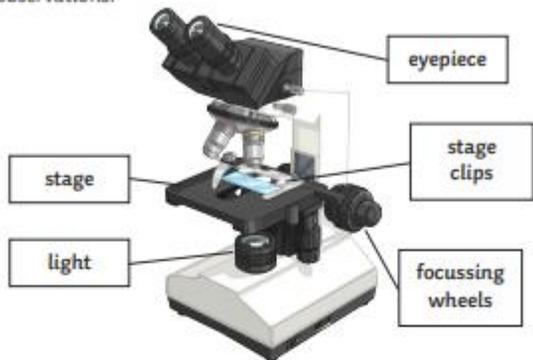


## Required Practical

### Microscopy Required Practical

- Includes preparing a slide, using a light microscope, drawing any observations – use a pencil and label important observations.



### Osmosis and Potato Practical

- Independent variable – concentration.
- Dependent variable – change in mass.
- Control variable – volume of solution, temperature, time, surface area of the potato.

The potato in the sugar solution will lose water and so will have less mass at the end; the potato in the pure water solution will gain water.



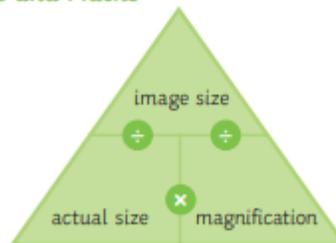
## Specialised Cells

When a cell changes to become a specialised cell, it is called differentiation.

Specialised Cell	Function	Adaptation
sperm	To get the male DNA to the female DNA.	Streamlined head, long tail, lots of mitochondria to provide energy.
nerve	To send electrical impulses around the body.	Long to cover more distance. Has branched connections to connect in a network.
muscle	To contract quickly.	Long and contain lots of mitochondria for energy.
root hair	To absorb water from the soil.	A large surface area to absorb more water.
phloem	Transports substances around the plant.	Pores to allow cell sap to flow. Cells are long and joined end-to-end.
xylem	Transports water through the plant.	Hollow in the centre. Tubes are joined end-to-end.

## Equations and Maths

### Equation



### Maths Skills

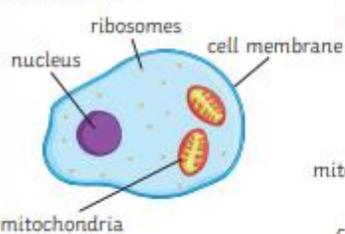
Conversions:  
Micrometres to millimetres: divide by 1000.

Standard Form:  
 $0.003 = 3 \times 10^{-3}$

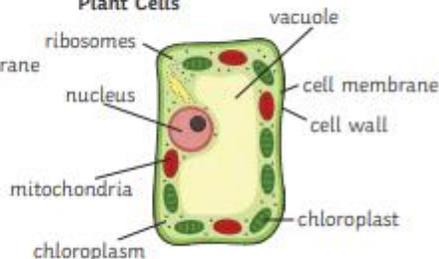
$5.6 \times 10^{-5} = 0.0056$

## Prokaryotic and Eukaryotic Cells

### Animal Cells



### Plant Cells



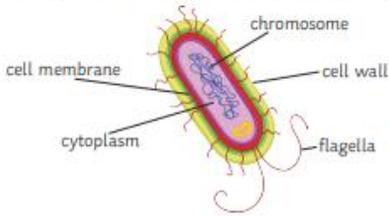
Plant and animal cells have similarities and differences:

	Animal	Plant
nucleus	✓	✓
cytoplasm	✓	✓
chloroplast	X	✓
cell membrane	✓	✓
permanent vacuole	X	✓
mitochondria	✓	✓
ribosomes	✓	✓
cell wall	X	✓

# CELL BIOLOGY

## Bacterial Cells

Bacterial cells do not have a true nucleus, they just have a single strand of DNA that floats in the cytoplasm. They contain a plasmid.



## Stem Cells

**Embryonic stem cells** are undifferentiated cells, they have the potential to turn into any kind of cell.



**Adult stem cells** are found in the bone marrow, they can only turn into some types of cells e.g. blood cells.

### Uses of stem cells:

- Replacing faulty blood cells;
- making insulin producing cells;
- making nerve cells.

Some people are against stem cell research.

For Stem Cell Research	Against Stem Cell Research
Curing patients with stem cells - more important than the rights of embryos.	Embryos are human life.
They are just using unwanted embryos from fertility clinics, which would normally be destroyed.	Scientists should find other sources of stem cells.

## Stem Cells in Plants

In plants, stem cells are found in the **meristem**. These stem cells are able to produce clones of the plant. They can be used to grow crops with specific features for a farmer, e.g. **disease resistant**.

## Key Vocabulary

- active transport
- alveoli
- chromosome
- diffusion
- eukaryotic
- gas exchange
- mitosis
- multicellular
- osmosis
- prokaryotic
- undifferentiated
- replicated
- specialised
- villi

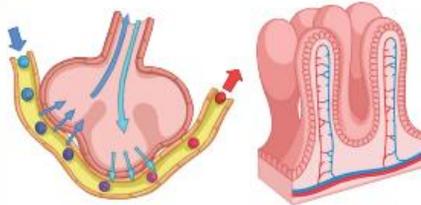
## Exchange - Humans

**Multicellular** organisms have a large surface area to volume ratio so that all the substances can be exchanged.

### Gas exchange: Lungs

The alveoli are where gas exchange takes place.

They have a large surface area, moist lining, thin walls and a good blood supply.

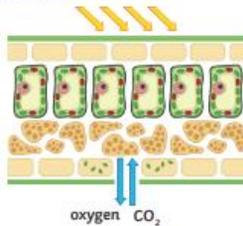


### Villi: Small Intestine

Millions of villi line the small intestine increasing the surface area to absorb more digested food.

They are a single layer of cells with a good blood supply.

## Exchange in Plants

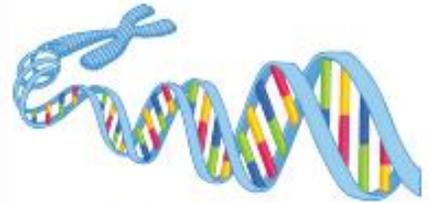


The surface of the leaf is flattened to increase the surface area for more gas exchange by diffusion.

Oxygen and water vapour diffuse out of the stomata. Guard cells open and close the stomata, controlling water loss.

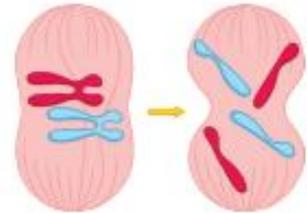
## Chromosomes and Mitosis

In the nucleus of a human cell there are 23 pairs of **chromosomes**. Chromosomes contain a double helix of **DNA**. Chromosomes have a large number of genes.



The **cell cycle** makes new cells.

**Mitosis**: DNA has to be **copied/replicated** before the cell carries out mitosis.



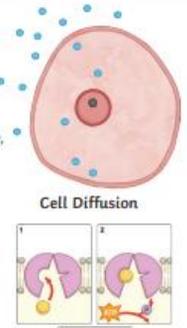
## Key Processes

**Diffusion** is the spreading out of particles from an area of higher concentration to an area of lower concentration.

**Cell membranes** are semi-permeable, only small molecules can get through.

**Osmosis** is the movement of water molecules across a partially permeable membrane from a region of higher concentration to a region of lower concentration.

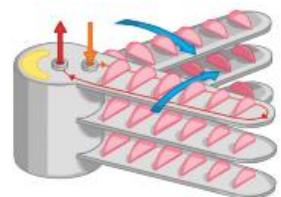
**Active transport** is the movement of substances against the concentration gradient. This process requires energy from respiration.



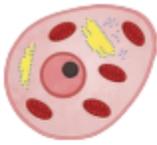
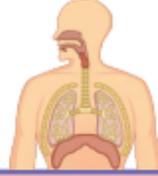
Active Transport in Cells

## Exchange in Fish

Fish have a large surface area for gas exchange. These are called **gills**. Water enters the fish through the mouth and goes out through the gills. The oxygen is transported from the water to the blood by **diffusion**. Carbon dioxide diffuses from the blood to the water. Each gill has **gill filaments** which give the gills a large surface area. **Lamellae** cover each gill filament to further increase the surface area for more gas exchange. They have a **thin surface layer** and **capillaries** for good blood supply which helps with diffusion.



## Principles of Organisation

				
<b>cell</b>	<b>tissue</b>	<b>organ</b>	<b>organ system</b>	<b>organism</b>
Cells are the basic building blocks of all living things.	A group of cells with a similar structure and function is called a tissue.	An organ is a combination of tissues carrying out a specific function.	Organs work together within an organ system.	Organ systems work together to form whole living organisms.

## Food Tests – Required Practical

What are you testing for?	Which indicator do you use?	What does a positive result look like?
sugar	Benedict's reagent	Once heated, the solution will change from blue-green to yellow-red.
starch	iodine	Blue-black colour indicates starch is present.
protein	biuret	The solution will change from blue to pink-purple.
lipid	sudan III	The lipids will separate and the top layer will turn bright red.

## Effect of pH on the Rate of Reaction of Amylase – Required Practical

**Iodine** is used to test for the presence of starch. If starch is present, the colour will change to blue-black.

The **independent variable** in the investigation is the pH of the buffer solution.

The **dependent variable** in the investigation is the time taken for the reaction to complete (how long it takes for all the starch to be digested by the amylase).

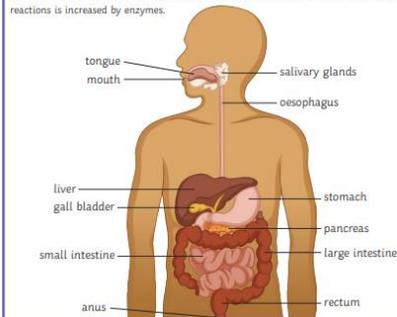


### Method:

- Use the marker pen to label a test tube with the first value of pH buffer solution (pH 4) and stand it in the test tube rack.
- Into each well of the spotting tiles, place a drop of iodine.
- Using a measuring cylinder, measure 2cm<sup>3</sup> of amylase and pour into the test tube.
- Using a syringe, measure 1cm<sup>3</sup> of the buffer solution and pour into the test tube.
- Leave this to stand for five minutes and then use the thermometer to measure the temperature. Make a note of the temperature.
- Add 2cm<sup>3</sup> of starch solution into the test tube, using a different measuring cylinder to measure, and begin a timer (leave the timer to run continuously).
- After 10 seconds, use a pipette to extract some of the amylase/starch solution, and place one drop into the first well of the spotting tile. Squirt the remaining solution back into the test tube.
- Continue to place one drop into the next well of the spotting tile, every 10 seconds, until the iodine remains orange.
- Record the time taken for the starch to be completely digested by the amylase by counting the wells that were tested positive for starch (indicated by the blue/black colour change of the iodine). Each well represents 10 seconds of time.
- Repeat steps 1 to 8 for pH values 7 and 10.

## The Digestive System

The purpose of the digestive system is to break down large molecules into smaller, soluble molecules, which are then absorbed into the bloodstream. The rate of these reactions is increased by enzymes.



## Enzymes

An enzyme is a biological **catalyst**; enzymes speed up chemical reactions without being changed or used up.



This happens because the enzyme lowers the **activation energy** required for the reaction to occur. Enzymes are made up of chains of amino acids folded into a globular shape.

Enzymes have an **active site** which the **substrate** (reactants) fits into. Enzymes are very specific and will only catalyse one specific reaction. If the reactants are not the complimentary shape, the enzyme will not work for that reaction.

Enzymes also work optimally at specific conditions of pH and temperature. In extremes of pH or temperature, the enzyme will **denature**. This means that the bonds holding together the 3D shape of the active site will break and the active shape will deform. The substrate will not be able to fit into the active site anymore and the enzyme cannot function.

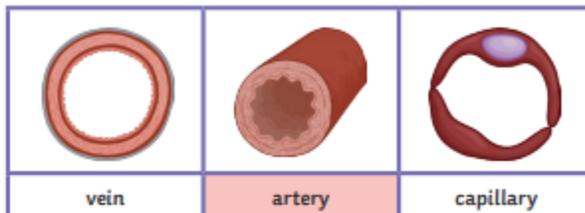
Enzyme	Reactant	Product
amylase	starch	sugars (glucose)
protease	protein	amino acids
lipase	lipid	glycerol and fatty acids

The products of digestion are used to build new carbohydrates and proteins and some of the glucose is used for respiration.

**Bile** is produced in the **liver** and stored in the gall bladder. It is an **alkaline** substance which **neutralises** the hydrochloric acid in the stomach. It also works to **emulsify** fats into small droplets. The fat droplets have a higher **surface area** and so the rate of their digestion by lipase is increased.

## The Heart and Blood Vessels

The **heart** is a large muscular organ which **pumps blood** carrying oxygen or waste products around the body. The **lungs** are the site of **gas exchange** where oxygen from the air is exchanged for waste carbon dioxide in the blood. Oxygen is used in the **respiration** reaction to release energy for the cells and carbon dioxide is made as a waste product during the reaction.



The three types of blood vessels, shown above, are each adapted to carry out their specific function.

**Capillaries** are narrow vessels which form networks to closely supply cells and organs between the veins and arteries. The walls of the capillaries are only **one cell thick**, which provides a short **diffusion pathway** to increase the rate at which substances are transferred.

The table below compares the structure and function of arteries and veins:

	Artery	Vein
direction of blood flow	away from the heart	towards the heart
oxygenated or deoxygenated blood?	oxygenated (except the pulmonary artery)	deoxygenated (except the pulmonary vein)
pressure	high	low (negative)
wall structure	thick, elastic, muscular, connective tissue for strength	thin, less muscular, less connective tissue
lumen (channel inside the vessel)	narrow	wide (with valves)

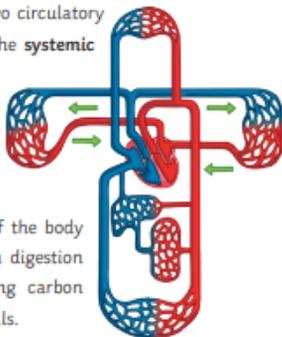
## The Heart as a Double Pump

The heart works as a **double pump** for two circulatory systems; the **pulmonary** circulation and the **systemic** circulation.

The pulmonary circulation serves the lungs and bring deoxygenated blood to exchange waste carbon dioxide gas for oxygen at the **alveoli**.

The systemic circulation serves the rest of the body and transports oxygen and nutrients from digestion to the cells of the body, whilst carrying carbon dioxide and other waste away from the cells.

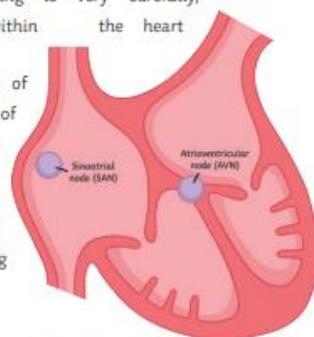
The systemic circulation flows through the whole body. This means the blood is flowing at a much higher pressure than in the pulmonary circuit.



## The Heart as Pacemaker

The rate of the heart beating is very carefully, and automatically, controlled within the heart itself.

Located in the muscular walls of the heart are small groups of cells which act as pacemakers. They produce electrical impulses which stimulate the surrounding muscle to contract, squeezing the chambers of the heart and pumping the blood.



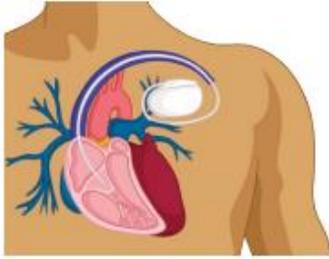
The **sino-atrial node (SAN)** is located near the right atrium and it stimulates the atria to contract.

The **atrio-ventricular node (AVN)** is located in between the ventricles and stimulates them to contract.

# ORGANISATION

## The Heart as Pacemaker

Artificial pacemakers can be surgically implanted into a person if their heart nodes are not functioning correctly.



## Coronary Heart Disease

**Coronary heart disease** is a condition resulting from **blockages** in the **coronary arteries**. These are the main arteries which supply blood to the heart itself and they can become blocked by build-up of **fatty deposits**.

In the UK and around the world, coronary heart disease is a major cause of many **deaths**.

The main symptoms can include **chest pain, heart attack or heart failure**. Yet, not all people suffer the same symptoms, if any at all.

**Lifestyle factors** can increase the risk of a person developing coronary heart disease.

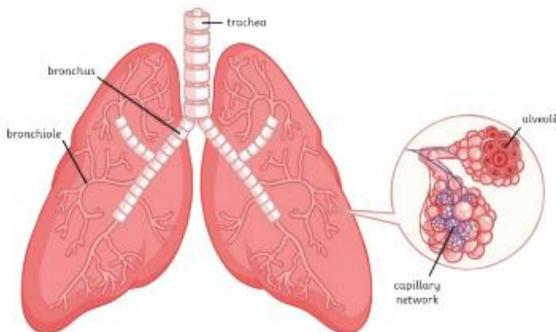
**Diet** – a high-fat diet (containing lots of saturated fat) can lead to higher cholesterol levels and this cholesterol forms the fatty deposits which damage and block the arteries.

**Smoking** – chemicals in cigarette smoke, including nicotine and carbon monoxide, increase the risk of heart disease. Carbon monoxide reduces the amount of oxygen which can be transported by the red blood cells and nicotine causes an increased heart rate. The lack of oxygen to the heart and increased pressure can lead to heart attacks.

**Stress** – prolonged exposure to stress or stressful situations (such as high pressure jobs) can lead to high blood pressure and an increased risk of heart disease.

**Drugs** – illegal drugs (e.g. ecstasy and cannabis) can lead to increased heart rate and blood pressure, increasing the risk of heart disease.

**Alcohol** – regularly exceeding unit guidelines for alcohol can lead to increased blood pressure and risk of heart disease.



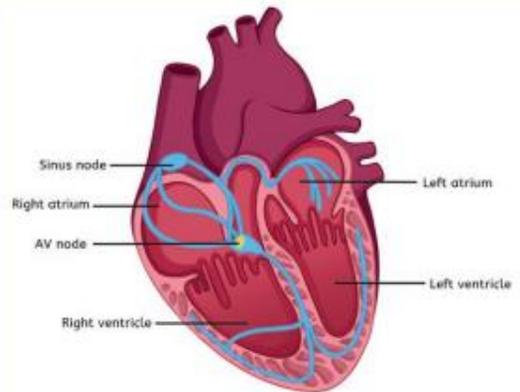
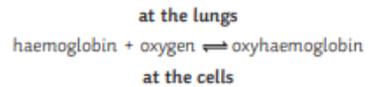
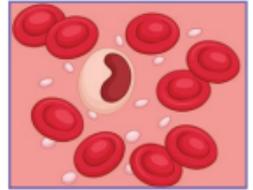
## Blood

Blood is composed of red blood cells (erythrocytes), white blood cells and platelets, all suspended within a plasma (a tissue).

The **plasma** transports the different blood cells around the body as well as carbon dioxide, nutrients, urea and hormones. It also distributes the heat throughout the body.

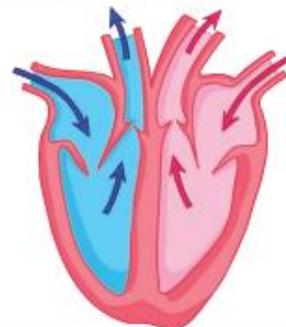
**Red blood cells** transport oxygen attached to the haem group in their structure. It has a biconcave shape to increase surface area and does not contain a nucleus so it can bind with more oxygen molecules.

**White blood cells** form part of the immune system and ingest pathogens and produce antibodies. **Platelets** are important blood clotting factors.



The **right atrium** receives deoxygenated blood via the **vena cava**. It is then pumped down through the valves into the right ventricle. From here, it is forced up through the **pulmonary artery** towards the **lungs** where it exchanges carbon dioxide for oxygen. The oxygenated blood then enters the **left atrium** via the **pulmonary vein** and down into the left ventricle. The muscular wall of the **left ventricle** is much thicker so it can pump the blood more forcefully out of the heart and around the entire body, via the **aorta**.

The blood only flows in **one direction**. This is because there are **valves** in the heart which close under pressure and prevent the backward flow of blood.



# ORGANISATION

## Rate Calculations for Blood Flow

The number of beats the heart performs each minute is called the **pulse** (or heart rate).

It is easily measured by counting the number of beats in a given time, e.g. 15s, and finding the total beats **per minute**.

Typically, a lower resting pulse rate indicates a greater level of physical **fitness**. During exercise, and for some time after, the pulse rate increases while the heart is working to provide more **oxygen** to the muscles.

**Cardiac output** is a measure of the volume of blood pumped by the heart each **minute**. **Stroke volume** is a measure of the volume of blood pumped from the heart each **contraction** (heart beat).

$$\text{Cardiac output (cm}^3\text{/min)} = \text{heart rate (bpm)} \times \text{stroke volume (cm}^3\text{/beat)}$$

## Plant Tissues, Organs and Systems

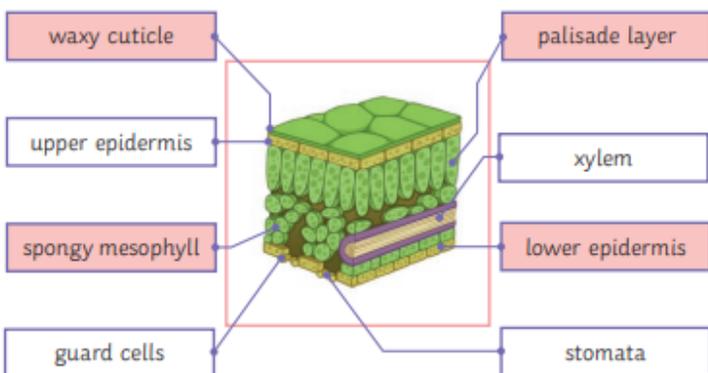
**Leaves** are plant organs and their main function is to absorb sunlight energy for use in **photosynthesis**. Within the cells are small organelles called **chloroplasts** which contain a green pigment called **chlorophyll**. This is the part of the plant which absorbs the sunlight and where photosynthesis occurs.



Leaves are adapted to carry out their function. Leaves are typically flat and thin with a large **surface area**. This means they have a maximum area to absorb the sunlight and carbon dioxide. The **thin** shape reduces the distance for **diffusion** of water and gases.

Leaves contain vessels called **xylem** and **phloem**. The **xylem** transport water and dissolved minerals toward the leaves. The **phloem** transport glucose and other products from photosynthesis around the plant.

The large **air spaces** between the cells of the spongy mesophyll layer allow for the diffusion of gases. **Carbon dioxide** enters the leaves and **oxygen** exits the leaves.



The **guard cells** are specially adapted cells located on the underside of the leaf. They are positioned in pairs, surrounding the **stomata** (a small opening in the epidermis layer). The guard cells change shape to open and close the stomata, controlling the rate of **gas exchange** in the leaf.

## Cancer

**Cancer** is the result of **uncontrolled** cell growth and division. The uncontrolled growth of cells is called a **tumour**.

Benign Tumour	Malignant Tumour
<ul style="list-style-type: none"> <li>Usually grows slowly.</li> <li>Usually grows within a membrane and can be easily removed.</li> <li>Does not normally grow back.</li> <li>Does not spread around the body.</li> <li>Can cause damage to organs and be life-threatening.</li> </ul>	<ul style="list-style-type: none"> <li>cancerous</li> <li>Usually grows rapidly.</li> <li>Can spread around the body, via the bloodstream.</li> <li>Cells can break away and cause secondary tumours to grow in other areas of the body (metastasis).</li> </ul>

## Root Hair Cells

Plants absorb water by **osmosis** through the root hair cells of the roots. Dissolved in the water are important minerals for the plant's growth and development, which are absorbed by **active transport**.

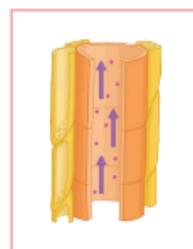


The **root hair cells** are adapted to their function with the following features:

- Finger-like projection in the membrane increases the **surface area** available for water and minerals to be absorbed across.
- The narrow shape of the projection can squeeze into small spaces between soil particles, bringing it closer and reducing the distance of the **diffusion pathway**.
- The cell has many **mitochondria**, which release energy required for the active transport of some substances.

## Xylem and Phloem

**Xylem** vessels transport **water** through the plant, from roots to leaves. They are made up of **dead**, lignified cells, which are joined end to end with no walls between them, forming a long central tube down the middle. The movement of the water, and dissolved minerals, along the xylem is in a **transpiration stream**.

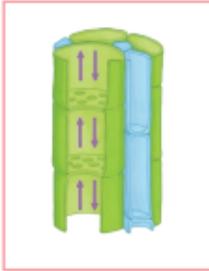


Xylem vessels also provide **support** and **strength** to the plant structure. They are found in the middle of roots so they aren't crushed within the soil. They are found in the middle of the stem to provide strength and prevent bending. In the leaves, they are found in **vascular bundles** alongside the phloem and can be seen as the veins which network across the leaf.

# ORGANISATION

## Xylem and Phloem

**Phloem** vessels transport **food** such as dissolved sugars and glucose from photosynthesis. The food is transported around the plant to where growth is occurring (root and shoot tips), as well as to the organs which store the food. The transport occurs in **all directions** throughout the plant. The cells making up the phloem tube are **living**, with small holes in the walls where the cells are joined.



## Disease Interactions

Having one type of illness can often make a person more susceptible to another type of illness:

- immune disorders → increased risk of infectious disease
- viral infection of cells → increased risk of cancer
- immune reactions → can trigger allergies
- very poor physical health → increased risk of depression or other mental illness

## Transpiration and Translocation

**Transpiration** is the loss of water, by **evaporation** and **diffusion**, from the leaves of the plant. Water is a cohesive molecule and as it evaporates, there is less water in the leaf, so water from further back moves up to take its place. This, in turn, draws more water with it. This is the **transpiration stream**.

**Transpiration** occurs naturally as there is a tendency for water to diffuse from the leaves (where the concentration is relatively high) to the air around the plants (where the concentration is relatively low), via the **stomata**.

**Environmental factors** can change the rate at which transpiration occurs:

- Increased **light intensity** will increase the rate of transpiration because light stimulates the stomata to open. The leaf will also be warmed by the sunlight.
- Increased **temperature** will cause the water to evaporate more quickly and so increase the rate of transpiration.
- Increased **humidity** (moisture in the air) will reduce the rate of transpiration. Whereas if the air becomes drier, the rate increases. A greater concentration gradient will increase the rate of diffusion.
- If the **wind speed** increases, then the rate of transpiration also increases. This is because as the water surrounding the leaves is moved away more quickly, the concentration gradient is increased.
- If the **water content** in the soil is decreased, then the rate of absorption in the roots decreases. This causes the stomata to become flaccid and close, reducing transpiration. If the loss of turgor affects the whole plant, then it will wilt.

## Health and Disease

**Health** is the state of being free from **illness** or **disease**. It refers to **physical** and **mental** wellbeing.

Disease and lifestyle factors, such as diet, stress, smoking, alcohol consumption and the use of illegal drugs, can all impact the health of a person.

Some conditions are associated with certain lifestyle choices:

- Liver conditions are associated with poor **diet** and prolonged excessive **alcohol** consumption.
- Lung cancer is associated with **smoking**.
- Memory loss, poor physical health and hygiene are associated with the use of illegal or recreational **drugs**.
- Obesity and diabetes are associated with poor diet.
- Anxiety and depression are associated with **stress** and prolonged excessive alcohol consumption.

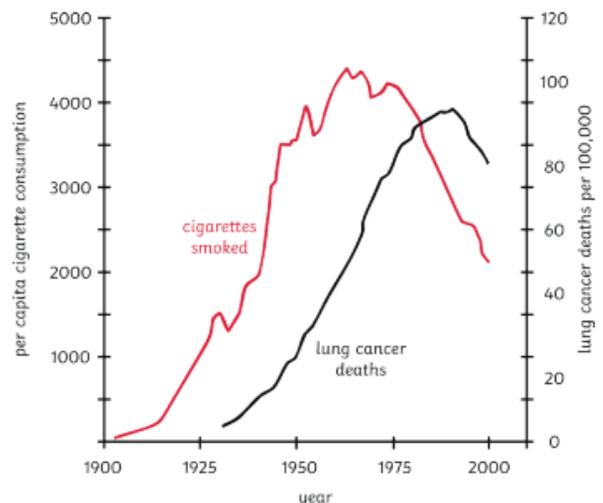
There can often be correlations between some factors and types of illness or specific diseases.

For example, in the graph shown to the right, there is a positive correlation between the number of cigarettes smoked and the number of lung cancer deaths.

However, there are other factors which can contribute to the development of lung cancer e.g. working with asbestos, genetic predisposition.

This means that although the evidence in the graph gives a strong indication that smoking is a cause of lung cancer, it cannot be stated that **'smoking will cause lung cancer'**. Not every person who smokes will develop lung cancer and not every person who develops lung cancer will be a smoker.

Therefore, it can be stated that **smoking increases the risk of lung cancer**.



## Heart Disease Treatments

Treatment	Description	Advantages	Disadvantages
statins	<b>Drugs</b> used to lower cholesterol levels in the blood, by reducing the amount produced in the liver.	<ul style="list-style-type: none"> <li>• Can be used to prevent heart disease developing.</li> <li>• Improved quality of life.</li> </ul>	<ul style="list-style-type: none"> <li>• Long-term treatment.</li> <li>• Possible negative side-effects.</li> </ul>
stents	<b>Mechanical device</b> which is used to stretch narrow or blocked arteries, restoring blood flow.	<ul style="list-style-type: none"> <li>• Used for patients where drugs are less effective.</li> <li>• Offers long-term benefits.</li> <li>• Made from metal alloys so will not be rejected by the patients body.</li> <li>• Improved quality of life.</li> </ul>	<ul style="list-style-type: none"> <li>• Requires surgery under general anaesthetic, which carries risk of infection.</li> </ul>
heart transplant	The entire organ is replaced with one from an organ <b>donor</b> (a person who has died and previously expressed a wish for their organs to be used in this way).	<ul style="list-style-type: none"> <li>• Can treat complete heart failure in a person.</li> <li>• extended life</li> <li>• Improved quality of life.</li> <li>• Artificial plastic hearts can be used temporarily until a donor is found.</li> </ul>	<ul style="list-style-type: none"> <li>• Requires major surgery under general anaesthetic, which carries risks.</li> <li>• Lack of donors available.</li> <li>• Risk of infection or transplant rejection.</li> <li>• Long recovery times.</li> </ul>