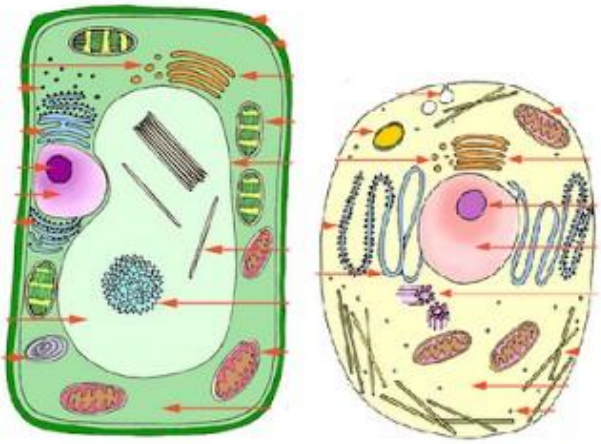
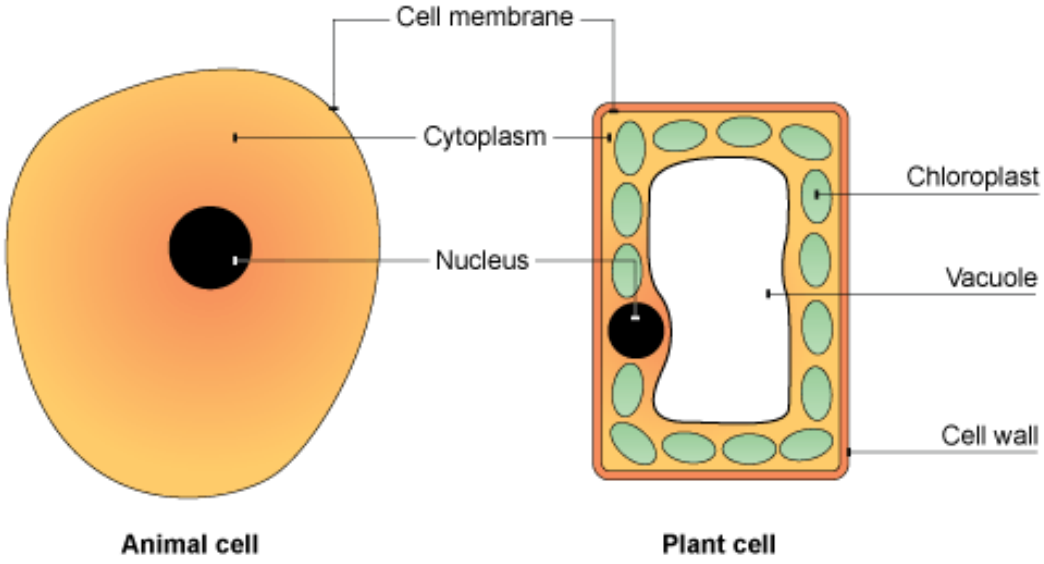
#14 Cell structure



Plant cell Animal cell

Most living things are made of cells. Cell shape varies according to its function. Plant and animal cells differ in size, shape and structure (plants cells are usually larger than animal cells).

Similarities and differences between animal cell and plant cell



Animal cell Plant cell

Tips for drawing

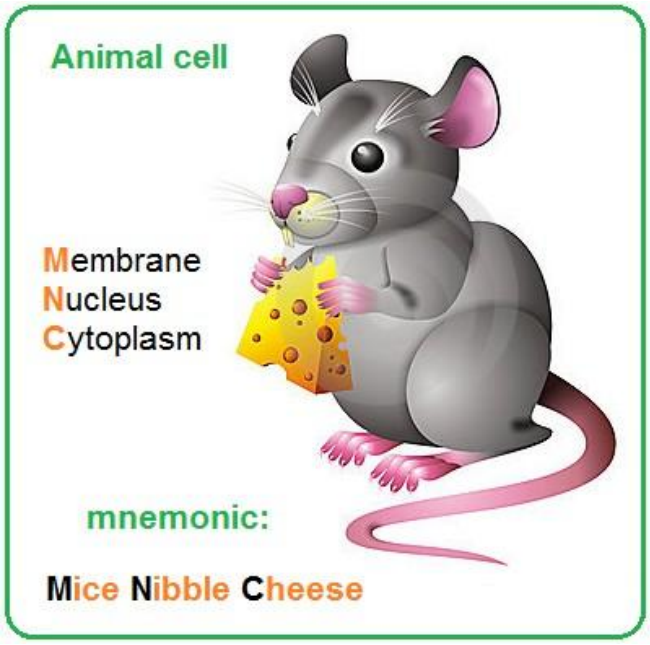
A plant cell

- To **label** parts of a plant cell, start **from** the **outside** and work inwards. The correct order: *cell wall, membrane, cytoplasm, chloroplast, nucleus, vacuole.*
- Draw the cell wall as a **double line** to show its thickness.
- Make the **cell wall** label line touche the **outer** line, and the **membrane** label line touche the **inner** line.

An animal cell

- Contains only **3** main **parts: Membrane, Nucleus, Cytoplasm.**

Mnemonic



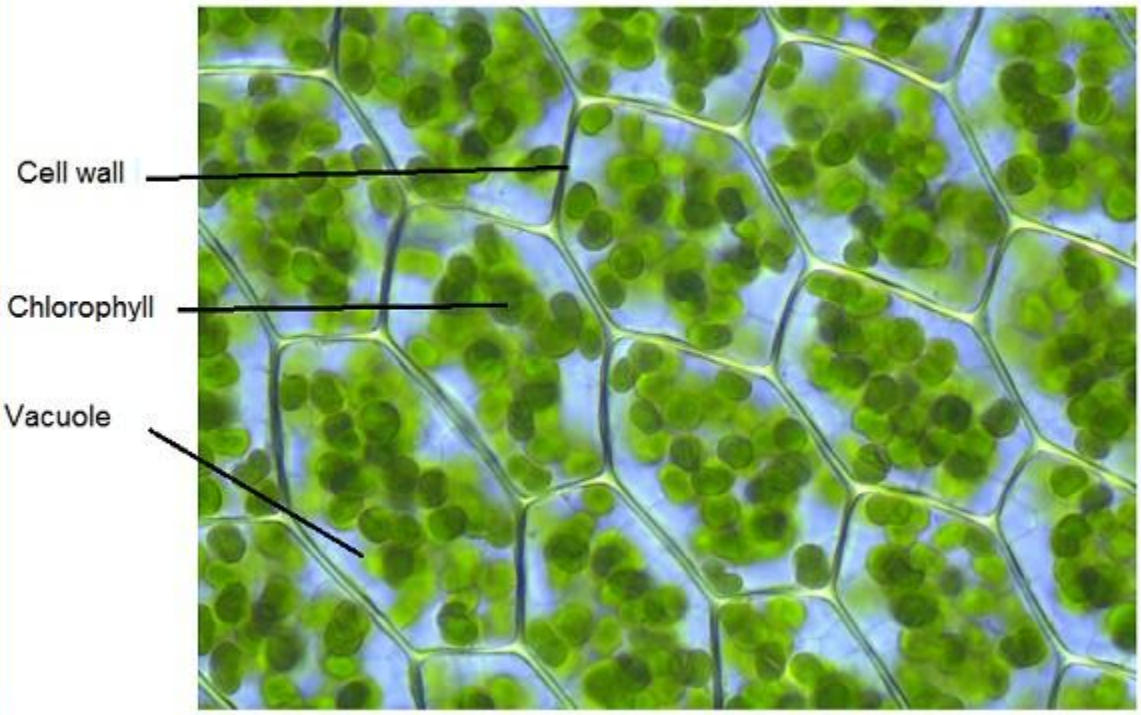
Animal cell features

1. **Irregular** shape as does not have a **rigid cell wall.**
2. **Vacuoles:** may have several **small**, **temporary** vacuoles, for **digestion** or the **excretion** of excess water.
3. **Denser cytoplasm:** contain more **dissolved substances** and **organelles** (e.g. more mitochondria where respiration take place to realease more energy for fast movement).
4. **Store food** (carbohydrates) in the form of **glycogen**

Plant cell features

1. **Regular** shape as **cell wall** (made of cellulose) is **rigid** (stiff).
2. **Vacuoles**: **large, permanent** vacuoles, contains H_2O and dissolved substances (**cell sap**). Helps to maintain pressure in the cell.
3. **Chloroplasts:** contain **chlorophyll** and **enzymes** for photosynthesis.
4. **Store food:** Glucose produced by photosynthesis is converted into **starch** and stored in the cytoplasm.

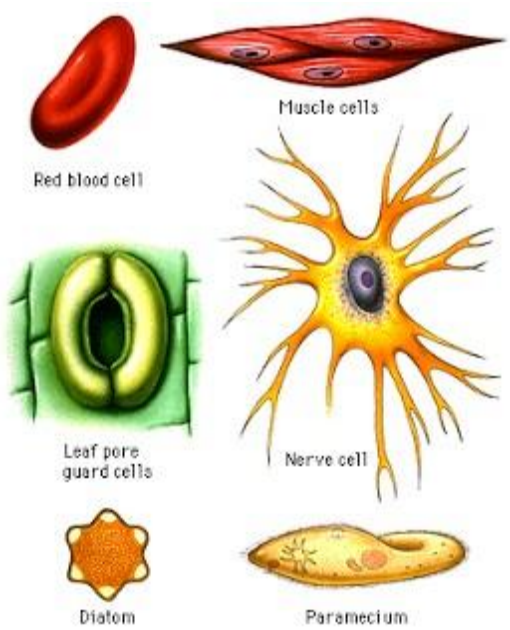
Plant cells



Common misconceptions

- Animal cells **never** have a cell wall, chloroplast or sap vacuole (they may have temporary vacuoles where food is stored.
- **Not all** cells have all cell **parts** when matured, e.g. red blood cell do not have nucleus, xylem cells do not have a nucleus or cytoplasm.
- **Not all** plant cells contain **chloroplasts**, e.g. epidermis cells and root cells do not.
- Chloroplasts (organelle) are **different** from chlorophyll (the chemical found in them)

#15 Cell functions



Multicelullar plants and animals contain many different types of cell. Each type of cell is design for a particular function.

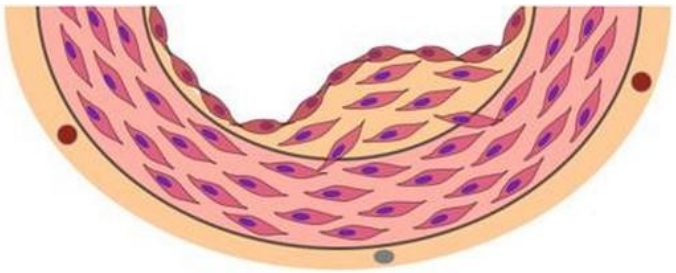
Here are examples of cells and their functions in tissues

1. Ciliated cells in respiratory tract

F**eatures:** tiny hairs called **cilia** which can move mucus.
Function: waft mucus with bacteria and dust away from the lungs.

2. Muscle cells

Features: cells merge together to form fibres that can **contract**.
Function: cause movement

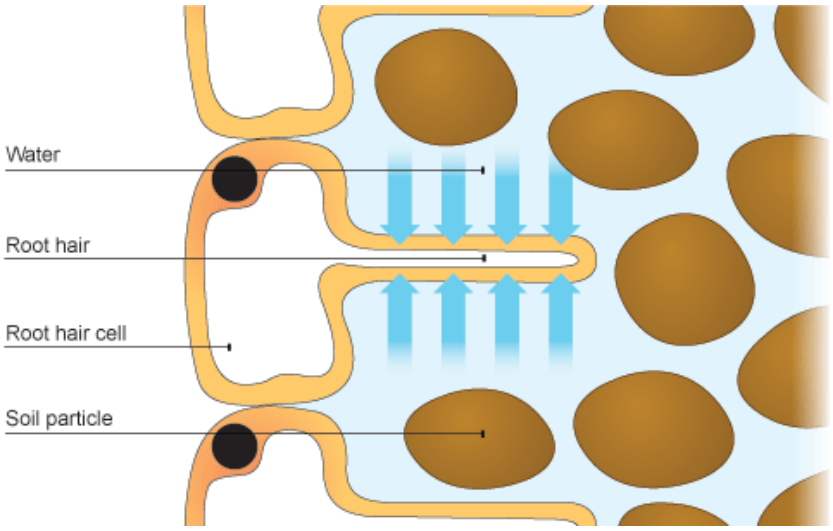


3. Red blood cells

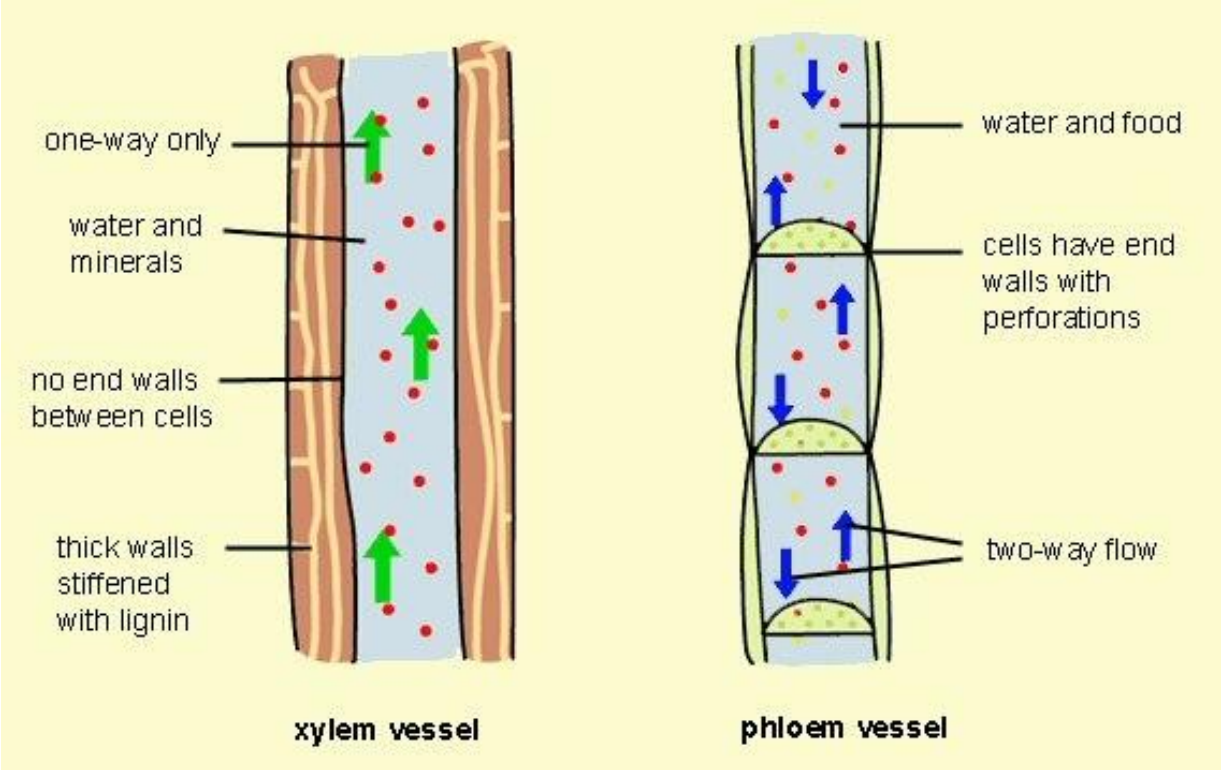
Features: have no nucleus, contain hemoglobin
Function: **transport** oxygen around the body

4. Root hair cell (plants)

Features: the hair gives a large surface area
Function: **absorb** water and mineral ions; anchor the plant firmly in soil



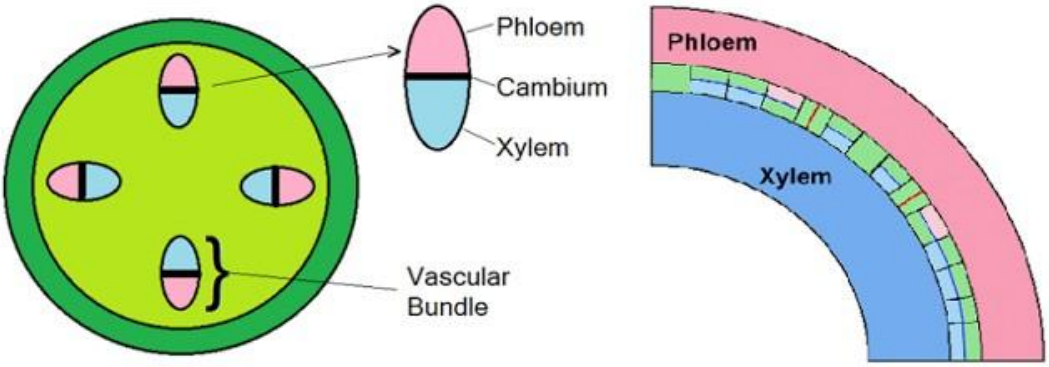
5. Xylem cells

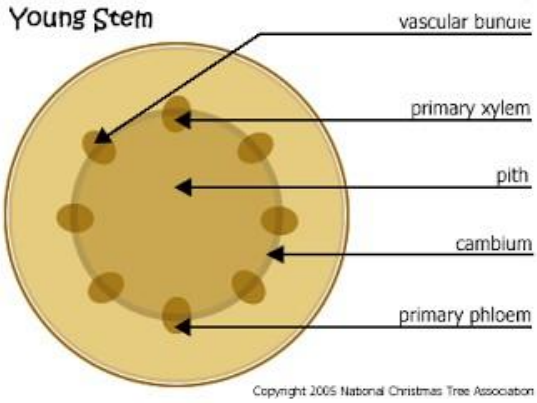


Features: long, thin cells arranged end-to-end to form vessels (tubes). The cells lack end wall and cell contents such as cytolplasm and nucleus. The walls become lignified (woody).

Function: **conduction** (transport water and mineral ions from roots to leaves)

support (Ligmin provides strength for the stem).





Common misconceptions

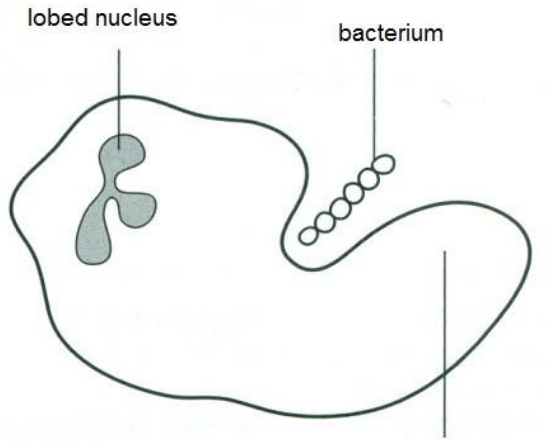
Xylem and phloem tissue are often confused. **Xylem** carries **water** and **mineral** salts, while **Phloem** transports **sugars** and **amino acids**.
In a vascular bundle in a stem, **Phloem** is on the **outside** and **Xylem** is on the **inside**.

Examiner's tips

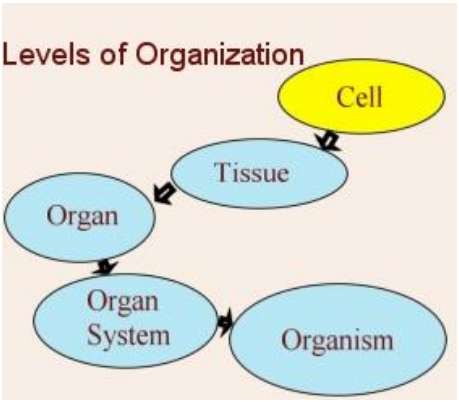
1. You need to be able to give examples of tissues, organs and organ systems in both plants and animals. A leaf is an organ made up of a number of tissues, e.g. upper epidermis, palisade, mesophyll.
2. If you draw a diagram to support an exam answer, make sure you refer to its in your written answer. Annotation is more likely to help you gain extra mark.

Example of annotation

Action of phagocyte



#16 Tissues, Organs and organ Systems



Cells are organized to form tissue, organs, and organ systems. In a healthy organism, all the systems work together.

SPECIALIZED CELLS

- A specialized cell is designed to do a particular job.
- Nerve cells have long fibres to carry massages.
- Muscle cells can contract and relax.
- White blood cells attack bacteria.
- Platelets help clotting.

TISSUES

- Large numbers of specialized cells make up **tissue.**
- Muscles, blood and nerves are all tissues.
- Blood tissue contains red cells for carrying oxygen, white cells for destroying harmful bacteria, and platelets to cause clotting in cuts

ORGANS

- Various tissues together make up an **organ**.
- Each organ has its own specific job.
- The heart, the stomach and the brain are all organs.
- The heart has to pump blood around the body. It is made up of **muscle tissue, blood vessels** and **nerves.**
- Arteries and veins are usually thought of as organ as they consist of several tissue layers.

ORGAN SYSTEMS

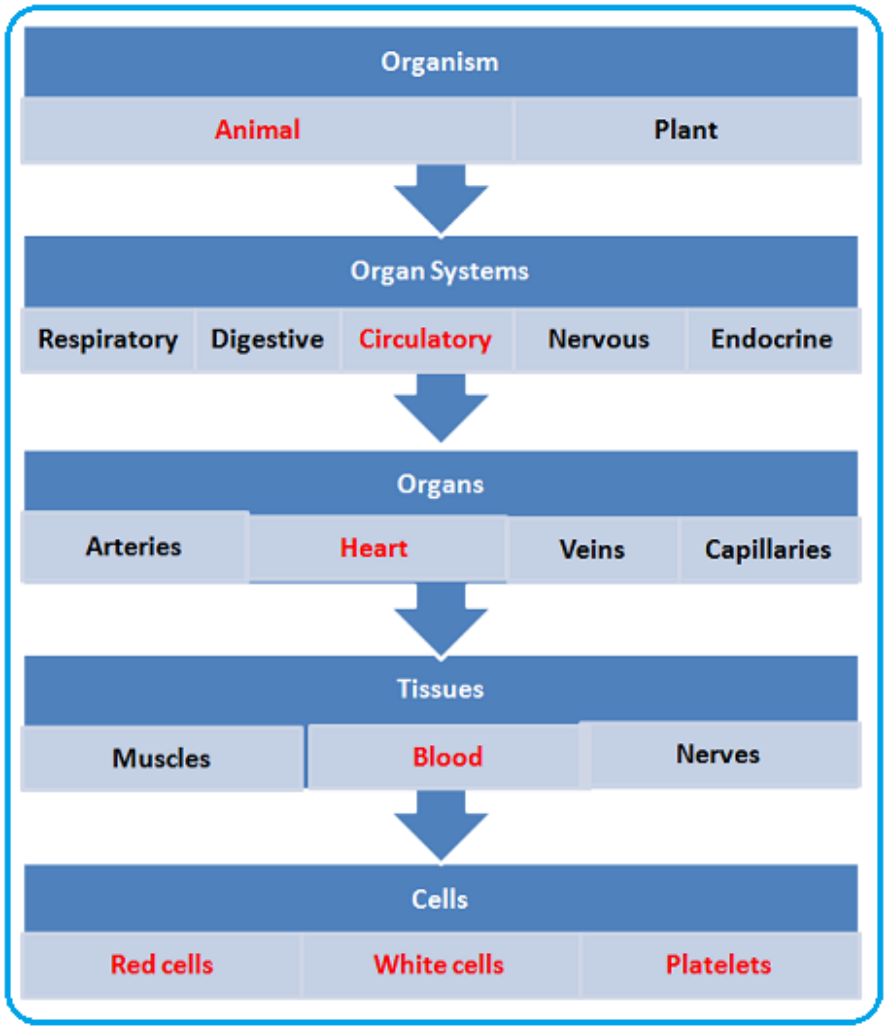
Various organs together make up an **organ system**. E.g. the **circulatory system** carries blood to all parts of the body. It is made up of heart, arteries, veins, capillaries and blood.

ORGANISM

Various organ systems together make up an **organism.**
An human organism has:

- Respiratory system
- Digestive system
- Circulatory system
- Nervous system
- Endocrine system

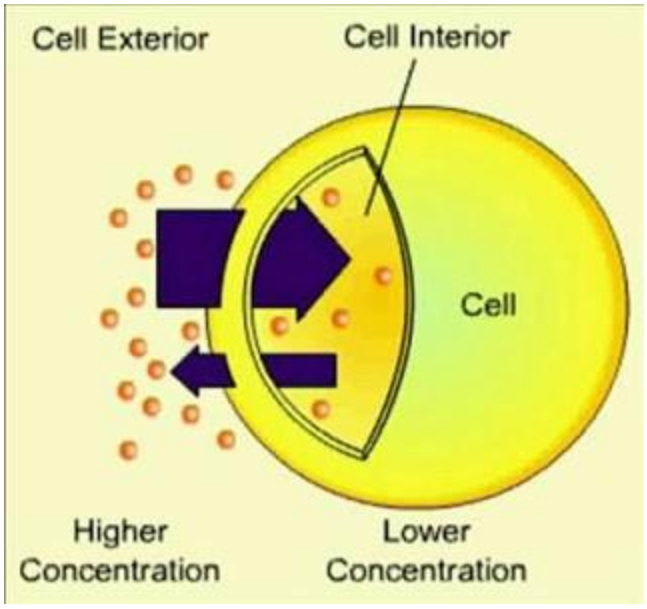
Levels of organisations



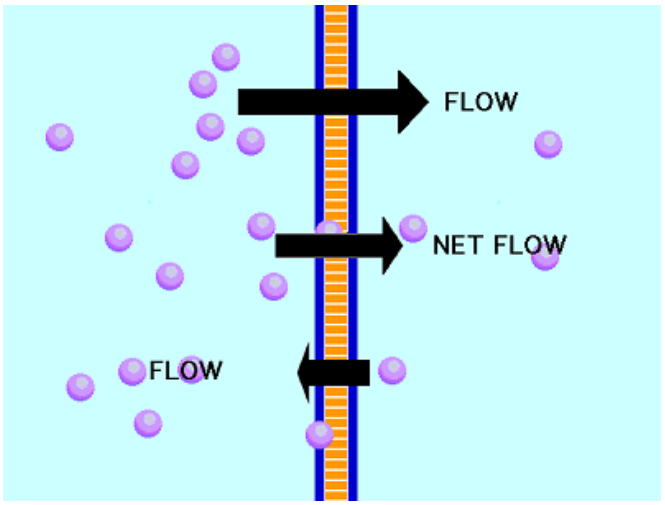
Key definitions

- **Organells**: a structure within a cell (e.g. nucleus, vacuole, cytoplasm and chloroplast are all organelles of a plant cell).
- **Tissue:** a group of cells with similar structures, working together to perform a shared function.
- **Organ:** a structure made up of a group of tissues, working together to perform specific functions.
- **Organ system:** a group of organs with related functions, working together to perform body functions.

#17 Diffusion



Diffusion is the net movement of molecules from a region of its **higher** concentration to a region of its **lower** concentration. Molecules move **down** a **concentration gradient**, as a result of their random movement.



For **living cells**, the principle of the movement down a concentration gradient is the same, but there is one problem:

The cell is surrounded by a **cell membrane**, which can restrict the free movement of the molecules à This is a **selective permeable membrane:** the composition of the membrane (lipid and protein) allows some molecules to cross with ease, but others with difficulty or not at all. The simplest sort of selection is based on the **size** of the molecules.

Importance of gaseous and solute diffusion

Diffusion helps living organisms to:

- **obtain** many of their **requirements**
- **get rid** of many of their **waste products**
- **gas exchange** for respiration

Examples

- CO_2 uses by plants for photosynthesis is diffuses from the air into the leaves, through the stomata (pores at the surface of leaves). There is a lower concentration of CO_2 inside the leaf, as the cells are using it up. O_2 (waste product of photosynthesis diffuses out in the same way).
- Flowering plants use diffusion to attract pollinators like bees.
- Some of the products of digestion are absorbed from the ileum of mammals by diffusion.

Site of diffusion	Substance	Description
Alveoli of lungs	O_2	Alveoli à Blood capillaries
	CO_2	Blood capillaries à Alveoli
Stomata of leaf	O_2	Air spaces of leaf à Atmosphere

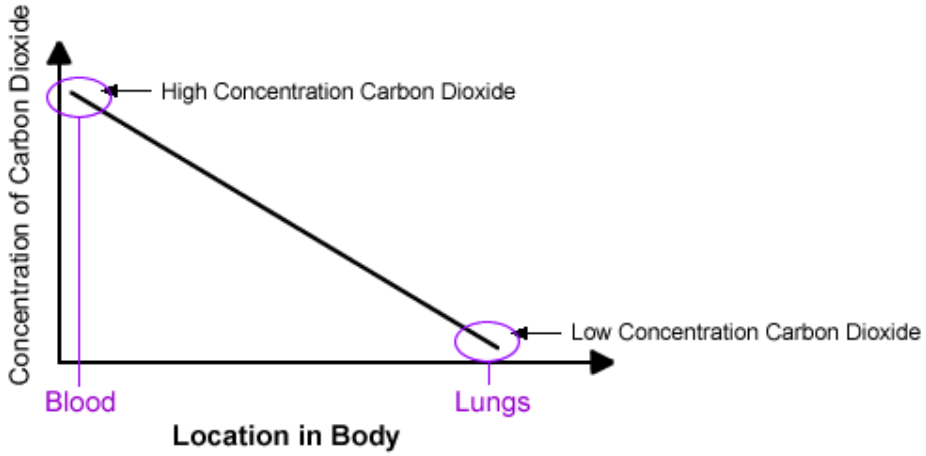
Factors favoring diffusion

- **Distance** (the shorter the better), e.g. thin walls of alveoli and capillaries.
- **Concentration gradient** (the bigger the better). This can be maintained by removing the substance as it passes across the diffusion surface. (Think about oxygenated blood being carried away from the surface of alveoli).
- **Size** of the **molecules** (the smaller the better).
- **Surface area** for diffusion (the larger the better).
- **Temperature** (molecules have more kinetic energy at higher temperature).

Importance of water as a solvent

- Most cells contain about **75%** of **wate.**
- Many **substances** move around a cell **dissolved** in water.
- Many important **reactions** take place in water.

What is a concentration gradient?



The gas particles are more concentrated in the blood than in the lungs. Thus there is a concentration difference between these 2 points. If you join the concentrations in the blood and in the lungs (their points on the graph), you get a straight line which is sloped or has a gradient. This line is the ***concentration gradient*** between the 2 points.

The difference in concentration between 2 regions is known as the concentration gradient.

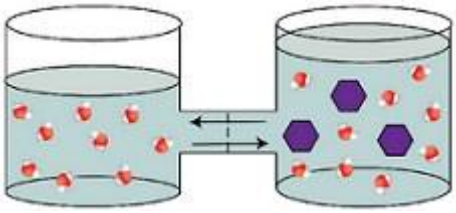
The particles of fluids (liquids and gases) possess kinetic energy. They are continually moving about. As their movement is random, the particles will move (diffuse) down the concentration gradient and become evenly spread out after some time. (So if you spray perfume in one corner of your room, eventually you can smell it from the other side of the room.)

The steeper the concentration gradient, the faster the particles will move. The steeper the concentration gradient for a substance, the faster the rate of diffusion is for that substance!

From http://askmichellebiology.blogspot.com

Additional resource: *http://askmichellebiology.blogspot.com*

#18 Osmosis

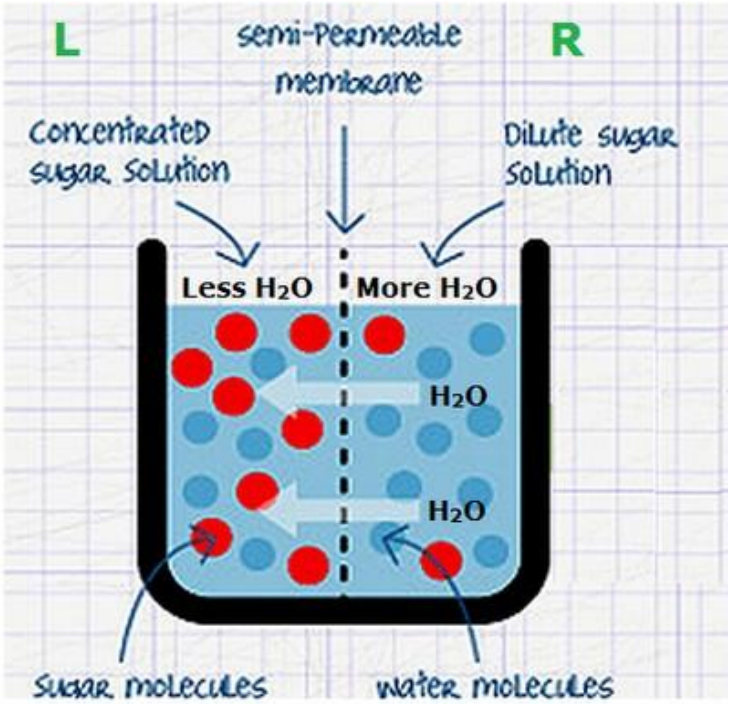


Osmosis is the *diffusion* of **water** molecules from a region of their **higher concentration** to a region of their **lower concentration**, through a *partially* permeable **membrane**.

Osmosis is a special form of diffusion and always involves the movement of H_2O across a membrane. Osmosis is:

- the movement of H_2O
- across a selectively permeable membrane
- down a water potential gradient.

In the picture below

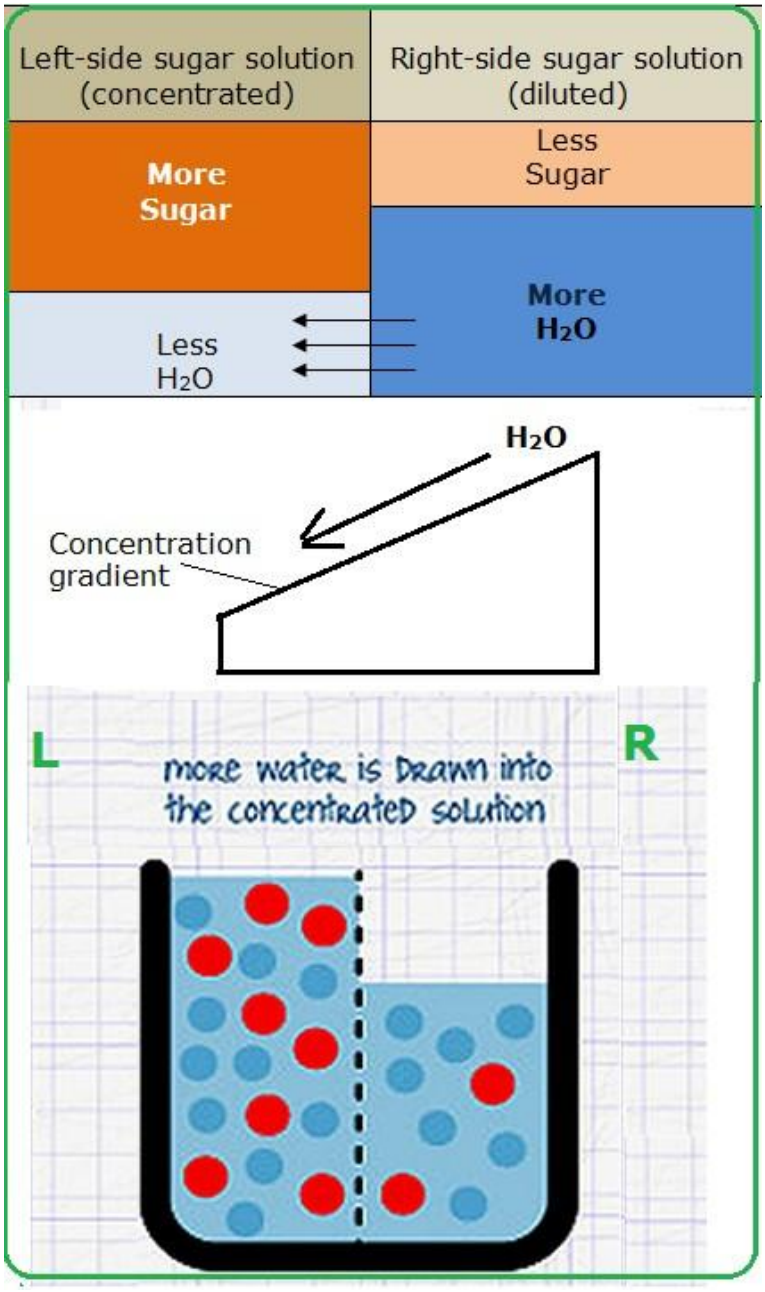


- The concentration of **sugar** molecules is **higher** on the **concentrated** solution **(L)** and lower on the **diluted** one **(R)**.

- The concentration of **wate**r molecules is **higher** on the **(R)** and lower on the **(L)** (a lot of place is taken up by sugar molecules).

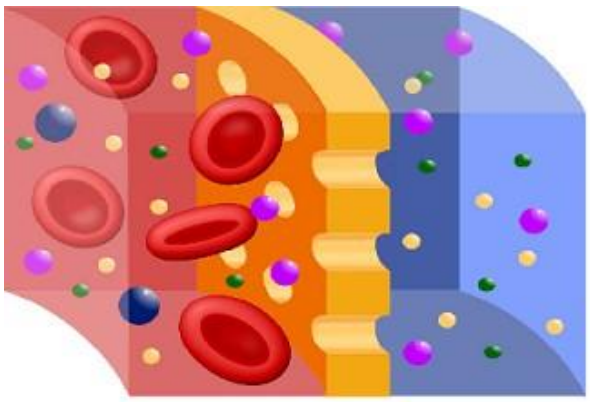
It is confusing to talk about the 'concentration of water', so we can say that a diluted solution (**R**) has a **high water potential** and a concentrated solution (**L**) has a **low water potentia**l.

There is a water **potential gradient** between the 2 sides. The water molecules diffuse **down** this **gradient**, from a high water potential (R) to a low water potential (L).

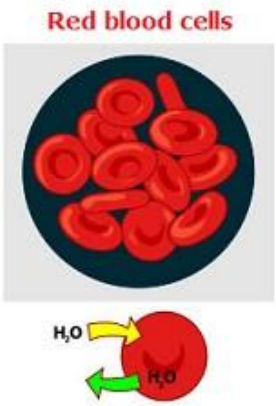


Cell membranes

- partially permeable (let some substances pass through, but not others).
- separate 2 solutions: cytoplasm and solution around the cell.
- If the solutions are of different concentrations, osmosis will occur.



A semi-permeable membrane



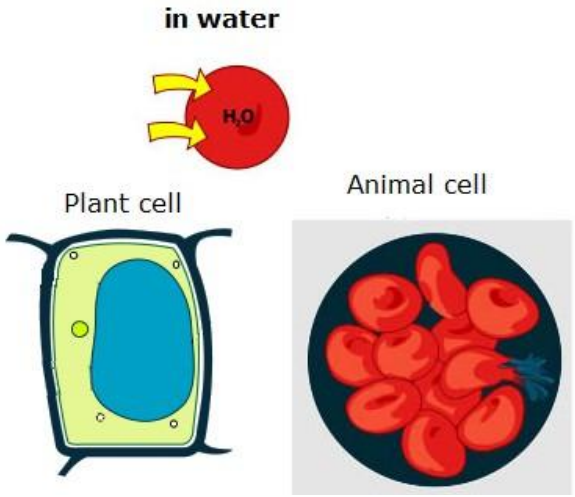
Cell membrane lets water go through

Effect of Osmosis on plant and animal cells

1. When placed **in H_2O:**

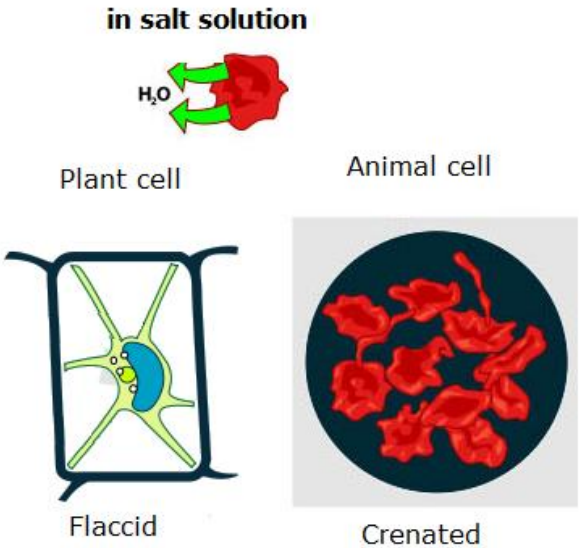
Concentration of H_2O **outside** the cell is **higher** than inside it. Cells will **take in** H_2O by osmosis:

- **plant** cells become **turgid** (swollen) but do not burst (have tough **cell wall** which is fully permeable).
- **animal** cells will burst (no cell wall).



2. When placed **in concentrated** sugar or salt **solutions**:

Concentration of H_2O **inside** the cell is **higher** than outside it. H_2O **get out** of the cells by osmosis:



- **plant** cells become **flaccid** (soft and limp), cytoplasm is no longer pressed against the cell wall. The plant loses it firmness and begin to **wilt**.
- **animal** cells shrink, become **crenated.**
-

Importance of H_2O potential gradient
in the uptake of H_2O by plants:

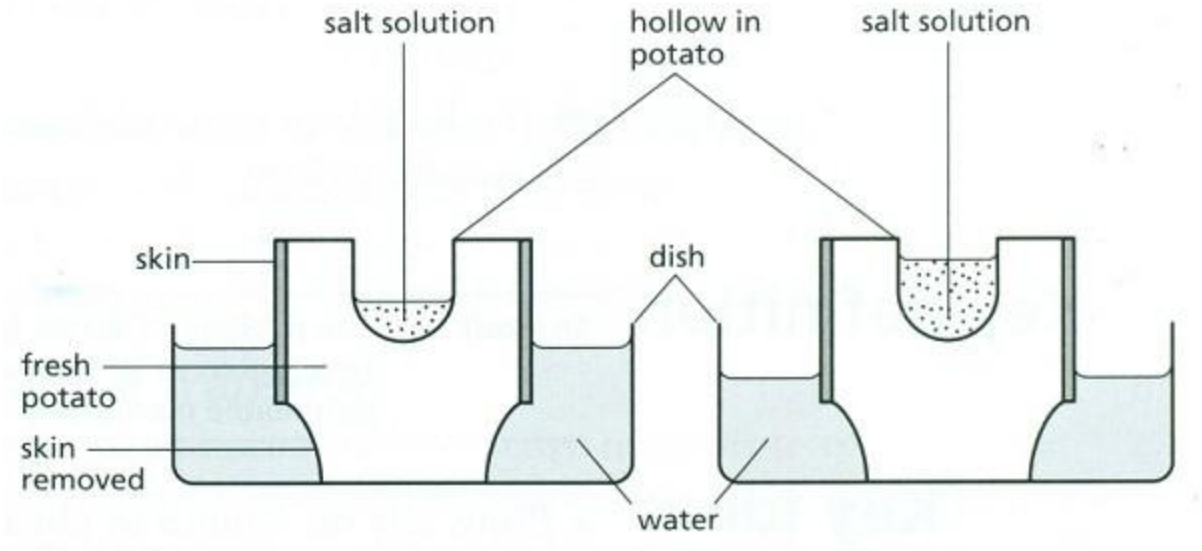
Enables H_2O movement by **osmosis**

- from **soil** to **root** hairs
- from **tissue** fluid to **cells**
- from **xylem** to leaf **mesophyll** cells.

Common misconceptions
Sugar and salt do **not** move by osmosis. Cell membranes prevent them entering or leaving the cell.

Try this

A potato was set up as shown in the figure below (left-hand side). The investigation was left for several hours. The results are shown on the right-hand side of the figure.



1. Describe what happened to
 a. the water in the disk
 b. the salt solution in the hollow in the potato. [2 marks]
2.

a. Name the process that is responsible for the changes that have occurred. [1 mark]

b. Explain why these changes have occurred. [3 mark]

c. Where does this process occur in a plant? [1 mark]

d. What is the importance to the plant of this process? [1 mark]

Answers

1. *a. The volume of water in the dish decreased.*
b. The volume of salt solution in the potato increased.

2. *a. Osmosis*

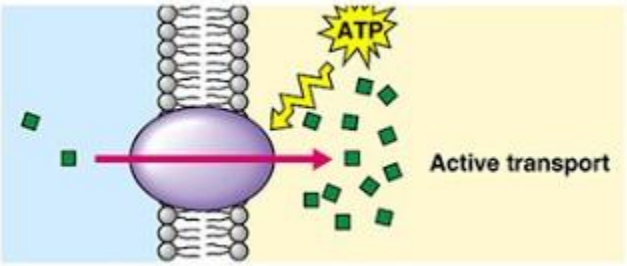
b. 3 points from:

- there was a higher concentration of water in the dish than in the potato
- so water moved into the potato.
- from a high concentration of water to a lower concentration of water
- by osmosis.

c. Root hairs, or in the roots.

d. Osmosis enables the plant to absorb water to maintain cell turgidity (or to replace water lost by transpiration).

#19 Active transport



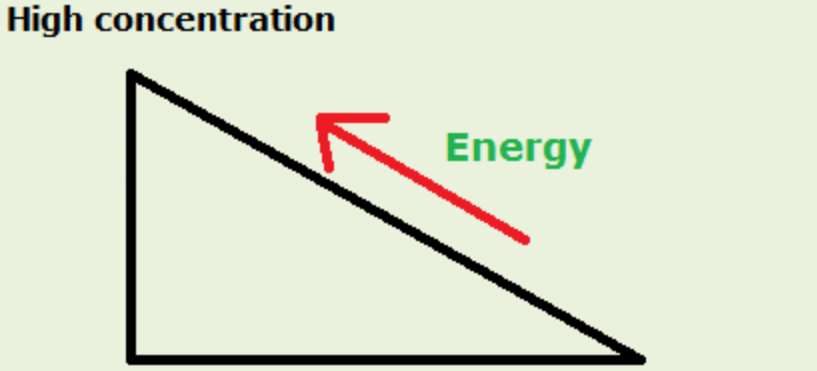
Sometimes substances are required to be move **against** the **Concentration Gradient**, or faster than they would by Passive Transport. In these cases, **Active Processes** are used, which require **energy**.

There are many occasions when cells need to take in **substances** which are only present in **small quantities** around them.

E.g. **root hair** cells in plants take in **nitrate** ions *from* the *soil*. Their concentration are often higher inside the root hair cell than in the soil, so the **diffusion gradient** is from the *root hair* à the *soil*. Despite this, the root hair cells still can take nitrate ions in, by **active transport**.

Active transport

- movement of ions (in or out of a cell through cell membrane) from a region of their **lower** concentration to a region of their **higher** concentration
- **up** a **concentration gradient**
- using **energy** released during *respiration*.



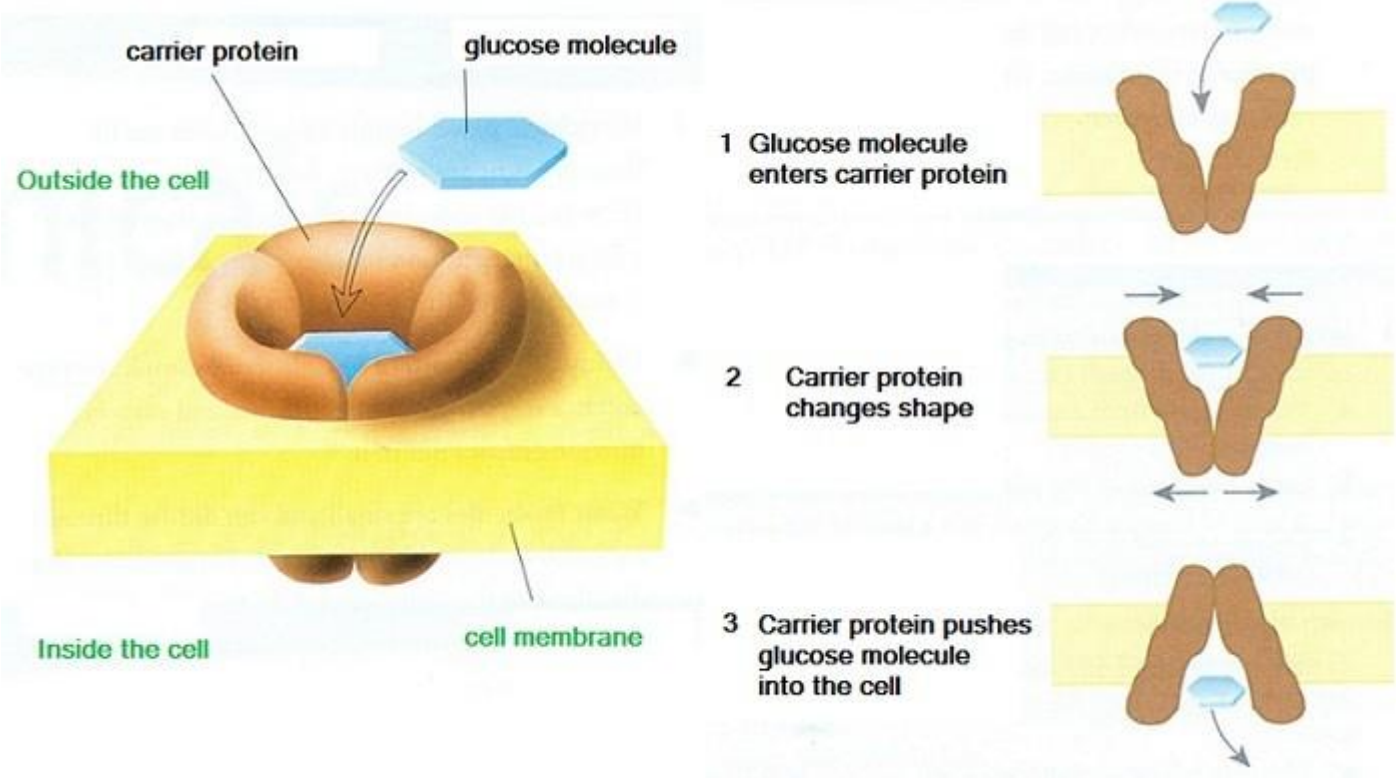
The **importance** of **active transport:** energy-consuming process by which substances are transported against a concentration gradient, e.g. ion uptake by root hairs and glucose uptake by epithelial cells of villi.

Site	Substance	Direction
Root hair cells	Mineral salts (phosphate…)	Soil → roots
Wall of small intestine (villi)	Glucose	Small intestine→ blood plasma

Two big differences between diffusion and active transport:

- **direction** of movement (**down** or **up** a gradient)
- use of **energy** for movement

The active transport is carried out by '**carrier proteins'** in the membrane, which bind to the solute molecule, change shape and carry the molecule across the membrane.



Try this

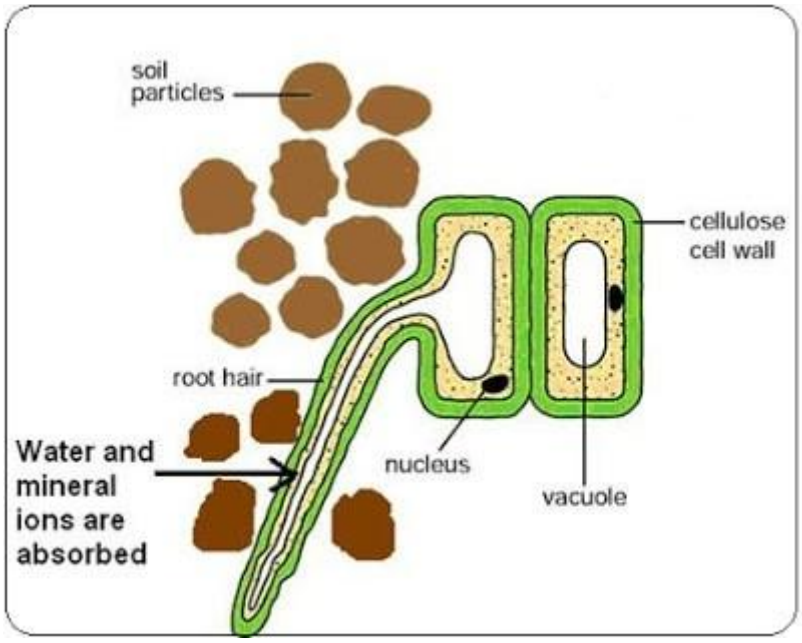


Figure above shows root hair cells.

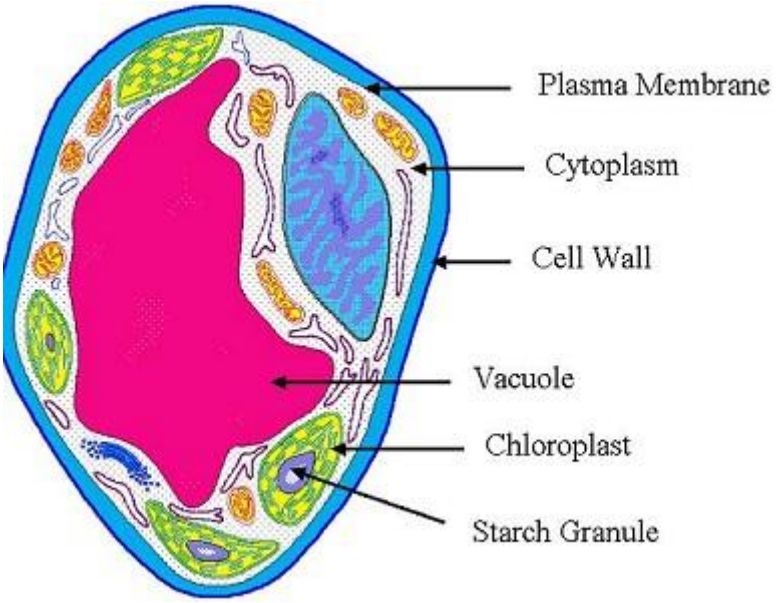
1. Explain how the presence of root hair cells on roots enables the efficient absorption of water and minerals. [*2 marks]*
2. Root hair cells can absorb mineral ions by diffusion and active transport.

a)Define the term active transport [*2 marks*]
b)Explain why respiration rates may increase in root hair cells during the uptake of mineral ions [*1 mark*]

Answers

1. - Large number of root hair cells give a large surface area to the root.
- Mitochondria are present to provide energy for active transport.
2. a) active transport is absorption of a substance into a cell or across a membrane
- against (up) a concentration gradient.
- using energy
b) active transport requires energy

#20 Sum mary of Cells



Structure

- **Cells** are the smallest units of living things. They are too **small** to be seen with the naked eye, so we need to use **microscopes** to see their structures.

- Cells have a cell **membrane**, **cytoplasm** and a **nucleus**. Plant cells also have a **cell wall**, and oft en have **chloroplasts** and a large **vacuole** containing cell sap.

- The cell **membrane** is **partially permeable**, and it controls what enters and leaves the cell.

- The **cytoplasm** is a jelly-like solution of many different substances in water. It is the site of many different **metabolic** reactions.

- The **nucleus** contains the **chromosomes**, which are made of **DNA**. This is the genetic information and it controls the activities of the cell.

- The **cell wall** of a plant cell is made of criss-crossing fibres of **cellulose**. It is fully permeable. It helps to **support** the cell, and prevents the cell bursting if it absorbs a lot of water.

- The **vacuole** of a plant cell contains **cell sap**, which is a solution of **sugars** and other substances in water.

- **Chloroplasts** contain the green pigment **chlorophyll**, which absorbs sunlight for **photosynthesis**. There may be **starch grains** inside the

chloroplasts, which are the form in which plants store the **food** that they make in photosynthesis.

- A **tissue** is a group of **similar cells** which work together to carry out a particular function. Tissues are grouped into **organs**, and organs are grouped into organ **systems.**

Movement in and out of cells

- Particles in gases, liquids and solutions are in constant random motion. As a result of this, there is a net movement from where they are in a **high concentration** to where they are in a **low concentration**. This is **diffusion**.

- **Diffusion** is important to cells. For example, **oxygen** enters a respiring cell by diffusion, and **carbon dioxide** diffuses out of it.

- Water molecules are small and can diffuse through a **partially permeable membrane**. Larger molecules dissolved in the water cannot do this. The diffusion of water through a partially permeable membrane is called **osmosis**.

- Osmosis is important to cells. In a **dilute solution**, water passes into a cell through its partially permeable cell membrane. The cell gets bigger. **Animal cells** may **burst**, but **plant cells** do not because of their **strong cell wall.**

- In a **concentrated solution**, water passes out of a cell by osmosis through its partially permeable membrane. The cell **shrinks**. Plant cells may become **plasmolysed** – that is, the cell membrane pulls away from the cell wall.

- A solution containing a lot of water is said to have a high water potential. A solution containing only a little water has a low water potential. Water moves by **osmosis down** a **water potential gradient**, from a high water potential to a low water potential.

- Cells can use **energy** to move substances **up** their **concentration gradient,** from a low concentration to a high concentration. This is called **active transport**. It uses energy that the cells release by **respiration**.