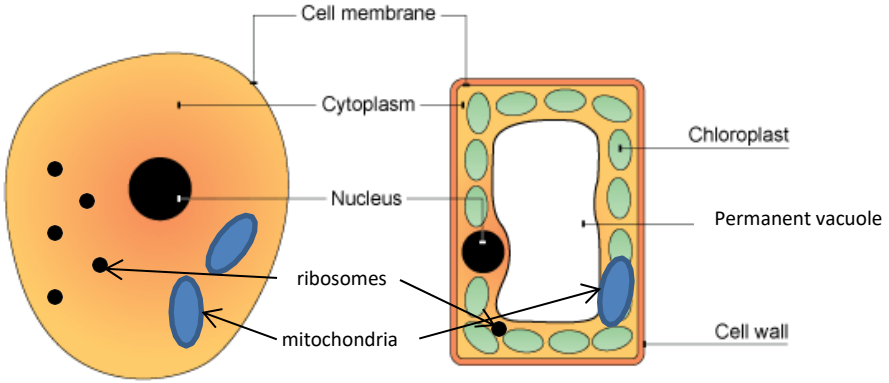
Biology Knowledge Organiser
B1 - Cell structure and transport

Eukaryotic Cells

Eukaryotic cells include all plant and animal cells. Their most important feature is that they have a nucleus, unlike prokaryotic cells.

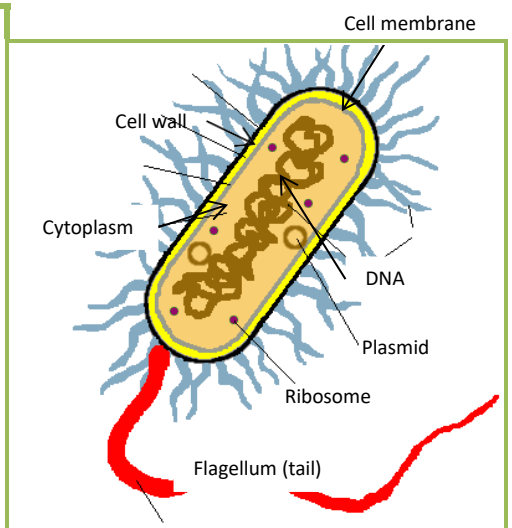


Prokaryotic Cells

Bacteria are prokaryotic cells (all bacteria are single-celled organisms). The most important differences to eukaryotic cells are that they are smaller and their genetic material (DNA) is not enclosed in a nucleus.

Prokaryotic cells have DNA in a loop, and, in addition to the main loop of DNA, they have small loops of DNA called plasmids.

Plasmids allow bacteria to swap genetic information between them.

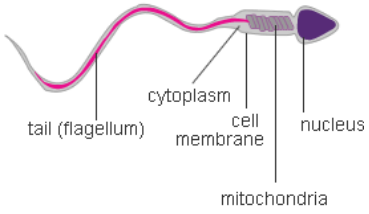


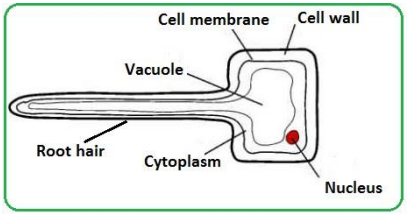
Key Terms	Definitions
Cell	The basic unit of all forms of life.
Eukaryotic Cells	Cells with a genetic material enclosed in a nucleus – e.g. plant and animal cells.
Prokaryotic Cells	Bacterial cells; these don't have a nucleus to enclose their genetic material.
Cell Membrane	The border of all types of cell. The cell membrane separates the inside of the cell from the environment. It controls the movement of substances into and out of the cell.
Sub-cellular structure	A part of a cell. (Sub- means less than – so these are the component parts of cells.) Also known as organelles.
Nucleus	The enclosure for genetic material found in plant and animal cells. It controls the activities of the cell.
Cytoplasm	The interior of a cell, where most of the chemical reactions needed for life take place.
Mitochondria	The sub-cellular structure where aerobic respiration takes place.
Ribosome	The sub-cellular structure where proteins are made (synthesised)
Chloroplast	A sub-cellular structure responsible for photosynthesis – only found in plant cells and algal cells.
Permanent Vacuole	A sub-cellular structure only found in plant and algal cells – it is filled with cell sap (a store of nutrients for the cell).
Cell Wall	A sub-cellular structure that is never found in animal cells. It is made of cellulose, it is outside the cell membrane and it strengthens the cell.
DNA	The molecule that holds the genetic information in a cell. In eukaryotic cells, it is one linear strand. In prokaryotic cells, the DNA forms a loop.
Plasmid	A small loop of extra DNA, only found in prokaryotic cells.

Biology Knowledge Organiser
B1 - Cell structure and transport

Multicellular Organisms

You are a multicellular organism, just like all animals, plants and many types of fungus. But, not all your cells are the same. Cells become specialised by **differentiation**, which means they develop new features to help them perform a specific function. E.g. sperm cells and root hair cells.





Tissues are formed when cells with similar structures and functions work together. For example: muscle tissue in animals; phloem tissue in plants.

Organs are formed from multiple tissues working together. For example: the stomach in animals; the leaf in plants.

Organ systems are formed when multiple organs work together. For example: the digestive system in animals; the vascular (transport) system in plants.

Microscopy

Use of a microscope is called microscopy. Microscopes allowed scientists to discover cells and find all the sub-cellular structures.
Because cells and their parts are very small, it is not useful to measure them in metres. Instead, we use small divisions of the metre as follows:

Centimetre = 1/100 metre (10^{-2}). A centimetre is 1 one hundredth of a metre. (cm)
Millimetre = 1/1000 metre (10^{-3}). A millimetre is 1 one thousandth of a metre. (mm)
Micrometre = 1/1 000 000 (10^{-6}). A micrometre is 1 one millionth of a metre. (µm)
Nanometre = 1/1 000 000 000 (10^{-9}) A nanometre is 1 one billionth of a metre. (nm)

Electron microscopes were a vital invention for understanding cells. They have higher magnification and more resolving power than light microscopes, so they let you see smaller structures.

Key Terms	Definitions
Multicellular	This describes an organism that is made of lots of cells – such as animals or plants.
Specialised Cell	Almost all cells in multicellular organisms have a particular job, or function.
Tissue	A group of cells with similar structures and functions – i.e. a group of specialised cells.
Organ	An organ is a collection (or aggregation) of tissues performing a specific function.
Organ System	Organs don't operate alone: they work together to form organ systems.
Organism (again)	An organism has many organ systems, all contributing to its survival.
Light microscope	A usual school microscope is a light microscope. You can see large sub-cellular structures like a nucleus with it, but not a lot more detail than that.
Magnification	This is the measure of how much a microscope can enlarge the object you are viewing through it.
Resolution	This is the measure of the level of detail you can see with a microscope.
Electron microscope	A type of microscope with much high magnification and resolution than a light microscope. Essential for discovering the smaller sub-cellular structures.

Equation	Meanings of terms in equation
$magnification = \frac{size\ of\ image}{size\ of\ real\ object}$	*The image Is how it looks through the microscope. The real object is what you are looking at. The image and object must be measured with the same unit, e.g. both in µm or nm.*

Biology Knowledge Organiser
B1 - Cell structure and transport

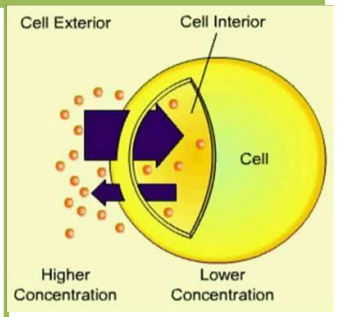
Exchange and Transport

To stay alive, all organisms must exchange substances with their environment. This means they must transport **into** cells the substances they need from the environment and transport **out** waste products to the environment.

Substances can be transported into or out of cells by: **diffusion, osmosis** or **active transport**.

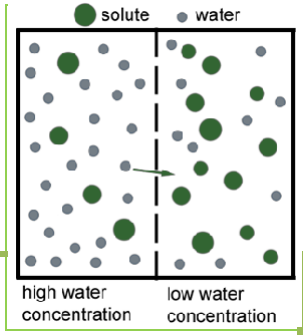
Diffusion

Diffusion allows many substances to move into or out of cells. Thanks to the random motion of particles in liquids and gases, particles will spread out until the concentration is equal throughout. If there is a cell membrane that lets the substance through (is **permeable**) in the way, it doesn't matter. Overall, the **net movement** of the substance will be from higher to lower concentration, as the diagram shows.



Diffusion is the process by which oxygen is transported into the bloodstream, and carbon dioxide is transported out (in the lungs, or gills of fish). It is also how the waste product **urea** moves from cells into the bloodstream, before removal in the urine.

The **rate** of diffusion is affected by:
1. the steepness of the concentration gradient
2. the temperature (a higher temperature increases the rate of diffusion as particles have more kinetic energy)
3. The surface area of the membrane (a larger surface area of cell membrane increases the rate of diffusion into/out of a cell).



Osmosis

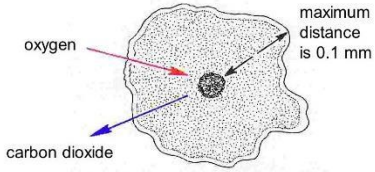
Osmosis is the movement of water from a more dilute solution (more 'watery') to a more concentrated solution (less 'watery') across a partially permeable membrane, such as a cell membrane. Osmosis causes cells to swell up if they are placed in a dilute solution, or shrivel up if they are placed in a concentrated solution (a solution of salt, for instance, or sugar).

Key Terms	Definitions
Diffusion	The net (overall) movement of particles from a higher concentration to a lower concentration. Diffusion happens across cell membranes. It does not require any energy from the cell.
Concentration gradient	The difference in concentration of a substance between two places. A 'steeper' concentration gradient means there is a bigger difference in concentration.
Surface area to volume ratio	The surface area divided by the volume of an organism, organ or cell. Generally, the smaller something is, the larger the surface area to volume ratio.
Exchange surface	A place, such as the walls of the small intestine, where exchange of substances takes place e.g. by diffusion across it.
Diffusion pathway	The distance over which a substance must diffuse. A thin wall or membrane is a short diffusion pathway.
Osmosis	Osmosis only describes the movement of water. It is the diffusion of water from a dilute solution to a more concentrated solution across a partially permeable membrane.
Partially permeable membrane	A membrane that only allows some substances through – others are prevented from travelling through.
Active transport	The movement of substances **against** the concentration gradient – from lower to higher concentration. This requires energy from respiration.

Active transport

Active transport is so-named because it requires energy. A good example of where it happens is in plant roots. Root hair cells (see specialised cells topic) absorb mineral ions (like magnesium ions and nitrate ions) from the very dilute solution in the soil by active transport. They need ions like these for healthy growth. An example in animals is absorption of sugar from the intestine into the blood – the blood has a higher sugar concentration so active transport is needed. The sugar is needed by all cells in the body for respiration.

Biology Knowledge Organiser
B1 - Cell structure and transport



Specialised exchange surfaces

To be effective at exchanging substances with the environment, any exchange surface must have a **large surface area**, and a thin wall/membrane for a **short diffusion pathway**. In animals, a constant blood supply also increases effectiveness, and in the lungs, ventilation (breathing in and out) increases effectiveness by refreshing the concentration gradient with each breath.

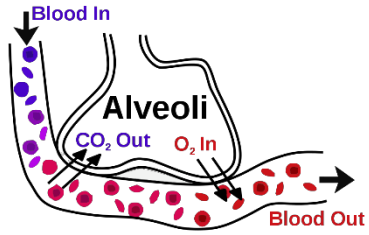
Exchange in animals and plants

Gas exchange in many animals, including us, happens in the lungs. The structures in the lungs where it happens are the **alveoli**. There are millions of these tiny air sacs, so in total their surface area is gigantic. They also have a short diffusion pathway, a good blood supply and air supply due to **ventilation**. (look at the diagram of one alveolus)

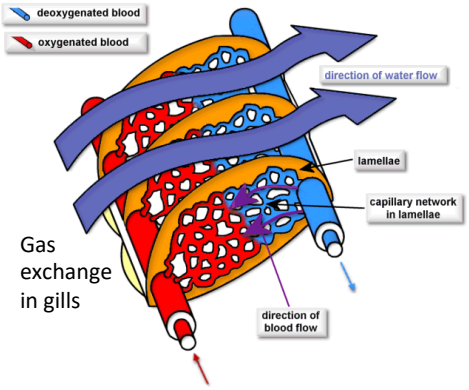
In fish, gills are where gas exchange takes place (see diagram). Again, a huge surface area increases the efficiency of gas exchange, along with a short diffusion pathway and good blood supply. The huge surface area comes from the division of gills into very thin plates of tissue called lamellae. This also creates the short diffusion pathway.

In plants, the roots absorb water and mineral ions. The root hair cells have **long projections** that increase the surface area of this exchange surface, and shorten the diffusion pathway. The leaves are responsible for gas exchange, including oxygen out and water vapour out, and carbon dioxide in. Being flat and broad increases the effectiveness of the leaves as exchange surfaces, by increasing the surface area and shortening the diffusion pathway. In leaves, exchange happens through microscopic holes called **stomata**.

Key Terms	Definitions
Small intestine	The organ in the digestive system where products of digestion are absorbed into the bloodstream.
Lungs	The organs were gas exchange takes place. The air sacs where gases are actually exchanged are called **alveoli**.
Gills	The organs in fish where gas exchange takes place. Oxygen is absorbed from the water into the blood, and carbon dioxide is transferred to the water.
Leaves	The plant organs responsible for gas exchange.
Ventilation	Technical term for breathing in and out. Breathing in brings fresh air, with a relatively high oxygen concentration, into the lungs, and breathing out removes the air with a relatively high concentration of carbon dioxide (and low concentration of oxygen).

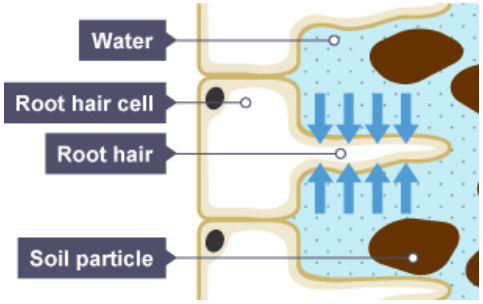


Gas exchange in lungs



Gas exchange in gills

Substance exchange in roo



Gas exchange in leaves