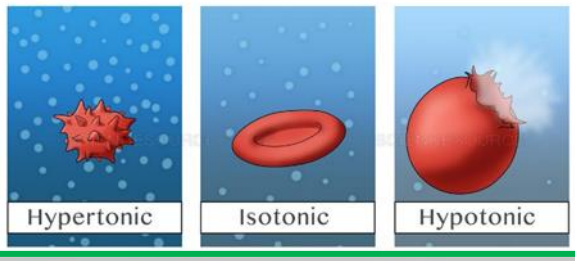
If the solution inside the cell is the same concentration as the solution outside the cell, then there will be no overall mass change. This is because water will move by osmosis in both directions equally.

How are cells affected by osmosis?

In plant cells the cell wall prevents the cell from bursting, since it does not stretch. As more water enters the vacuole, pressure builds up. This pressure is called **turgor pressure** and the cell is described as **turgid**.



However animal cells will simply burst since they do not have a cell wall to withstand the pressure.



Required practical: Investigating the effect of sugar or salt solutions on plant tissue

1

Use a cork borer to cut five potato cylinders of the same diameter.

Trim the cylinders so that they are all the same length (about 3 cm).

2

3

Accurately measure and record the mass of each potato cylinder

Measure 10 cm^3 of distilled water and put into the first boiling tube. Label boiling tube as: 'water'.

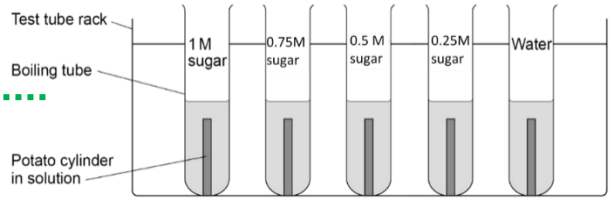
4

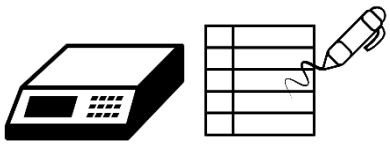
5

Measure 10 cm3 of each sugar solution (0.25, 0.5, 0.75, 1M) and put into separate boiling tubes. Label each of the boiling tubes with their sugar solution and your initials.

Add one potato cylinder to each boiling tube. Make sure you know the mass of each potato cylinder in each boiling tube.

6



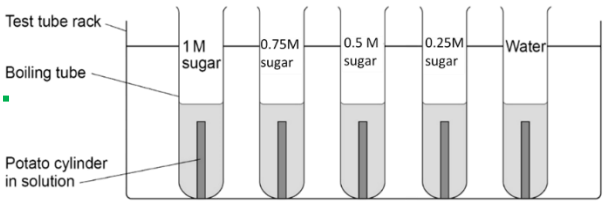


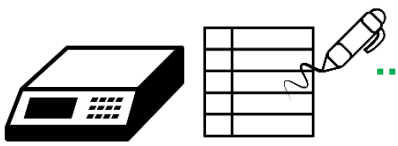
7

Record the masses of each potato cylinder in a table.

Leave the potato cylinders in the boiling tubes overnight in the test tube rack.

8





9

Remove the cylinders from the boiling tubes and carefully blot them dry with a paper towel. Re-measure the mass of each potato cylinder (make sure you know which is which).

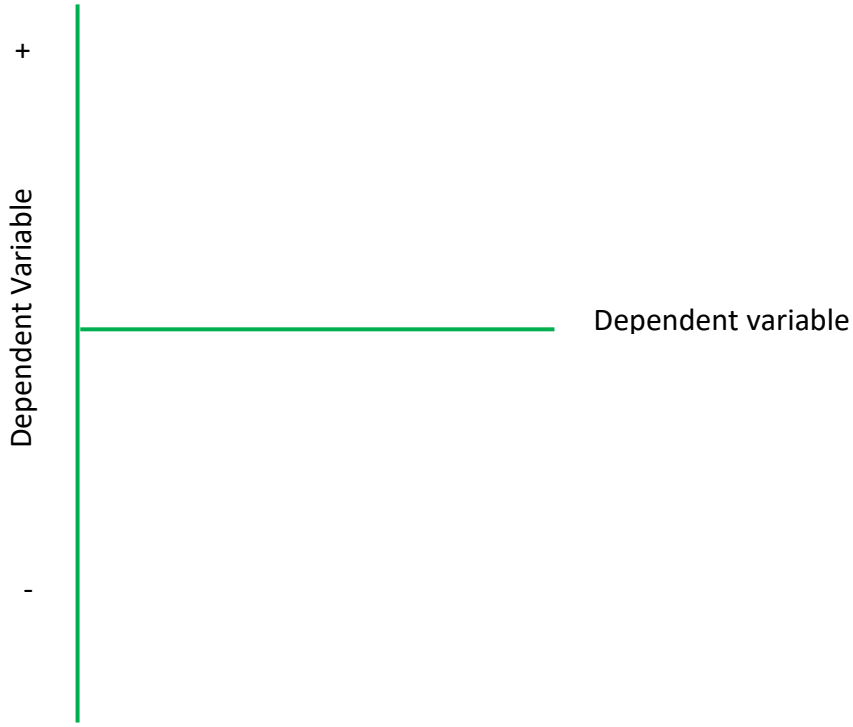
Record your results in the table below:

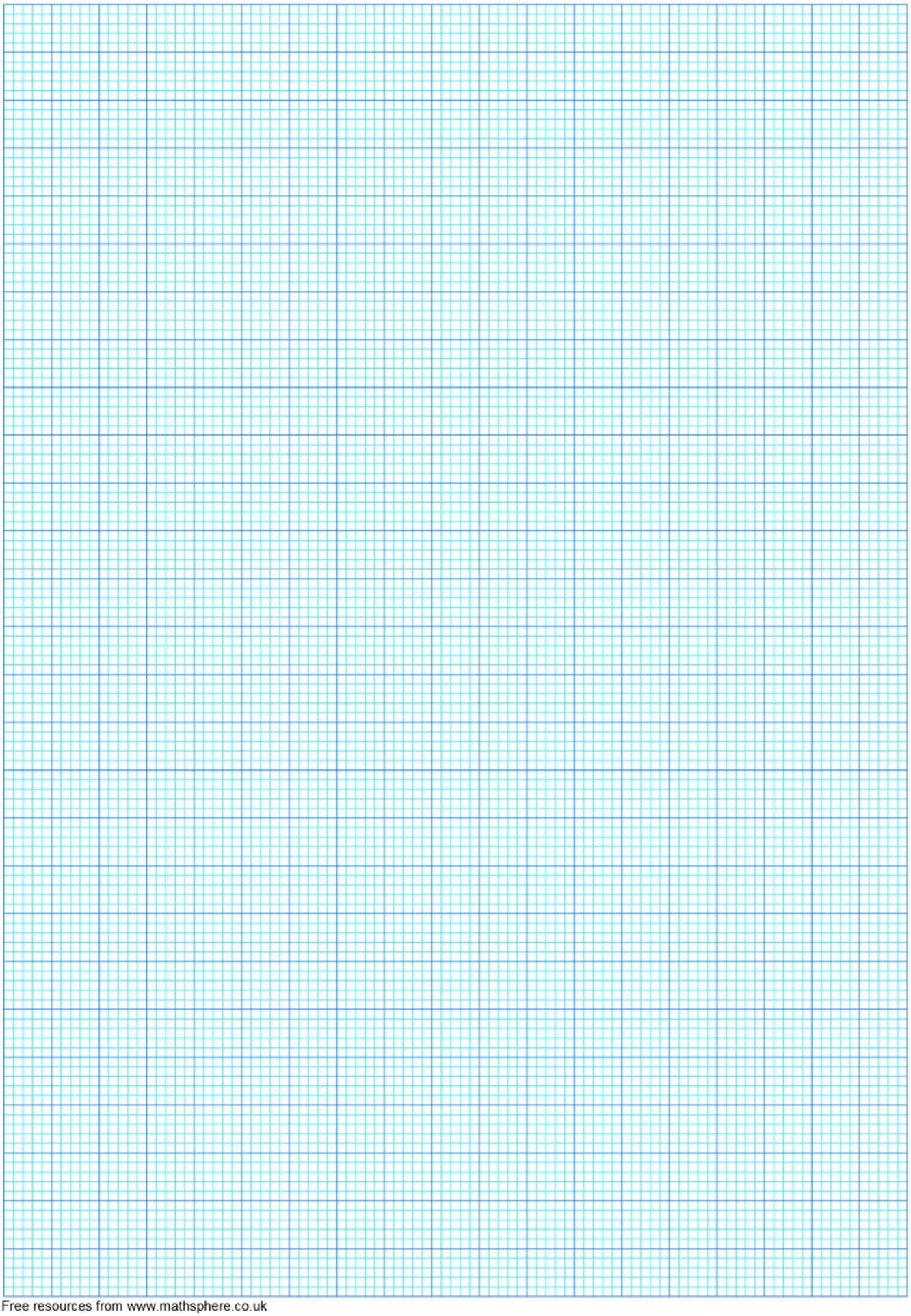
Concentration of solution (M)	Mass of potato at start (g)	Mass of potato at end (g.)	Change in mass (g)	Percentage change in mass (%)
0 (water)				
0.25				
0.5				
0.75				
1				

To calculate percentage change in mass use the following equation:

Percentage change = (change in mass / starting mass) x 100

Draw a line graph with a smooth line of best fit through the points.
You will have some negative percentage changes to plot so make sure your axes can support this e.g:





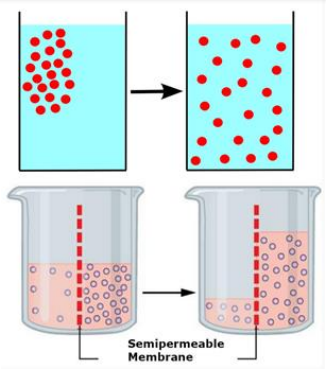
Active Transport

Date: _____

RETRIEVAL ACTIVITY

	Question	Answer	Mark
1	When particles move from a high to a low concentration, what is it called?		
2	True or false? Large molecules can move through cell membranes.		
3	How does an increase in temperature affect the rate of diffusion?		
4	True or False? Having a large surface area increases the rate of diffusion.		
5	If the concentration outside a cell is greater than the concentration inside the cell. Which direction will particles move in? Into or out of the cell?		
6	When water moves from a dilute solution (high water concentration) to a more concentrated solution (low water concentration) through a semi permeable membrane, what is it called?		
7	True or false? Water moves in both directions through a cell membrane by osmosis?		
8	What would happen to an animal cell if it was placed in distilled water?		
9	What happens to potato cylinders that are put into distilled water? Do they gain mass or lose mass?		
10	What happens to potato cylinders that are put into strong sugar/salt solution? Do they gain mass or lose mass?		
		Score	**/10**

ACTIVATE KNOWLEDGE



What does this diagram show?

What does this diagram show?

CONTENT

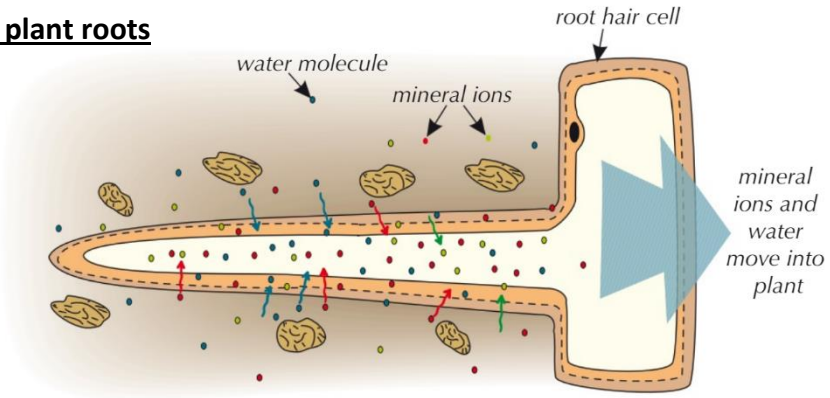
What is active transport?

Active transport is the movement of particles against a concentration gradient (i.e. from an area of lower concentration to and area of higher concentration), across a partially permeable membrane using energy released from **respiration**.

Active transport, like diffusion can be used to move substances in and out of cells. It allows cells to absorb ions from very dilute solutions.

Active transport takes place in both plants and animals. For example, in the plant root hairs and in humans the small intestine.

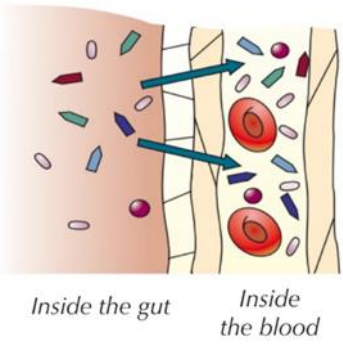
Active transport in plant roots



The concentration of mineral ions is usually higher in the root hair cells than in the soil around them, so the root hair cells can't use diffusion to take up minerals from the soil. Instead they use **active transport**.

Active transport allows the plant to absorb minerals from a very dilute solution, against a concentration gradient. This is essential for its growth. But active transport needs energy from respiration to make it work.

Active transport in the small intestine



Active transport is used in the digestive system when there is a lower concentration of nutrients in the gut, but a higher concentration of nutrients in the blood.

When there's a higher concentration of glucose and amino acids in the small intestine, they will **diffuse** into the blood. This is how most food molecules area absorbed.

But, sometimes there is a lower concentration of nutrients in the small intestine than in the blood

This means the nutrients need to move from an area of lower concentration to an area of higher concentration.

Active transport allows the nutrients to be taken into the blood, using the energy released in respiration.

So, both diffusion and active transport are used in the small intestine depending on the concentrations inside the small intestine and the blood.

Summary of the three methods of transporting materials.

Type of transport	Description
Diffusion	• Movement of particles from an area of higher concentration to an area of lower concentration. • Doesn't require energy.
Osmosis	• Movement of water molecules across a partially permeable membrane from a region of higher water concentration (dilute solution) to a region of lower water concentration (concentrated solution) • Doesn't require energy
Active transport	• Movement of particles against a concentration gradient. • Requires energy.

Date: _____

Exchange surfaces

RETRIEVAL ACTIVITY

	Question	Answer	Mark
1	When particles move from a high to a low concentration, what is it called?		
2	True or False? Having a large surface area increases the rate of diffusion.		
3	If the concentration outside a cell is greater than the concentration inside the cell. Which direction will particles move in by diffusion? Into or out of the cell?		
4	When water moves from a dilute solution (high water concentration) to a more concentrated solution (low water concentration) through a semi permeable membrane, what is it called?		
5	What would happen to an animal cell if it was placed in distilled water?		
6	What happens to potato cylinders that are put into distilled water? Do they gain mass or lose mass?		
7	What happens to potato cylinders that are put into strong sugar/salt solution? Do they gain mass or lose mass?		
8	When particles move against a concentration gradient (i.e. from Low concentration to high concentration), across a partially permeable membrane using energy. What is it called?		
9	True or false? Both diffusion and active transport are used in the small intestine to absorb nutrient from food.		
10	Where does the energy needed in active transport come from?		
		Score	**/10**

ACTIVATE KNOWLEDGE

This is a photo of the villi in the small intestine. How is it adapted to help in the digestion and absorption of food?

CONTENT

Living organisms need to be able to exchange dissolved substances with their environment in order to survive. An organisms size and surface area affect how quickly this is done.

Life processes need gases or other dissolved substances (solutes) before they can happen. Dissolved substances move to where they need to be by **diffusion** and **active transport**. Water moves by **osmosis**.

Cells can use diffusion to take in substances they need and get rid of waste products. E.g. Oxygen and carbon dioxide area transferred between cells and the environment during gas exchange.

How easy it is for an organism to exchange substances with its environment depends on the organism's surface area to volume ratio (SA : V)

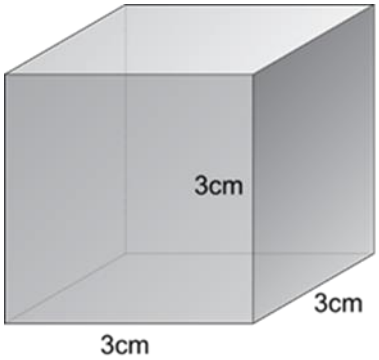
Surface area to volume ratios

A ratio shows how big one value is compared to another. The larger an organism is, the smaller its surface area is compared to its volume. You can show this by calculating surface area to volume ratios.

Calculating Volume and Surface Area

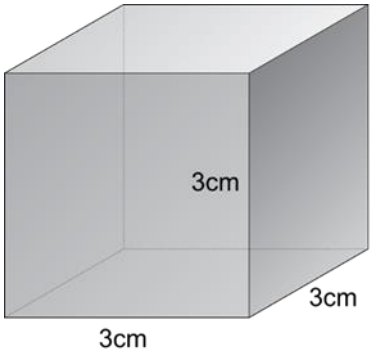
- **Write the formula for area of a cube:** _____

- **Now calculate the area of the cube:**



✎ **Write out the formula for volume of a cube:** _____

✎ **Now calculate the volume of the cube:**



How do we calculate surface area to volume ratio?

The surface area to volume ratio is the surface area per unit volume of the object.

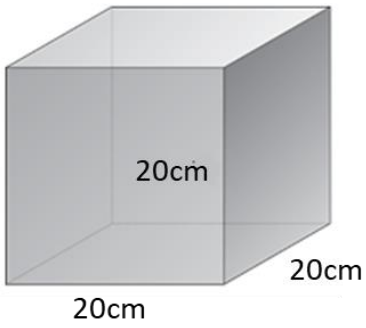
If an object has a surface are of $54cm^2$ and a volume of $27cm^3$ then the surface area (SA) : volume (V) ratio is:

✎ **Complete the following:**

Surface area (SA) : Volume (V) =

This means that this object has $2cm^2$ of surface area for each $1cm^3$ of volume.

A cube has sides of 20cm. Calculate the surface area to volume ratio of this cube. Show all of your working out.



CONTENT

The larger the organism, the lower the surface area to volume ratio

Organisms like the tapeworm, which have a large surface area to volume ratio, can use the process of diffusion alone to sustain life.

It is able to take all of the oxygen that it needs across the body surface by diffusion

Larger organisms like humans, who have a small surface area to volume ratio, cannot use diffusion alone to survive.

This is because diffusion over this greater distance will not occur fast enough to meet the demands of the cells of the body.

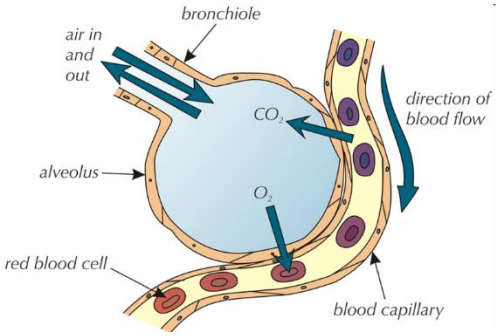
Gas Exchange – Adaptations of the Lungs

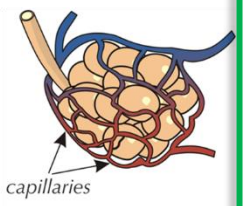
The job of the lungs is to transfer oxygen to the blood and to remove waste carbon dioxide from it.

To do this the lungs contain millions of little air sacs called **alveoli** where gas exchange takes place.

The **alveoli** are specialised to maximise the diffusion of oxygen and CO_2. They have:

- A large surface area.
- Very thin walls.
- A good blood supply.
- A moist lining for dissolving gases.



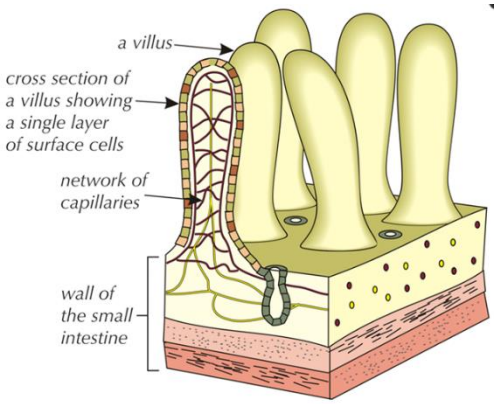


Adaptations of the small intestine

Villi increase the surface area of the small intestine so that digested food is absorbed much more quickly into the blood. They also have:

a single layer of surface cells.

a very good blood supply to assist quick absorption.



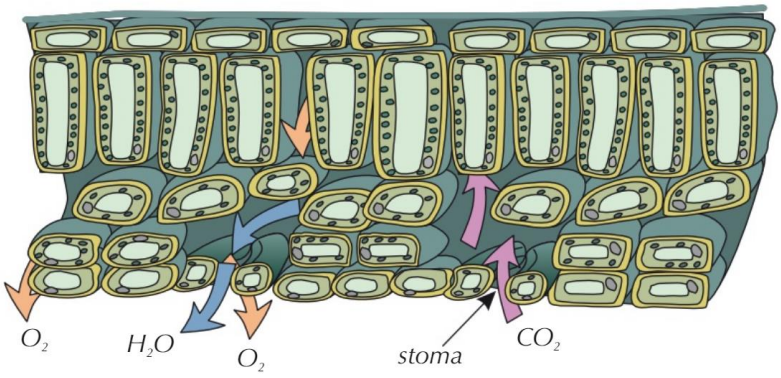
Gas exchange through gills

Water (containing oxygen) enters the fish through the mouth and passes out through the gills. As this happens oxygen diffuses from the water into the blood in the gills and carbon dioxide diffuses from the blood into the water.

Each gill is made of lots of thin plates called gill filaments, which give a large surface area for gas exchange. Blood flows through the gills in one direction and water flows over in the opposite direction, this maintains a large concentration gradient.

Gas Exchange in Plants

Carbon dioxide is needed for photosynthesis. Carbon dioxide diffuses into the air spaces within the leaf, then into the cells where photosynthesis happens. The leaf has a flattened shape to increase the surface area. The air spaces inside the leaf also increase the surface area. Carbon dioxide diffuses into the leaf through the stomata. Oxygen and water vapour also diffuse out through the stomata.



Oxygen (O_2) and water vapour (H_2O) diffuse out of the leaf.

Carbon dioxide (CO_2) diffuses into the leaf.

Absorption of water and minerals in plants

The roots of plants are also adapted for uptake and absorption of water and minerals. The cells on the surface of the roots grow into long 'hairs'. Each branch of the rood will be covered in millions of these microscopic hairs. This gives them a large surface area for absorbing water and mineral ions from the soil.

Why are exchange surfaces needed?

In single celled organisms, gases and dissolved substances can diffuse directly into or out of cells across the cell membrane. This is because they have a large surface area compared to their volume, so enough substances can be exchanged across the membrane to supply everything the cell needs.

Multicellular organisms have a smaller surface area compared to their volume – not enough substances can diffuse from their outside surface to supply their entire volume. This means they need some sort of exchange surface for efficient diffusion.

What adaptations are needed for exchange of gas and solutes in any organism?

- A **large surface area** to give plenty of opportunity for substances to diffuse.
- A way of removing the substances exchanged (e.g. a rich blood supply) to **maintain a steep concentration gradient** and carry them to where they are needed.
- **Moist surfaces** for substances to dissolve.
- A **short distance** between the two areas – this makes diffusion as effective as possible. Often referred to as a short diffusion pathway.

Date: _____

Cell division and mitosis

RETRIEVAL ACTIVITY

	Question	Answer	Mark
1	When particles move from a high to a low concentration, what is it called?		
2	If the concentration outside a cell is greater than the concentration inside the cell. Which direction will particles move in by diffusion? Into or out of the cell?		
3	When water moves from a dilute solution (high water concentration) to a more concentrated solution (low water concentration) through a semi permeable membrane, what is it called?		
4	What happens to potato cylinders that are put into distilled water? Do they gain mass or lose mass?		
5	What happens to potato cylinders that are put into strong sugar/salt solution? Do they gain mass or lose mass?		
6	When particles move against a concentration gradient (i.e. from Low concentration to high concentration), across a partially permeable membrane using energy. What is it called?		
7	True or false? Both diffusion and active transport are used in the small intestine to absorb nutrient from food.		
8	Give one adaptation of the alveoli for efficient gas exchange.		
9	Give a second adaptation of the alveoli for efficient gas exchange.		
10	Give a third adaptation of the alveoli for efficient gas exchange.		
		Score:	**/10**

ACTIVATE KNOWLEDGE

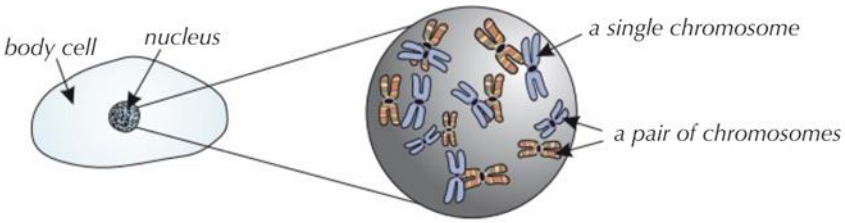
Match the sentences to the correct label:

Cell	A short section of a chromosome carrying genetic information.
Nucleus	Thread-like structures carrying genetic information, found in the nucleus of cells.
Chromosome	The chemical that genes and chromosomes are made from. It is the material of inheritance – deoxyribonucleic acid.
Gene	An organelle which controls all the activities of the cell. It contains the genetic information.
DNA	The structural, functional and biological unit of all living organisms.

CONTENT

Cells

Cells contain a nucleus which holds 46 chromosomes. Each chromosome is made up of a number of genes.



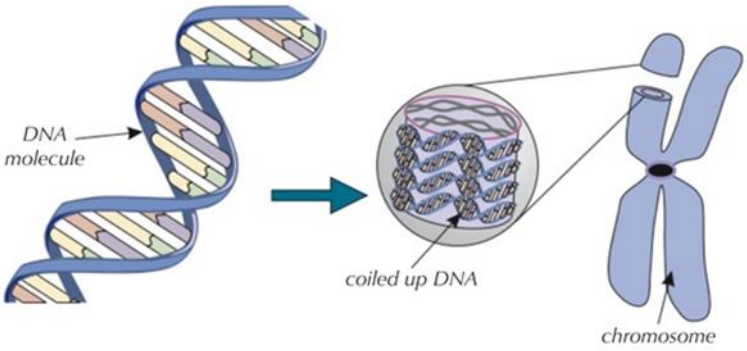
Chromosomes are always found in pairs called homologous pairs.

The members of each pair control the same characteristics in an organism.

In each of these homologous pairs, one chromosome comes from the mother and one from the father.

Chromosomes are long lengths of a molecule called DNA.

The DNA is coiled up to form the arms of the chromosome.

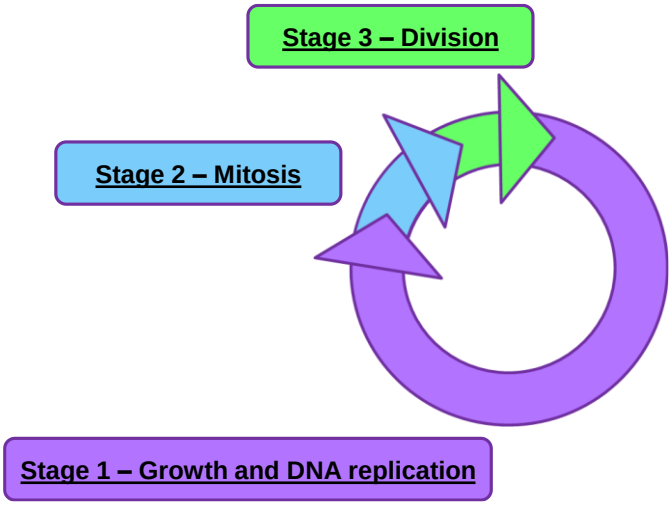


Mitosis and the cell cycle

Our body cells are able to make copies of themselves so that we can grow, repair damaged tissue or replace cells.

The cell cycle

Cells divide in a series of stages call the cell cycle.



Stage 1 – Growth and DNA replication

This is the longest part of the cycle.

Before a cell can divide it needs to grow and increase the number of sub-cellular structures such as **ribosomes** and **mitochondria**.

The **DNA replicates** to form two copies of each chromosome (the cell will now have 92 chromosomes)

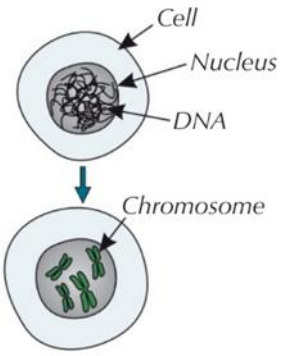


Diagram showing the growth and replication stage of the cell cycle.

Stage 2 – Mitosis

The chromosomes line up at the centre of the cell and cell fibres pull them apart.

One set of chromosomes moves to each end of the cell.

Membranes form around each of the sets of chromosomes.

The **nucleus** divides and splits into two.

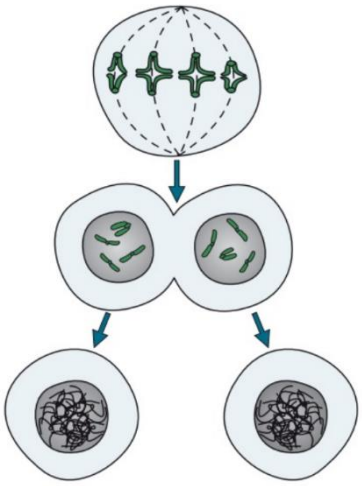


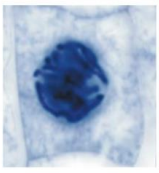
Diagram showing the steps of mitosis in the cell cycle.

Stage 3 – Division

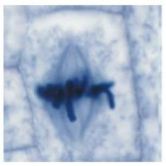
The cytoplasm and the cell membrane also divide to form two **genetically identical daughter cells**.

Recognising mitosis

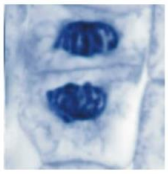
In an exam you may have to identify what is going on in photos of real cells undergoing mitosis.

A 

In cell A, the chromosomes area visible in the nucleus. The DNA has formed X-shape chromosomes because it's being duplicated. So this cell is in the first stage – replication – of the cell cycle.

B 

In cell B, the chromosomes are lined up across the centre of the cell. So this cell is undergoing stage 2 – mitosis.

C 

In cell C, the chromosomes have been pulled apart to opposite ends of the cell. They have formed two separate nuclei. A cell membrane is visible between the two halves, dividing the cytoplasm, so the cell must be at stage 3 of the cell cycle. It is about for form two identical daughter cells.

How long is e ach stage of the cell cycle?

The time taken for a stage of the cell cycle varies depending on the cell type and the environmental conditions.

You can calculate how long a stage lasts if you're given the right information.

The fraction of cells in any one stage of the cell cycle is proportional to the time taken for that stage.

So if you know the number of cells in a particular stage, the total number of cell s and the total time for the cell cycle, you can work out an estimate for how long that particular stage takes.

Example

A scientist observes a section of growing tissue under a microscope. He counts 120 cells in one field of view.

Of those, 42 cells are in the replication stage (stage 1) of the cell cycle.

One complete cell cycle of the cells in this tissue lasts 24 hours.

How long do the cells spend in the replication stage of the cell cycle? Give your answer in minutes.

Solution:

1. The scientist has observed that 42 out of 120 cells are in the replication stage of the cell cycle. This suggests that the proportion of time the cells spend in this stage must be $42/120^{th}$ of the cell cycle.
2. You're told that the cell cycle in these cells lasts 24 hours.

   That is 24 x 60 = 1440 minutes
3. So the cells spend $42/120^{th}$ of 1440 minutes in the replication stage, which you can work out like this:

   $$\frac{42}{120} \times 1440$$

   = **504 minutes** in the replication stage of the cell cycle.