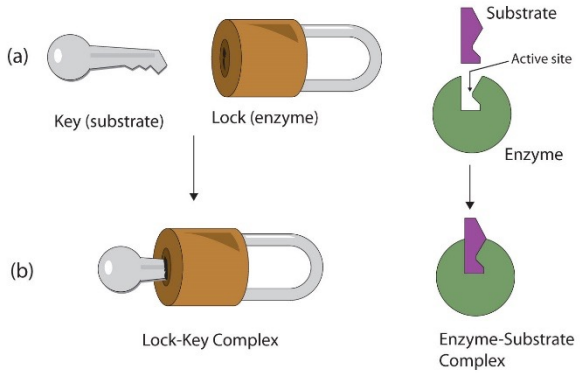
Organisation

The human digestive system

- The body needs a balanced diet with carbohydrates, lipids, proteins, vitamins, minerals, dietary fibre and water, for its cells' energy, growth and maintenance.
- The digestive system is an example of an organ system in which organs work together to digest and absorb food.
- Organs of the digestive systems are adapted to break large food molecules into smaller ones which can travel in the blood to cells and are used for life processes.
- The **stomach** contains glandular tissue that produces **enzymes** and **hydrochloric acid,** muscle tissue that contracts to churn food and epithelial tissue that protects your stomach against the hydrochloric acid.
- The **pancreas** is a gland that secretes enzymes.
- The **liver** is an organ that produces **bile**. Bile is stored in the **gallbladder** and released by the bile duct after the chyme (partially digested food) leaves the stomach. Bile is an **alkaline emulsifier**. The alkaline pH of bile provides the optimum conditions for lipase to digest **lipids**. Bile also emulsifies lipids allowing smaller droplets to be suspended in the watery chyme rather than large droplets. Smaller droplets increase the surface area of the lipids increasing the rate of digestion.
- Most of our food is absorbed into our blood in the **small intestine**. The inside of the small intestine is covered in small structures called **villi** that increase its surface area and contain blood vessels. Each villus is covered with epithelial cells that have microvilli that increase the surface area even more. The increase in surface area and proximity to our circulatory system speeds up the rate of **diffusion** of food molecules.
- The digestive system is also made up of the large intestine, rectum and anus.
- The products of digestion are used to build new carbohydrates, lipids and proteins. Some glucose is used in respiration.



Enzymes

- Enzymes are **biological catalysts** that control the rate of biological process and the digestion of food molecules.
- Enzymes are structures made of **protein**. Enzymes have specific shapes and attach to food molecules using an active site. Scientists use the idea of a **lock and key** to show that an enzymes shape is important and that enzymes digest specific food molecules.
- Enzymes are affected by **temperature**. If an enzymes conditions do not match its requirements it will not work properly. All enzymes found in the body prefer body temperature (37 °C). If an enzyme's conditions are too cold, they will move slowly and sluggishly slowing down digestion. If an enzymes conditions are too hot then their shape will be affected. When an enzyme's shape changes the shape of the active site changes and the enzyme can no longer attach to and digest food molecules. When the active site changes shape the enzyme is **denatured**.
- Enzymes are affected by **pH**. If an enzyme's conditions do not match its requirements it will not work properly. In extreme cases the enzyme will lose its structure and the shape of the active site will change. When the active site changes shape the enzyme is denatured.
- **Amylase** is an enzyme that digests starch. It is secreted from the salivary glands, pancreas and small intestine. Amylase breaks down large molecules of starch into smaller sugars such as maltose and glucose. This process begins in the mouth.
- Amylase works best in acidic to neutral condition.
- **Proteases** are enzymes that digest proteins. They are secreted from the stomach, pancreas and small intestine. Protease breaks down large molecules of protein into smaller amino acids. This process begins in the stomach.
- Protease works best in acidic conditions (provided by the hydrochloric acid secreted by the stomach.
- **Lipases** are enzymes that digest lipids. They are secreted from the pancreas. Lipase breaks down large lipid molecules into fatty acids and glycerol. This process begins in the small intestine
- Lipase works best in alkaline conditions (provided by the bile secreted by the bile duct).

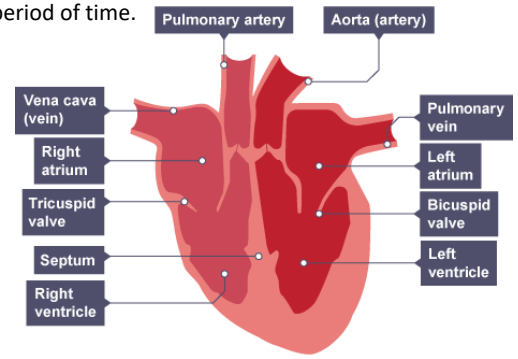
Food tests

- Food tests can be carried out on foods to test for a range of carbohydrates, lipids and proteins.
- **Benedict's** test is used to detect sugars. Sugars classed as reducing sugars (e.g. glucose) will react with Benedict's solution on heating for a few minutes. A positive result will be red or brown colour. If there's not much present then the final colour may be green, yellow or orange.
- **Iodine** is used to test for starch. Adding a few drops of iodine to a food containing starch will change the colour of the iodine from orange/brown to blue/black.
- The **Biuret** test is used to detect protein. Adding Biuret reagent to a food containing protein will change the colour of the reagent from blue to purple.
- The **Sudan III** test us used to detect lipids. Drops of Sudan III carefully added to solution containing lipids will form a red stained layer.

Organisation

The Heart

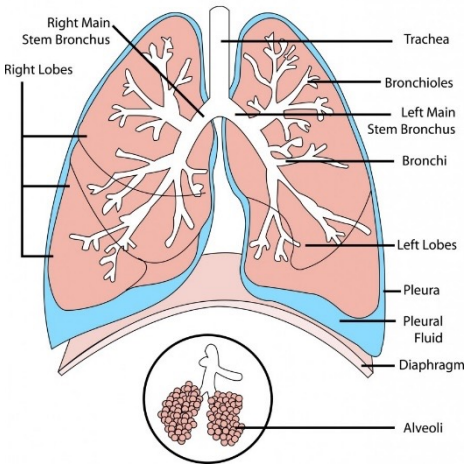
- The **heart** is an organ that pumps blood around the body in a **double circulatory** system.
- **Deoxygenated** blood enters the heart through the **vena cava** and proceeds into the right atrium, through a valve (that prevents backflow) into the right ventricle. Blood is then pumped to the lungs, where it is oxygenated, through the **pulmonary artery**.
- Blood is **oxygenated** in the lungs before it returns to the heart through the **pulmonary vein**. The blood travels through the left atrium and into the left ventricle. It is then pumped out through the **aorta** to the rest of the body.
- Coronary arteries surround the heart, providing the heart with blood containing oxygen and glucose. Muscle tissue that makes up the majority of the heart needs oxygen and glucose for **respiration**. The energy released by respiration is used by the muscles cells to contract.
- The natural resting heart rate is controlled by a group of cells located in the right atrium that act as a pacemaker. Artificial pacemakers can be used if this is not working properly.
- We can measure our pulse to monitor our heart rate. The lower a person's resting pulse rate the fitter they may be. Pulse can be measured by counting the beats over a set period of time.

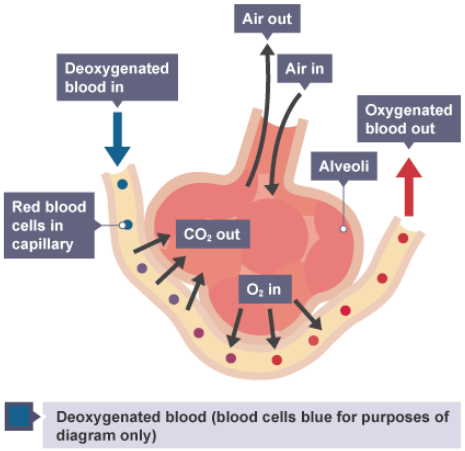


The Lungs

- The lungs are part of the **respiratory system**.
- Air travels to the lungs via the **trachea**. The trachea splits in to two **bronchi** (singular - bronchus) which carry the air to each of the lungs. When the bronchi reach the lungs, they split into many smaller tubes called **bronchioles**. These bronchioles spread though out the lungs with each ending in a small air sac called an alveolus (plural - **alveoli**).
- The lungs and airways have many adaptations. **Goblet cells** lining the trachea produce a sticky mucus that traps dust and microorganisms, preventing them from getting to the lungs. Ciliated cells, covered in small hair like projections called **cilia**, also trap dust and microorganisms.
- The lungs themselves have a **massive surface area**, are incredibly **moist** and contain many **capillaries** carrying blood close to the alveoli, which are the site of gas exchange. These factors increase the rate that oxygen is diffused into the blood and the rate that carbon dioxide is diffused into the lungs.

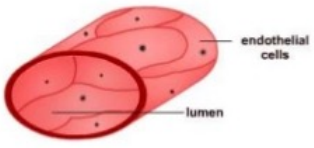
Diagram of the Human Lungs

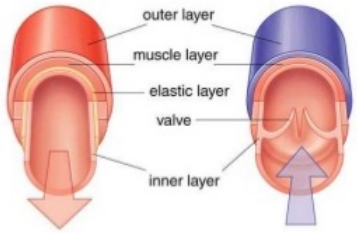




Blood vessels

- Arteries are blood vessels that carry blood away from the heart. The blood is under very **high pressure**, so the walls of the arteries are extremely thick. The lumen, that blood travels through, is smaller to maintain blood pressure.
- **Veins** are blood vessels that carry blood to the heart. The blood is under very **low pressure**, so the walls of the veins are thinner, and the lumen is much wider. Veins contain **valves** that prevent blood from flowing the wrong way.
- **Capillaries** are small blood vessels that carry blood to our tissues. Capillaries have walls that are one cell thick. This allows substances found in our blood, such as oxygen and glucose, to move through the wall and into the tissue.



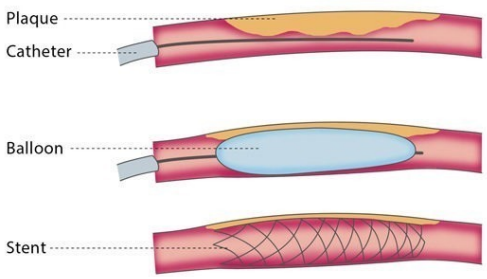


Organisation

Coronary heart disease

- In coronary heart disease layers of fatty material build up inside the coronary arteries, narrowing them.
- This reduces the flow of blood through the coronary arteries, resulting in a lack of oxygen for the heart muscle.
- **Stents** can be used to keep the coronary arteries open. Stents can be used as a long-term solution and do not lead to an immune response in the patient. Stents are safe but there are small risks associated with age, general health and whether they have had a heart attack. In some cases, further treatment is needed.

Angioplasty and stenting



- **Statins** are drugs that decrease a person's bad cholesterol and increase their good cholesterol. This reduces fatty material in arteries. These drugs must be taken for life to maintain the effect. They are not suitable for people who have liver disease or those that are pregnant or breastfeeding.
- In extreme circumstances a **heart transplant** may be required. Once complete a new heart will improve the quality of life for the patient. Few donor hearts are available and there is a very long recovery time. There is also a chance that the patient's immune system will attack the organ and cause rejection. Immunosuppressant drugs are taken to prevent this which leads to a higher chance of infection.
- **Artificial hearts** can be used to help patients waiting for heart transplants. These devices act as a pump outside of the body and often require a patient to remain in hospital.
- **Mechanical valves** can be used to replace faulty valves in a patient's heart. Faulty valves may not close, allowing the blood to leak backwards. The heart then has to pump harder to pump the required volume of blood. The valve may also not open fully. In this case the heart pumps harder to force the blood through the valve.
- Replacement valves can restore blood flow through the heart but may wear out or promote the formation of blood clots around the new valves. Anti-blood clotting drugs can be taken to prevent this.

Blood

- The blood contains plasma, in which the red bloods cells, white blood cells and platelets are suspended.
- **Plasma** is the liquid part of the blood. It contains carbon dioxide, digested food, urea, and hormones.
- **Red blood cells** are responsible for transporting oxygen.
- **White blood cells** ingest pathogens and produce antibodies.
- **Platelets** are involved in the clotting of blood.

Lifestyle

- Non-communicable diseases can have massive human and financial costs to an individual, a local community, a nation and globally.
- Lifestyle factors such as diet, alcohol and smoking have an effect on the incidence of non-communicable disease at a local, national and global level.
- **Risk factors** are linked to an increased rate of a disease.
- Risk factors can be an aspect of a person's lifestyle or substances in a person's body or environment.
- A **causal mechanism** has been proven for some risk factors, but not in others. A causal relationship is when one factor effects another, examples are:
    - The effects of diet, smoking and exercise on cardiovascular disease
    - Obesity as a risk factor for type 2 diabetes
    - The effect of alcohol on the liver and brain function
    - The effect of smoking on lung disease and lung cancer
    - The effect of smoking and alcohol on unborn babies
    - Carcinogens, including ionising radiation, as risk factors in cancer.

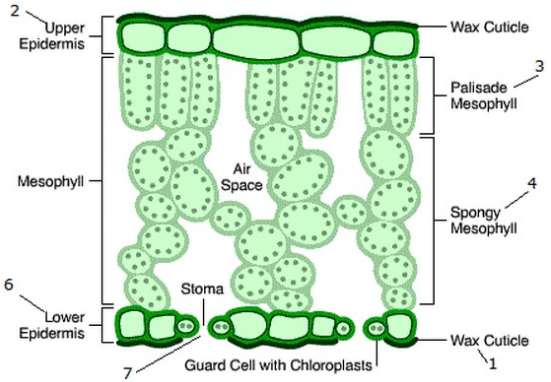
Health issues

- Health is the state of physical and mental well-being.
- Diseases, both communicable and non-communicable, are major causes of ill health.
- Other factors including diet, stress and life situations may have a profound effect on both physical and mental health.
- Different types of disease may interact:
    - *Defects in the immune system mean an individual is more like to suffer from infectious diseases*
    - *Viruses living in cells can be a trigger for cancers*
    - *Immune reactions initially caused by a pathogen can trigger allergies such as skin rashes and asthma*
    - *Severe physical ill health can lead to depression and other mental illness.*

Organisation

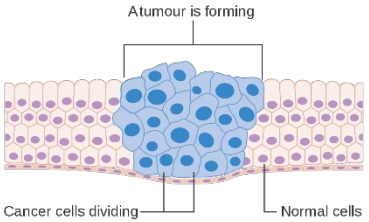
Plant tissues

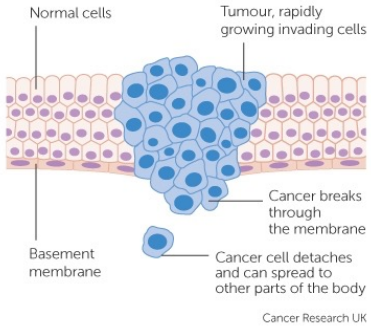
- Plants organs include the leaves, roots, and stem.
- These organs are made of tissues that contribute to the organ's function.
- **Epidermal** tissue covers the leaves, stem and the roots.
- Epidermal tissue forms a boundary between the plant and the external environment.
- Epidermal tissue protects against water loss and regulates gas exchange and water loss through holes called **stomata.**
- **Palisade mesophyll** tissue is the layer of the leaf that is adapted to absorb light efficiently.
- Palisade cells that make up the tissue contain many chloroplasts that absorb light needed for photosynthesis.
- Palisade cells are column shaped, packed closely together and are situated towards the upper surface of the leaf to increase the amount of light they can absorb.
- **Spongy mesophyll** tissue is packed loosely for efficient gas exchange.
- Gases dissolve in a thin layer of water that covers the cell which then allows the gases to move into and out of the cell.
- Carbon dioxide **diffuses** into spongy mesophyll cells and oxygen diffuses out.



Cancer

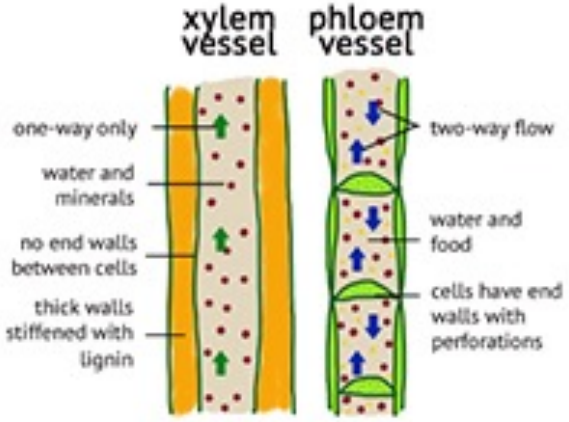
- Changes in cells can lead to uncontrolled growth and division.
- **Benign tumours** are growths of abnormal cells contained in one area, usually within a membrane. They do not invade other parts of the body.
- **Malignant tumour** cells are cancers. They invade neighbouring tissue and spread to different parts of the body in the blood, where they form secondary tumours.
- Scientists have identified lifestyle risk factors for various types of cancer.
- There are also genetic risk factors for some cancers.





Xylem & Phloem

- **Xylem** transport **water and minerals** from the roots of the plant up the stem and into the leaves.
- Water is used to photosynthesise, cool down leaves (by evaporation) and keep the cells turgid to support the plant.
- The elongated cells that make up the xylem are strengthened with a chemical called lignin.
- The dead cells, which contain no cytoplasm, form continuous hollow tubes that are impermeable to water.

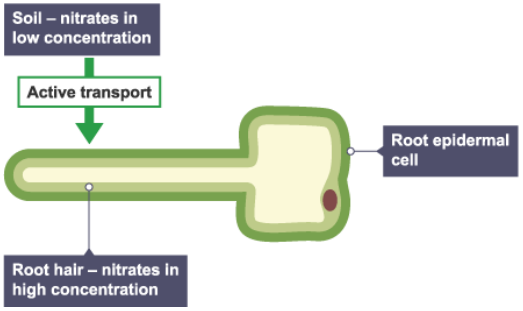


- **Phloem** transport **sugars and amino acids** around the plant.
- The process of moving sugars and amino acid throughout the plant is called translocation.
- Phloem consist of living cells that contain cytoplasm. This can move from one cell to the next through perforated cells called sieve plates. These cells contain no nucleus.
- Companion cells attach to each sieve tube to provide the energy needed for translocation.

Organisation

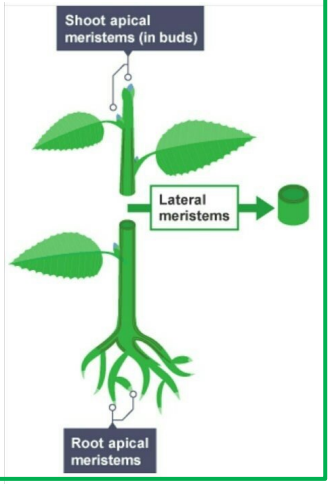
Root hair cells

- Root hair cells are long and thin so that they can penetrate between soil particles.
- Root hair cells have a large surface area for absorption of water through osmosis.
- Root hair cells have a large vacuole for storing water.
- Root hair cells contain many mitochondria that release energy from glucose for the active transport of minerals.



Meristems

- Meristem tissue contains cells that can differentiate to produce all types of plant cell.
- Meristem cells are found close to the tip of shoots and roots.
- Meristem cells allow a plant to grow.



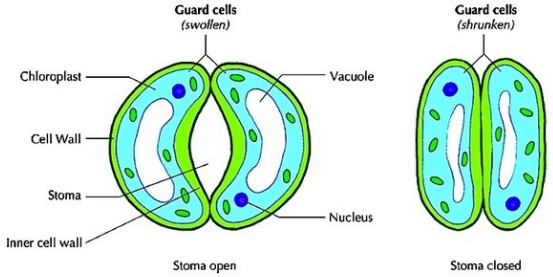
Transpiration

- The movement of water throughout a plant is caused by the transpiration stream.
- Water covering the spongy mesophyll cells evaporates and exits the leaf through tiny holes called stomata. This is called transpiration.
- Water molecules are attracted to each other, so they are cohesive or “sticky”.
- Transpiration produces a tension or “pull” on the water in the xylem vessels, moving the water and other minerals up the plant.
- Changing temperature, humidity, air movement and light intensity all have an affect of the rate of transpiration.

Factor	Effect on transpiration
Increasing temperature	Increases
Increasing humidity	Decreases
Increasing air movement	Increases
Light intensity	Increases

Guard cells

- Each stoma is surrounded by guard cells that can regulate the amount of water that exits the plant.
- When the vacuoles of the guard cells are full of water, they become turgid opening the stoma.
- In the light, the guard cells absorb water by osmosis, become turgid and the stoma opens.
- When the vacuoles of the guard cells lose water, they become flaccid and the stoma closes.
- In the dark, the guard cells lose water, become flaccid and the stoma closes.



Potometer

- We can measure water uptake using a potometer.
- A potometer is a piece of capillary tubing that is connected to a plant.
- A bubble in the tube moves as water is drawn up the plant.
- We can measure water uptake by recording the time taken for the bubble in the tube to move a set distance.