Contents

1. Characteristics and classification of living organisms

1.1 Characteristics of living organisms

7 Characteristics of living things (MRS GREN):

- Movement - an action by an organism or part of an organism causing a change of position or place.
- Respiration - the chemical reactions in cells that break down nutrient molecules and release energy for metabolism.
- Sensitivity - the ability to detect and respond to changes in the internal or external environment.
- Growth - a permanent increase in size and dry mass.
- Reproduction - the processes that make more of the same kind of organism.
- Excretion - the removal of the waste products of metabolism and substances in excess of requirements.
- Nutrition - the taking in of materials for energy, growth and development.

1.2 Concept and uses of classification systems

Organisms can be classified into groups by the features that they share.

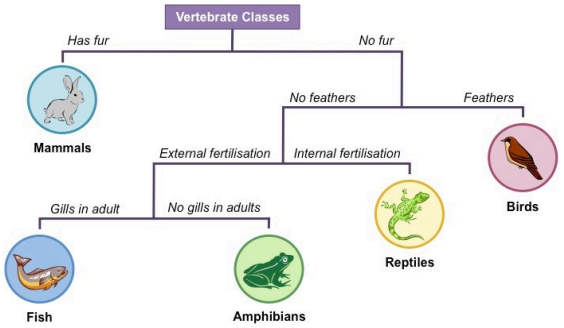
Classification - systems aim to reflect evolutionary relationships

- Sequences of bases in DNA are used for classification.
- They classify organisms by using their genetics to trace their evolutionary relationships.
- Many species have similar features that allow us to put them into groups.
- Organisms who share a more recent ancestor (i.e. more closely related) have DNA base sequences that are more similar than those who only share a distant ancestor.

Species - A group of organisms that can reproduce to produce fertile offspring (with organisms sharing similar characteristics and living space.)

Binomial Naming - an internationally agreed system in which the scientific name of an organism is made up of two parts showing the genus and species. E.g. homo (genus) sapiens (species)

Dichotomous key - used to classify animals based on their visible characteristics



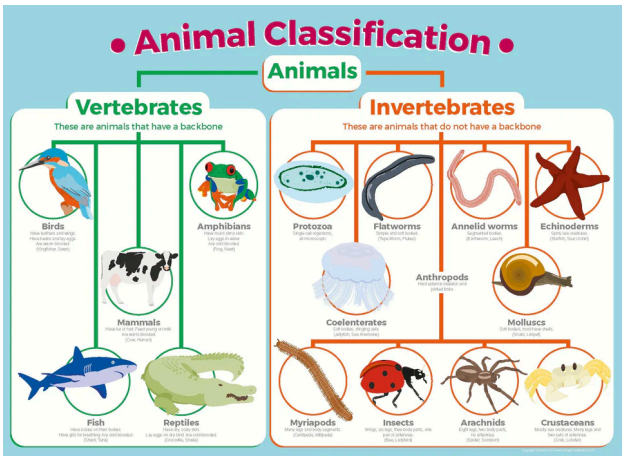
1.3 Features of Organism

Kingdom -> phylum -> class -> order -> family -> genus -> species

All living things are classified into five kingdoms:

- Plants - multicellular, contains nucleus, chloroplasts & cell walls.
- Animals - multicellular, contains nucleus, no chloroplasts/cell wall.
- Fungi - multicellular, contains nucleus & cell walls.
- Protoctists - unicellular, contains nucleus.
- Prokaryotes - unicellular, contain cell walls, no nucleus.

Animal kingdom



Main groups of vertebrates (animals with a backbone): mammals birds, reptiles, amphibians, fish

Vertebrate class	Body	Movement	Reproduction	Sense organs	Blood	Examples
Fish	Scales	Fins	Jelly-covered eggs	Eyes	Cold blooded	Herring Shark
Amphibians	Moist skin	4 limbs Webbed feet	Jelly-covered eggs in water	Eyes Ears	Cold blooded	Frog Newt
Reptiles	Dry scales	4 legs (apart from snake)	Rubbery-shelled eggs	Eyes Ears	Cold blooded	Lizard Snake
Birds	Feathers	2 wings 2 legs	Hard shelled eggs, laid on land	Eyes Ears	Warm blooded	Chicken Penguins
Mammals	Fur	4 limbs	Produce live young	Eyes Ears with pinna	Warm blooded	Cow Cat

Main groups of arthropods (invertebrates — animals with no backbone): myriapods, insects, arachnids, crustaceans

Traits:

- Most have a firm/hard external skeleton made up of chitin.
- Jointed limbs
    - **Arachnid**: 8 legs
    - **Crustaceans**: 10 legs
    - **Insects**: 6 legs
    - **Myriapods**: uncountable

- Body segmentation (2 or 3).
    - **Arachnid** and **Crustaceans**: cephalothorax, abdomen.
    - **Insects**: head, thorax and abdomen.
    - **Myriapods**: not obviously divided.
- Eyes
    - Arachnids & Myriapods: simple eyes.
    - Insects & Crustaceans: compound eyes.

Plant kingdom

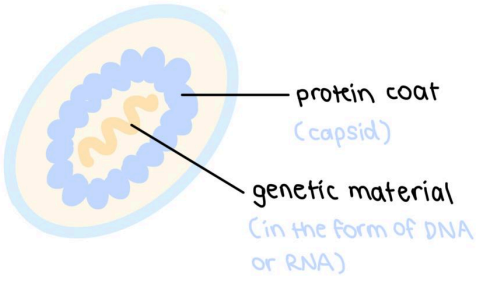
- **Ferns** - the first plants to adapt to living on land. They have evolved to have roots, stems, complex leaves and vascular tissues.
- **Angiosperms** - plants with flowers and seeds. They have evolved most recently.

Monocotyledon	Features	**Dicotyledon**
Narrow & elongated	Leaf shape	Round / broad
Parallel	Leaf vein	Net - like, reticulate, branching
Only one seed leaf	Cotyledon (seed leaf)	Double
3	Grouping of flower parts	5
Fibrous / branched	Roots	Tap (one main root)

Viruses

- Viruses are not considered as living things.
- They DO NOT display the 7 characteristics of living things.

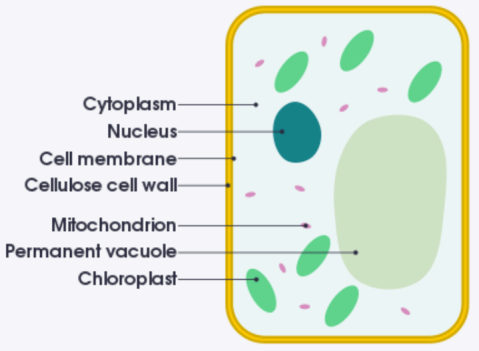
- They need a living host cell in order to make copies of themselves.



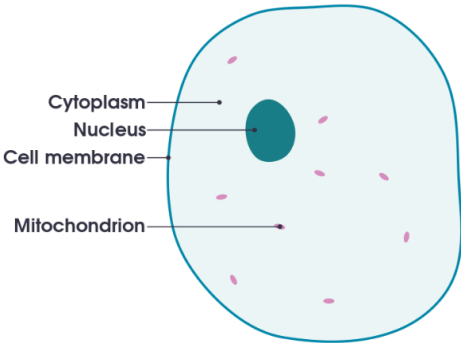
2. Cells

2.1 Cell structure

Plant cell

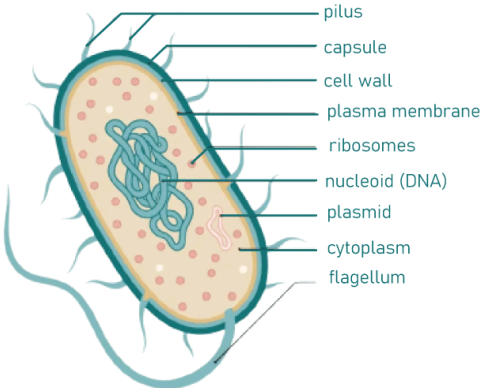


Animal cell



Cell membrane - Controls movement of substances, like oxygen, glucose and water, in and out of the cell.
Cell wall - Provides structure and protection.
Cytoplasm - Where metabolic (chemical) reactions take place.
Vacuole - Storage for water, sugars, ions, amino acids and waste. Provides turgor pressure.
Nucleus - Controls activities/development of the cell. Stores genetic information.
Chloroplasts - Contains chlorophyll for photosynthesis.
Mitochondria - The powerhouse where aerobic respiration takes place for energy.
Ribosome - Site of protein synthesis.

Bacterial cell



Specialised cells - cells that have structures adapted for their function.

Ciliated cells

- Movement of mucus in the trachea and bronchi.
- Covered in cilia.

Root hair cells

- Found in the roots of plants.
- They absorb water and mineral ions from the soil.
- Large surface area of absorption.

Palisade mesophyll cells

- Found in leaves.
- Used in photosynthesis.
- They are packed close together to maximise light absorption
- They contain chloroplasts to absorb light.

Neurones

- Found in sensory areas.
- Helps with conduction of electrical impulses.

Red blood cells

- Found in blood.
- Transports oxygen around the body.

Sperm and egg cells (gametes)

- Sperm is found in male testicles, eggs are found in the ovaries.
- They fuse together during reproduction.
- Sperm has a tail to swim, mitochondria for energy and an acrosome to release enzymes to digest the cell membrane of the egg.
- Egg cells have a jelly coating to allow only 1 sperm to fertilise the ovum.

Cell - basic building blocks for all living organisms.
Tissue - group of cells with similar structures, working together to perform a shared function.
Organ - group of specialised tissues working together to carry out a specific function.
Organ system - group of specialised organs working together to carry out a specific function.
Organism - a living thing.

2.2 Size of specimen

Magnification = image size ÷ actual size

1mm = 1000µm

3. Movement into & out of cells

3.1 Diffusion

Diffusion - the net movement of particles from a region of their higher concentration to a region of their lower concentration down a concentration gradient, as a result of their random movement.

The energy for diffusion comes from the kinetic energy of random movement of molecules and ions

Examples:

- CO2 for plants diffuse from air to leaves, through the stomata
- O2 (waste product of photosynthesis) diffuses out of the plant
- Products of digestion are absorbed from the ileum of mammals
- Some substances move into and out of cells by diffusion through the cell membrane

Factors that influence diffusion:

- Surface Area (Increased surface area, increases the rate of diffusion)
- Temperature (Higher the temperature, the higher the kinetic energy (mobility of the particles), therefore the higher the rate of diffusion.)
- Concentration Gradients (The greater the difference in concentration, the higher the rate of diffusion.)
- Diffusion Distance (The closer the distance, the higher the rate of diffusion.)

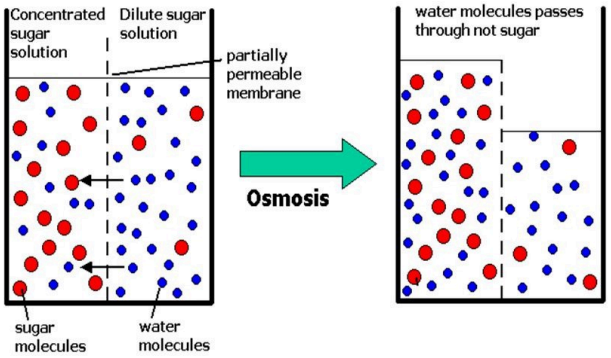
Diffusion helps living organisms to:

- Obtain many of their requirements (glucose, vitamin B & C)
- Get rid of waste products
- Gas exchange for respiration

3.2 Osmosis

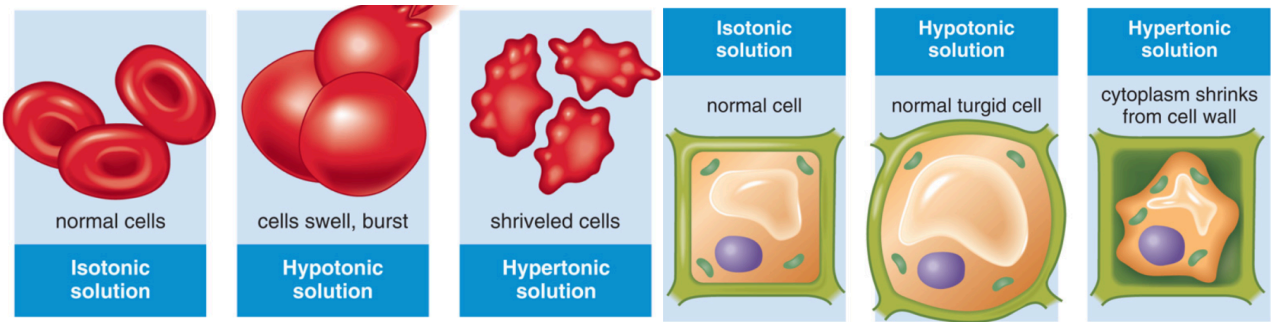
Osmosis - the net movement of water molecules from a region of higher water potential to a region of lower water potential down a concentration gradient, across a semi permeable membrane

The number of sugar molecules stays the same. Only water molecules travel.



Osmosis can affect the tissues of organisms by causing them to lose or gain water.

Isotonic: water potential inside = water potential outside
Hypotonic (diluted solution): water potential inside > water potential outside
Hypertonic (concentrated solution): water potential inside < water potential outside



Plasmolysis occurs when a plant cell shrinks due to a loss of water. Plants can become flaccid.

Importance of osmosis:

- Water is a solvent in organisms for digestion, excretion and transport.
- Plants are supported by the turgor pressure from water inside the cells pressing outwards on the cell wall.

3.3 Active transport

Active transport - the movement of particles through a cell membrane from a region of lower concentration to a region of higher concentration (against a concentration gradient), using energy from respiration, through a carrier protein.

Importance of active transport:

- Movement of molecules/ions across membranes. Examples:
    - Ion uptake by root hairs cells.
    - Glucose uptake by epithelial cells in the villi of the small intestine and kidney tubules.

Protein carriers move molecules or ions across a membrane during active transport.

4. Biological Molecules

4.1 Biological molecules

Carbohydrates: made of carbon, hydrogen, oxygen
Fats: made of carbon, hydrogen, oxygen
Proteins: made of carbon, hydrogen, oxygen, nitrogen

Biological molecules are macromolecules. Their large molecules are made from smaller molecules.

- Starch, glycogen and cellulose are made from glucose
- Proteins from amino acids
- Fats and oils from 3x fatty acids and 1x glycerol

To test for:

- *Starch*: iodine (turns from brown to blue black)
- *Reducing sugars* (sugars that contain bonds that allows it to act as a reducing agent): add benedict's solution and heat in water bath (turns from blue to red)
- *Protein*: biuret (turns from blue to purple)
- *Vitamin C:* DCPIP (turns from blue to colourless)
- *Fats*: add ethanol then water and shake (turns from colourless to cloudy white emulsion)

Structure of a DNA molecule:

- Two strands coiled together to form a double helix
- Each strand contains chemicals called bases
- Bonds between pairs of bases hold the strands together
- Bases always pair up in the same way: A with T, and C with G

Extended:
Glucose is a simple sugar (monosaccharide). 2 glucose joined together is called maltose (disaccharide). When many glucose join together, starch, glycogen or cellulose forms (polysaccharide).

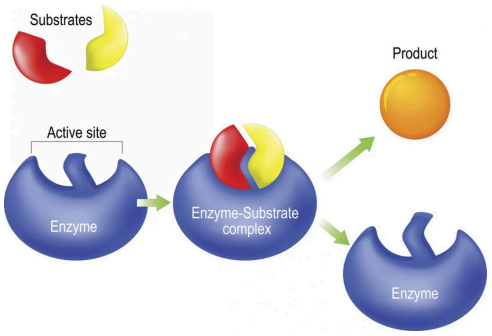
5. Enzymes

5.1 Enzymes

Enzymes - A protein that acts as a biological catalyst, speeding up biochemical reactions and is not used up.

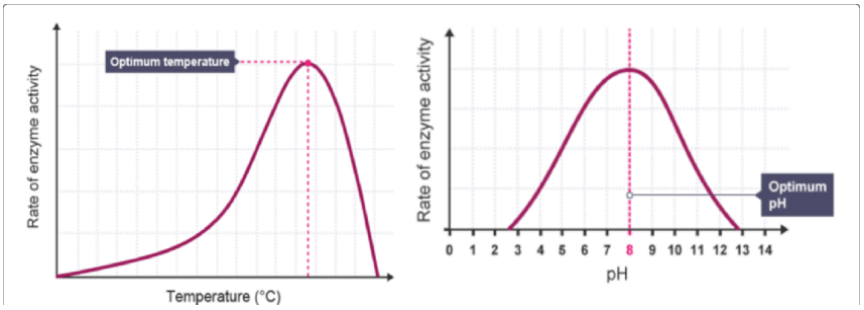
Importance of enzymes:

- Helps with reaction rate, necessary to sustain life.
- Some enzymes join small chemical substances to make them into new substances.
- Some enzymes break down large chemical substances to smaller chemical substances.



The substrate needs to be complementary (match) to the enzyme's active site, so that they can bind into the active site. Only then, enzyme substrates can be formed.

Factors that affect enzyme activity: temperature, pH



As temperature/pH increases, enzyme activity will increase. Enzymes will collide more and kinetic energy will increase. Frequency of effective collisions increases.
At its optimum temperature/pH, enzyme activity will be at its maximum.
When it surpasses the optimum temperature/pH, it will denature. The shape of the active site will change and the substrate will no longer bind with the active site. No products will form.

6. Plant nutrition

6.1 Photosynthesis

Photosynthesis - the process by which plants synthesise carbohydrates from raw materials using energy from light.

Carbon dioxide + water → glucose + oxygen (in the presence of light and chlorophyll)
$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$

Chlorophyll is a green pigment that is found in chloroplasts. It transfers energy from light into energy in chemicals, for photosynthesis.

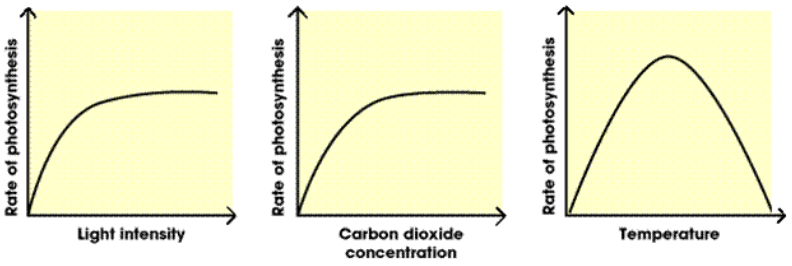
Use and storage of the carbohydrates:

- Starch as an energy store
- Cellulose to build cell walls
- Glucose used in respiration to provide energy
- Sucrose for transport in the phloem
- Nectar to attract insects for pollination

Plant minerals

- Plants absorb nitrate and magnesium ions from the soil.
- Nitrate ions are necessary for the production of amino acids.
- Magnesium is necessary for the production of chlorophyll. Without the chlorophyll, the plant leaf cannot absorb sunlight for photosynthesis.

Factors that affect rate of photosynthesis (limiting factors, factors that in scarcity, limit the rate of photosynthesis):



Light intensity:

- As light intensity increases, rate of photosynthesis increases, as more light can be absorbed and utilised by chlorophyll.
- At the point where the graph evens off, the increase of light would not affect the rate of photosynthesis anymore. CO_2 concentration and temperature becomes a limiting factor.

CO_2 concentration

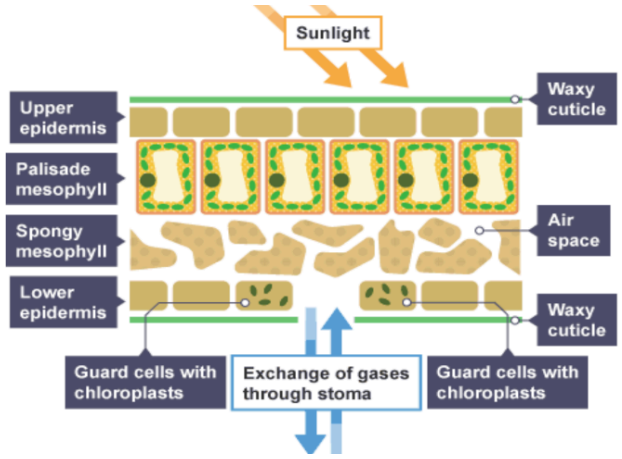
- As CO_2 concentration increases, rate of photosynthesis increases, as more CO_2 can be used in the reaction.
- At the point where the graph evens off, the increase of CO_2 concentration would not affect the rate of photosynthesis anymore. Light intensity and temperature becomes a limiting factor.

Temperature

- As temperature increases, rate of photosynthesis increases. Enzymes gain kinetic energy and collide more frequently.
- When the temperature passes the optimum temperature, enzymes denature and the rate of photosynthesis decreases.

Hydrogencarbonate indicators can detect the increase/decrease in CO2. An increase of CO2 changes the indicator from red to yellow. A decrease in CO2 changes the indicator from red to purple.

6.2 Leaf structure



Adaptation of the leaves

- The flat and wide structure of leaves increases the surface area, allowing more efficient absorption of sunlight and gas exchange.
- Palisade mesophyll cells are in vertical arrangement to allow more cells to be packed. More cells = more chloroplasts = more photosynthesis.

Waxy cuticle - retains water in plant
Upper epidermis - protects leaf in preventing water loss.
Palisade mesophyll - contains chloroplasts for photosynthesis.
Spongy mesophyll - interchange of gases for photosynthesis.
Stomata - shrinks to prevent water loss and expands to absorb water.
Guard cells - controls gas diffusion by regulating opening/closing of stomata.

7. Human nutrition

7.1 Nutrients

Balanced diet - A diet that contains all essential nutrients in the correct amounts for growth, repair and as an energy source.

Carbohydrates

- Provides energy from respiration.
- Helps blood circulation.
- Prevents starvation.

Protein

- Building muscle mass, growth.
- Prevents weakness and fatigue.
- Function body.
- Regulation of the body's tissues and organs.

Fat

- Gives energy.
- Reduce heat loss from the body (insulates).
- Provides mechanical protection for organs.
- Controls blood pressure.

Vitamin

- Helps with the immune system.
- Maintains our health.
- Fighting illnesses.
- Vitamin D - regulates the calcium and phosphate in the body, and prevents bone deformities.
- Vitamin C - antioxidant, protects cells from free radicals from digestion.

Mineral

- Strengthen our bones.
- Boost immune system.
- Acts as electrolytes.
- Control our blood pressure

Water

- Maintains body temperature.
- Keeps tissue hydrated.
- Gets rid of waste through urination.
- Helps transport nutrients and oxygen into the cell.
- Protects and moisturises our joints & organs.
- Moisture in the lungs helps with metabolism.

Fibre (not a nutrient, as it's not absorbed into the body)

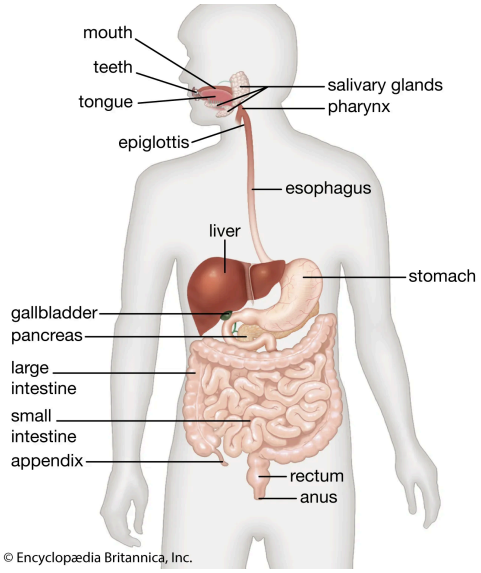
- Soluble Fibre regulates the body's sugar and cholesterol levels.
- Insoluble Fibre helps food travel through the digestive system more easily.

Scurvy is caused by vitamin C deficiency. This leads to anaemia, exhaustion, limb pain, inflammation, ulceration.

Rickets is caused by vitamin D deficiency. This softens bones, leading to delayed growth, muscle weakness.

7.2 Digestive System

Digestive system: A group of organs working together to break down food eaten to provide nutrients that can be absorbed into the blood and delivered to the cells.



The alimentary canal: Runs from the mouth to the anus, includes the liver and pancreas. They break down food to provide nutrients, where they are absorbed.

Features of alimentary canal:

1. Sphincter muscles
2. Lubricated with mucus

Mouth: Ingestion. Mechanical digestion with teeth. Chemical digestion with amylase.

Oesophagus: Peristalsis occurs. Bolus is pushed down towards the stomach.

Stomach: Mechanical digestion of churning. Contains goblet cells and HCl. Chemical digestion with pepsin.

Small intestine: Pancreatic juice flows in for chemical digestion. Bile flows in for mechanical digestion. Absorption occurs. Consists of duodenum and ileum

Pancreas: Forms pancreatic juice (which contains amylase, lipase and trypsin).

Liver: Assimilation. Produces bile.

Gallbladder: Stores bile.

Large intestine: Reabsorption of water. Egestion via the anus. Consists of the colon, rectum and anus

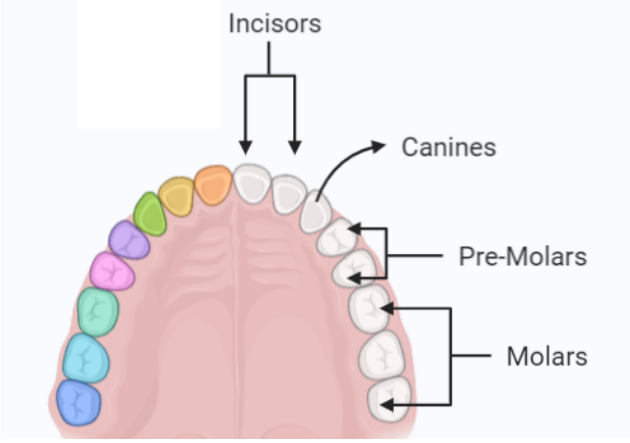
Peristalsis - a process where the walls of the alimentary canal contract/relax to move food.

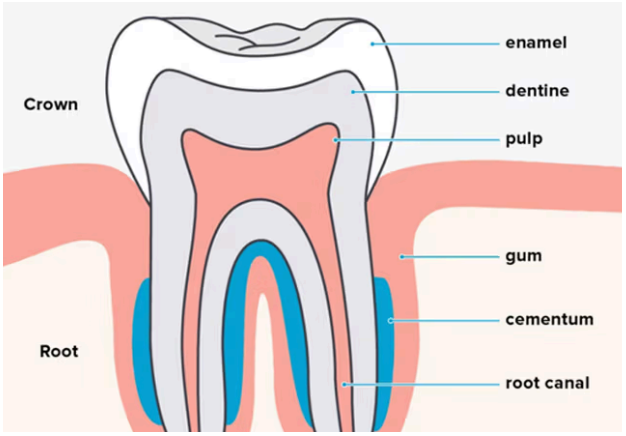
Ingestion – the taking of substances, e.g. food and drink, into the body.
Digestion – the breakdown of food.
Absorption – the movement of nutrients from the intestines into the blood.
Assimilation – uptake and use of nutrients by cells.
Egestion – the removal of undigested food from the body as faeces.

7.3 Physical Digestion

Physical digestion – The breakdown of food into smaller pieces without chemical change to the food molecules. It increases the surface area of food for the action of enzymes in chemical digestion.

Bile emulsifies fats and oils to increase the surface area for chemical digestion





Incisors: provides cutting action of food.
Canines: tears and grips food.
Premolars: grinds food.
Molars: grinds food.

7.4 Chemical digestion

Chemical digestion – The breakdown of large insoluble molecules into small soluble molecules, so that it can be absorbed.

Amylase breaks down starch to maltose. Amylase is formed in salivary glands & pancreas and found in the mouth and duodenum. Its optimum temperature is pH 7.

Maltase breaks down maltose to glucose. Maltase is secreted by the cells lining the small intestine and found in the membranes of the epithelium lining the small intestine. Its optimum temperature is pH 6.5.

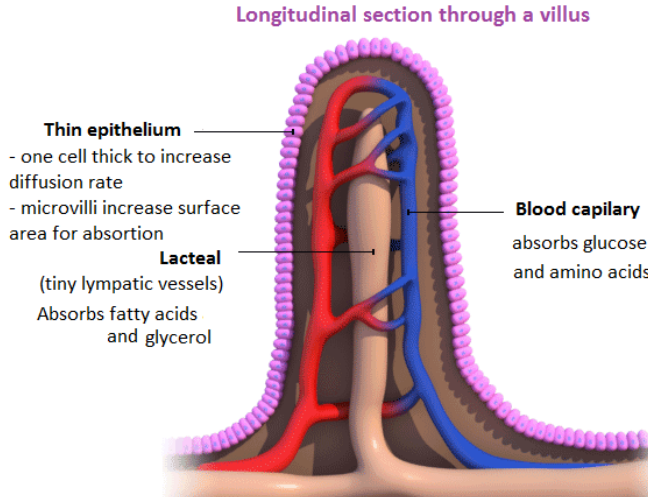
Proteases (pepsin & trypsin) break down protein to amino acids. **Pepsin** is formed & found in the stomach. Its optimum temperature is pH 2. **Trypsin** is produced in the pancreas and works in the small intestine. Its optimum temperature is pH 9.

Lipase breaks down fats and oils to fatty acids and glycerol. Lipase is secreted from pancreas and found in the small intestine. Its optimum temperature is pH 8.

Hydrochloric acid in gastric juice is used to kill harmful microorganisms in food and provides an acidic pH for optimum enzyme activity.	**Bile** is an alkaline mixture that neutralises the acidic mixture of food and gastric juices entering the duodenum from the stomach, to provide a suitable pH for enzyme action. It is also important in the emulsification of lipids, which increases its surface area for efficient digestion via lipase.

7.5 Absorption

The small intestine is the region where nutrients are absorbed. Most water is absorbed from the small intestine but some is also absorbed from the colon.

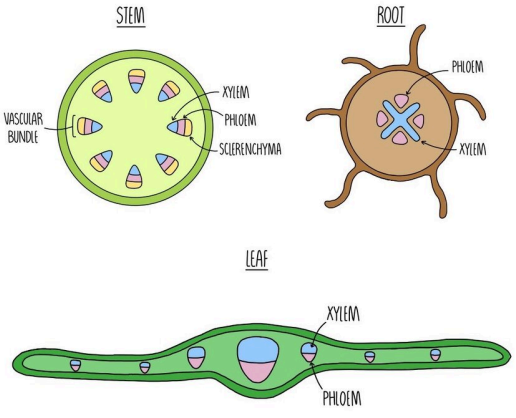


8. Transport in plants

8.1 Xylem & phloem

	Xylem	Phloem
Function	Transport of water and mineral ions through plants, and support.	Transport of sucrose and amino acids.
Cell structure	Hollow dead cells.	Living cells which lost many organelles. They have companion cells to keep them alive and transfer energy needed to transport sugar into phloem.
Are the cells continuous tubes?	Yes, they have continuous cell tubes strengthened by lignin, which gives support to plants and helps withstand water pressure in tubes.	No, they have end walls with pores, so that cell sap can move between cells.
Direction of flow of contents	From roots to leaves.	From leaves to growing areas and storage organs.
Process substances are moved	Transpiration - loss of water vapour from leaves pulls water through the xylem.	Translocation - movement of dissolved sugars.

Vascular bundles - a group of xylem vessels and phloem tubes.

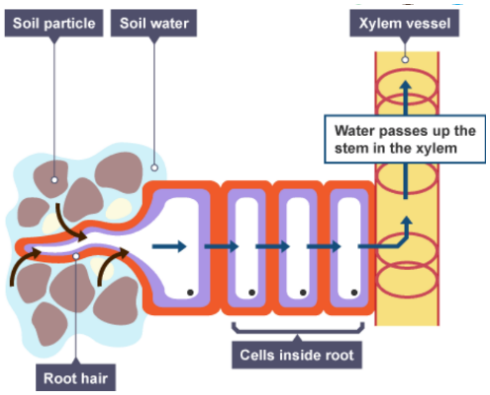


8.2 Water uptake

Water uptake:

1. Plants take in water ions, by osmosis, and mineral ions, by active transport, from the soil through the root hairs.

2. The large surface area of root hairs increases the uptake of water & mineral ions.
3. Water travels across the root hair cells, to the root cortex, to the xylem vessels, transporting it to the stem and leaves.
4. Water moves up the xylem by transpiration pull that draws up a column of water molecules, held together by cohesion force between water molecules.
5. Water enters the mesophyll cells.



8.3 Transpiration

Transpiration - The loss of water vapour from leaves. Water evaporates from the surfaces of the mesophyll cells into the air spaces and then diffuses out of the leaves through the stomata as water vapour. Temperature, wind and humidity affect transpiration rate.

Water vapour loss is related to the large internal surface area provided by the interconnecting air spaces between mesophyll cells and the size and number of stomata.

Water moves up the xylem by transpiration pull that draws up a column of water molecules, held together by cohesion force between water molecules.

Cohesion force:
Cohesion occurs when water molecules are attracted to each other. As water molecules move up the vessel, they pull other water molecules with them.

Transpiration pull:
Water is drawn up by xylem vessels, as transpiration is removing water from the top of them and pressure at the bottom stays high. The pressure difference is called the transpiration pull.

Factors on the rate of transpiration

- Temperature: Increase in temperature leads to more kinetic energy of water particles. Water evaporates faster and the rate of transpiration increases.
- Wind speed: Increase in wind speed causes water to get carried away. Rate of transpiration increases.
- Humidity: Increase in humidity leads to a smaller concentration gradient. Rate of transpiration decreases.

Wilting occurs when a plant cell shrinks due to a loss of water. Plants can become flaccid.

8.4. Translocation

Translocation – The movement of sucrose & amino acids in phloem from sources to sinks.

Sources - Parts of plants that release sucrose or amino acids.
Sink - Parts of plants that use or store sucrose or amino acids.

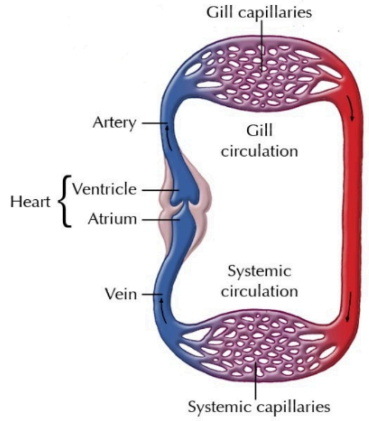
Some parts of a plant may act as a source and a sink at different times, because of seasonal changes and their growth cycle.

9. Transport in animals

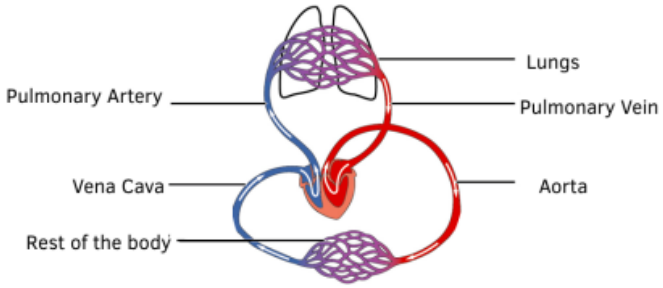
9.1 Circulatory systems

Circulatory system – A system of blood vessels with a pump and valves to ensure one-way flow of blood

Fish have single circulation. Fish have 2 chambers. Blood passes through it once in its circuit around the body. Oxygen is absorbed as blood passes its gills. Blood pressure is low.



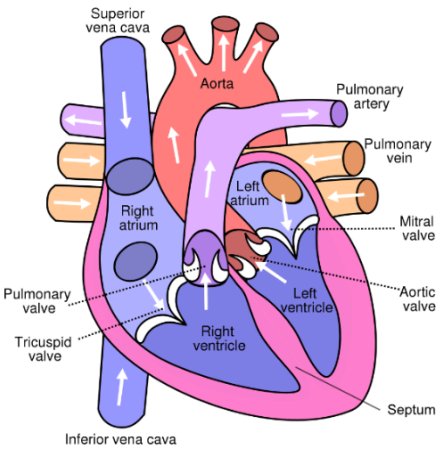
Mammals have double circulation. Blood passes the heart twice. Blood pressure is high.

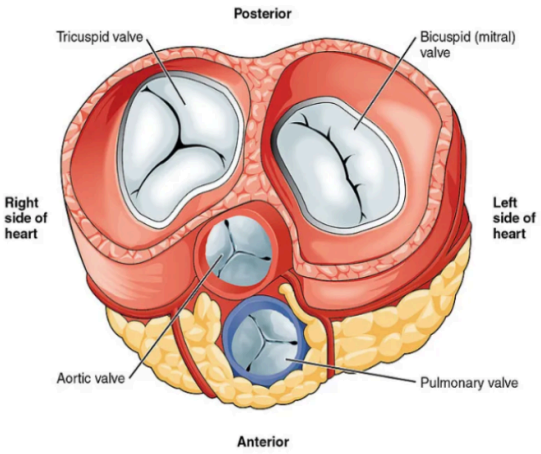


Advantages of double circulation:

- Higher blood pressure, allowing more efficient blood flow.
- Support better separation of oxygenated and deoxygenated blood.
- Ensures the body has a sufficient supply of oxygen.

9.2 Heart





Blood from body -> vena cava -> heart -> pulmonary artery -> lungs -> pulmonary vein -> heart -> aorta -> blood to body

Atrioventricular valves are the mitral and tricuspid valves.
Semilunar valves are the aortic and pulmonary valves. They stop blood from moving backwards.

Arteries	Veins
Pumps blood away from heart. Oxygenated blood (except pulmonary artery)	Pumps blood into heart. Deoxygenated blood (except pulmonary vein)

The walls of the left ventricle are bigger than the walls of the right ventricle. The right ventricle pushes blood to the lungs, which is closer. The left ventricle pushes blood out to the whole body.

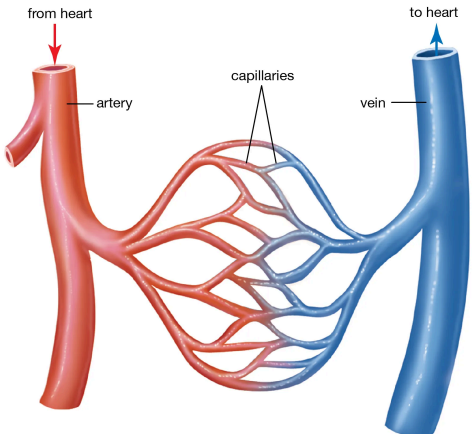
The septum separates oxygenated and deoxygenated blood.
The left atrium and left ventricle contains oxygenated blood. The right atrium and right ventricle contains deoxygenated blood.

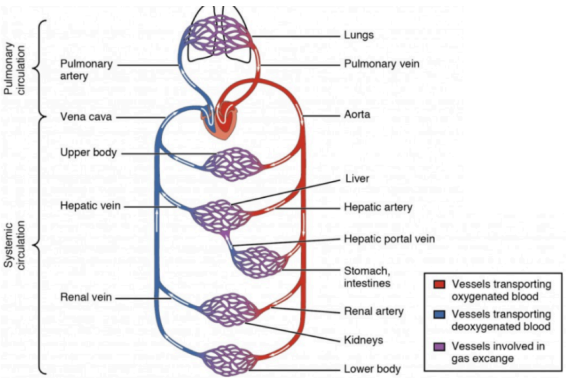
Activity of the heart may be monitored by: ECG, pulse rate and listening to sounds of valves closing.

Coronary heart disease is caused by the blockage of coronary arteries. Risk factors are diet, lack of exercise, stress, smoking, genetic predisposition, age and sex. It can be treated with bypass surgery and a stent.

9.3 Blood vessels

Blood Vessels - designed to carry blood to all areas of the body. There are 3 main types of blood vessels: artery, vein, capillary.





Arteries	Veins	Capillaries
Carries oxygenated blood away from heart.	Carries deoxygenated blood into heart.	Connects the arteries & veins.
Small lumen.	Large lumen.	Very small lumen.
Thick, elastic, muscular wall.	Thinner wall.	Very thin wall (one cell thick).
High pressure.	Low pressure.	Very low pressure.
No valves.	Have valves.	-

9.4 - Blood

Blood is a transport system used for moving things around the body. It is made up of the following components:

- **Red Blood Cells** – transports oxygen.
- **White Blood Cells** – phagocytosis and antibody production.
- **Plasma** – the liquid substance that suspends material for the transport of blood cells, ions, nutrients, urea, hormones and carbon dioxide.
- **Platelets** – blood clotting.

Red Blood Cells:

- Small, biconcave shape – gives a large surface area for absorbing and releasing oxygen
- Do NOT have a nucleus – which frees up more space for more Haemoglobin
- Contain Haemoglobin
- Flexible – so they can easily pass through tiny capillaries to get oxygen to all cells.

White Blood Cells

- Fight diseases
- Flexible shape – which helps them engulf microbes they come across, surrounding them and digesting them.
- Antibodies – which are proteins specific to antigens on the surface of pathogens. They attach to them destroying the pathogen.
- Antitoxins – which can be released by the white blood cell to neutralise the toxins (poisonous toxins) produced by some microbes.
- Types of white blood cells: phagocytes, lymphocytes.

Lymphocytes – antibody production
Phagocytes – engulfing pathogens by phagocytosis.

1. Blood clotting prevents blood loss and the entry of pathogens.
2. Blood clots are formed by platelets.
3. Prothrombin becomes thrombin.
4. Thrombin converts fibrinogen into fibrin.
5. Fibrin strands help to form an insoluble clot, by forming a mesh and trapping blood cells.

10. Diseases and Immunity

10.1 Diseases & Immunity

Pathogen	Disease-causing organism
Transmissible disease	A disease in which the pathogen can be passed from one host to another
Antigen	Any substance foreign to the body that evokes an immune response. Found on the surface of pathogens.
Antibody	Proteins that bind to antigens to destroy pathogens or marking of pathogens for destruction by phagocytes.

Ways a pathogen is transmitted:
- Direct contact (through blood & other bodily fluids)
- Contaminated food/water
- Air borne
- Vector (from animals)

Defences of body:
- Mechanical barrier - skin, hairs (e.g. nose hair)
- Chemical barrier - Mucus, stomach acid
- Cellular - white blood cells

How to control spread of disease:
- Clean water supply
- Hygienic food preparation
- Good personal hygiene
- Waste disposal
- Sewage treatment

Active immunity – The defence against a pathogen by antibody production in the body. It is gained after an infection by a pathogen or by vaccination.

Passive immunity – A short-term defence against a pathogen by antibodies acquired from another individual, including across the placenta and in breast milk. Memory cells are not produced.

Vaccination process:
1. Weakened pathogens or their antigens are put into the body.
2. The antigens stimulate an immune response by lymphocytes which produce antibodies.
3. Memory cells are produced that give long-term immunity.

Each pathogen has its own antigens, which have specific shapes. Specific antibodies have complementary shapes which fit specific antigens for detection

Cholera is a disease caused by a bacterium in contaminated water. The cholera bacterium produces a toxin that secretes chloride ions into the small intestine. Water moves into the

gut by osmosis, causing diarrhoea, dehydration and loss of ions from the blood.

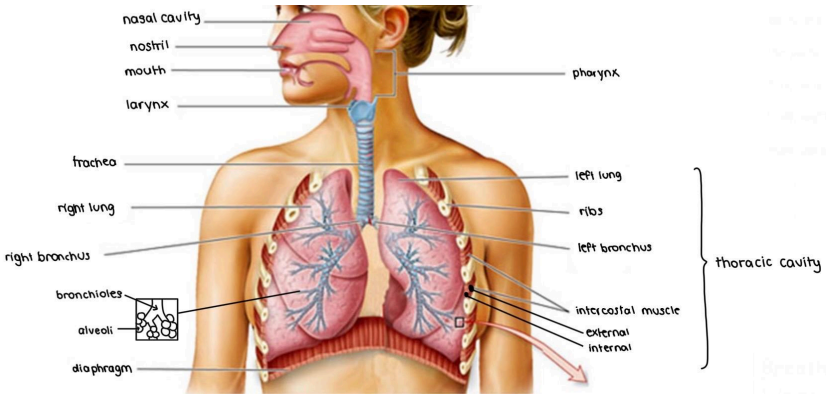
11. Gas Exchange

11.1 Gas exchange in humans

Gas exchange – The process of gases exchanging at the alveoli. Oxygen goes from alveoli to blood circulation. Carbon dioxide goes from blood circulation to alveoli.

Features of gas exchange surfaces:

- Large surface area
- Thin surface
- Good blood supply
- Good ventilation with air



Larynx (voice box): allows us to make sound
Trachea: passes air to both lungs
Bronchus: air is carried from trachea to lungs
Bronchioles: tiny tubes taking air to alveoli
Alveoli: tiny air sacs where gaseous exchange takes place
Diaphragm: a sheet of muscle that moves down to draw air into the lungs and to expel air out of the lungs
Ribs: bone that provides protection for lungs

Inspired	Expired
78% Nitrogen 21% Oxygen 0.04% Carbon dioxide >1% Other gases Less water vapour	78% Nitrogen 16% Oxygen 4.4% Carbon dioxide >1% Other gases More water vapour

Inspired	Expired
Internal intercostal muscles relax External intercostal muscles contract Diaphragm contracts Volume increases, pressure decreases Air enters to rebalance pressure	Internal intercostal muscles contract External intercostal muscles relax Diaphragm relaxes Volume decrease, pressure increase Air forced out

Investigation: Limewater is used to test for CO2.

Breathing & exercise:

- Frequency & depth of breathing increase when exercising.
- Muscles work harder and aerobically respire more, needing more oxygen to be delivered to them (and CO2 removed) to keep up with the energy demand.
- Pulse rate remains high after exercise, because the heart is beating faster to deliver oxygen to muscle tissue.

As respiration rates increase, more carbon dioxide is produced and enters the blood, which is acidic and affects the working of enzymes.

1. Increased carbon dioxide concentration in the blood
2. Detected by the brain
3. Increased rate and greater depth of breathing
4. Until pH of blood is back to normal

Goblet cells (produce mucus), mucus and ciliated cells protect the breathing system from pathogens and particles.

Cleaning the air

- The passages down the lungs are lined with ciliated epithelial cells, which beat mucus up towards the throat where it can be removed.
- The mucus (which is secreted from goblet cells) traps particles/dust and prevents them from getting into the lungs and damaging the cells there.

12. Respiration

12.1 Respiration

Uses of energy in living organisms

- Muscle contraction
- Protein synthesis
- Cell division
- Active transport
- Growth
- Nerve impulses
- Maintenance of a constant body temperature

12.2 Aerobic respiration

Aerobic Respiration - the chemical reactions in cells that use oxygen to break down nutrient molecules to release energy.

- Glucose + oxygen -> carbon dioxide + water (+ energy, ATP)
- $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$
- ATP - Energy is stored in a chemical compound, Adenosine Triphosphate (ATP). Breaking down this releases energy to be used by the body.

12.3 Anaerobic respiration

Anaerobic respiration - the chemical reactions in cells that break down nutrient molecules to release energy without using oxygen.

It releases a smaller amount of energy in cells compared to Aerobic Respiration. Glucose is not completely broken down, so much less energy is released.

During vigorous exercise

- Glucose -> energy + lactic acid

In plants and yeast

- Glucose -> carbon dioxide + ethanol + energy
- $C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$

When exercising:

1. Muscles contract more than usual -> require more energy. Cells in muscle perform aerobic respiration to release energy
2. Heart rate also increases, causing us to inhale more/deeper

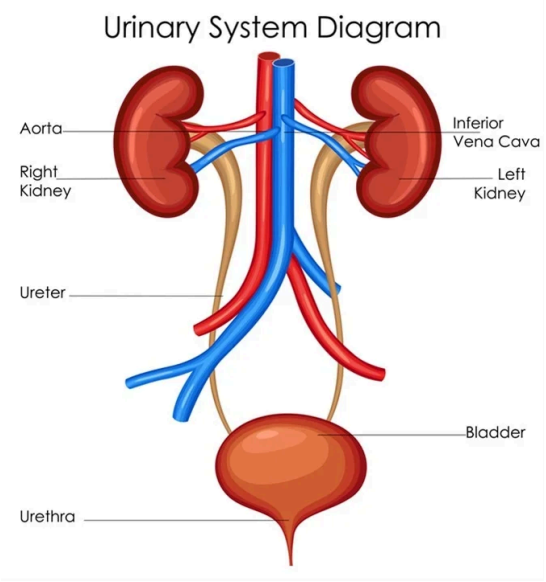
Lactic acid builds up in muscles and blood during vigorous exercise causing an oxygen debt and heavy breathing. Quick heart rate will transport lactic acid from muscle to liver. Continuation of deeper and faster breathing to supply oxygen for aerobic respiration of lactic acid, until all lactic acid is used up. Lactic acid converts to glucose and CO2.

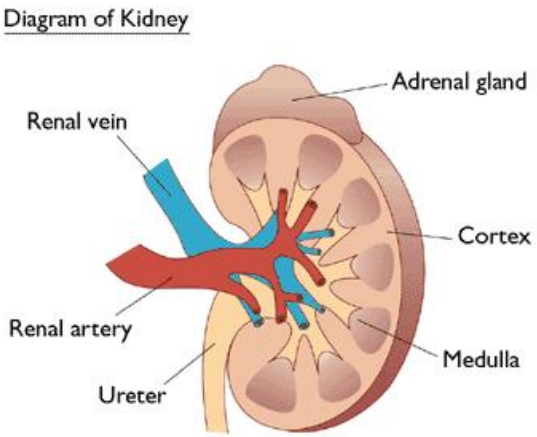
13. Excretion in humans

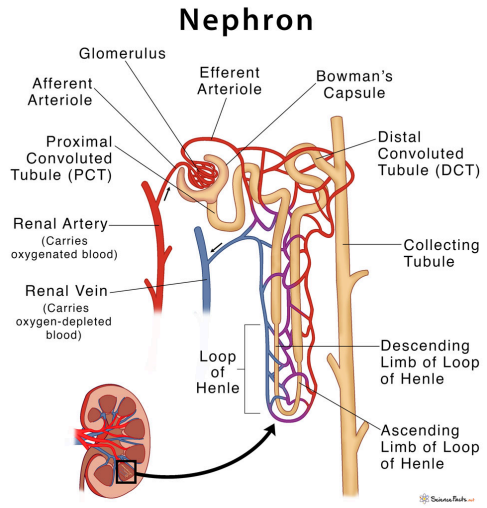
13.1 Excretion in humans

Carbon dioxide is excreted through the lungs
Excrete urea, excess water and ions are excreted through kidneys.

Nephron: the functional unit of the kidneys







Glomerulus: filtration from the blood of water, glucose, urea and ions
Convoluted tubule: Where reabsorption of all glucose, some urea and some ions back into the blood occurs
Loop of Henle: Reabsorbs most water depending on the needs of the body. The loop of Henle can adjust how permeable it is to water so maximise or minimise osmosis
Urine: contains urea (toxic), excess water and excess ions

Liver:

- Assimilation of amino acids by converting them to proteins
- Urea is formed in the liver from excess amino acids

- **Deamination** – The removal of the nitrogen-containing part of amino acids to form urea.

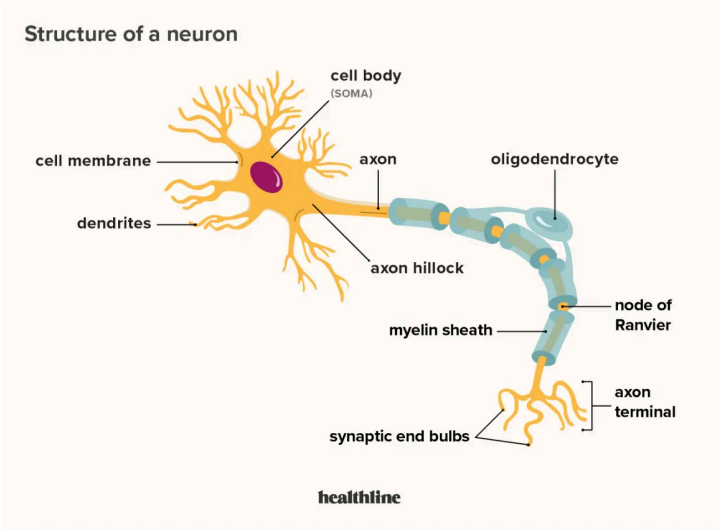
14. Coordination and response

14.1 Coordination & response .

Nervous system – A complex collection of nerves & cells that carry messages to **coordinate & regulate body functions**. It is made of billions of nerve cells called neurons. Signals travel along neurons as electrical impulses.

Nervous system is made of:

- Central nervous system (CNS): the brain and the spinal cord
- Peripheral nervous system (PNS): nerves outside of the brain and spinal cord



Sensory neuron	Relay neuron	Motor neuron
Long Cell body branching off the middle of axon	Short Small cell body at one end Many dendrites	Long Large cell body at one end Long dendrites.

Voluntary actions	Differences	Involuntary actions
Non automatic - with awareness	Type	Automatic - without awareness
Receptor -> spinal cord -> cerebrum -> spinal cord -> effectors	Nervous pathway	Receptor -> spinal cord -> medulla oblongata -> spinal cord -> effectors
Slow	Speed	Fast
Speaking, hearing, walking	Examples	Heartbeat, peristalsis, respiration, blinking

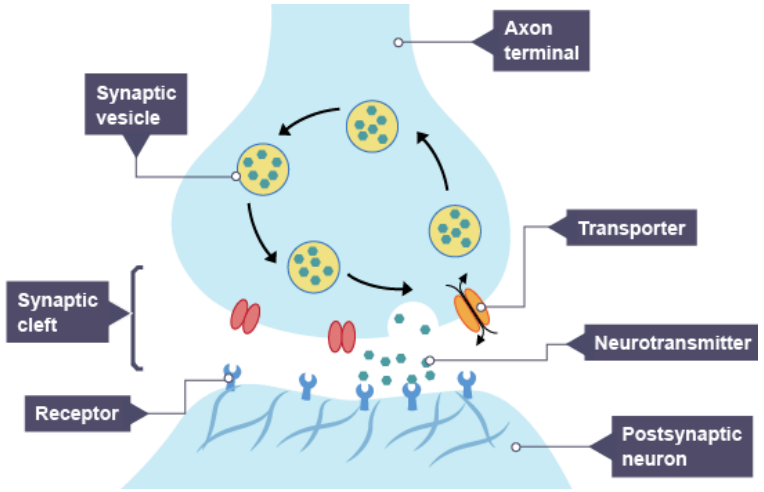
Stimulus – A change in the environment detected by receptors
Receptor – Cells that detect a stimulus and convert it into an electrical impulse
Effector – muscle or gland that responds to a stimulus

Reflex action – automatically and rapidly integrating and coordinating stimuli with the responses of effectors (muscles and glands)

Reflex arc: receptor -> sensory neurone -> relay neurone -> motor neurone -> effector

Benefits of reflexes:

- Fast response because the brain is not involved
- Keeps us safe e.g. finger in flame reflex action to move it away
- Minimises damage to the body from harmful conditions
- Doctors can use reflex reactions to check if a patient's nervous system is functioning properly



Structure of a synapse

- Vesicles containing neurotransmitter molecules
- Synaptic gap
- Receptor proteins

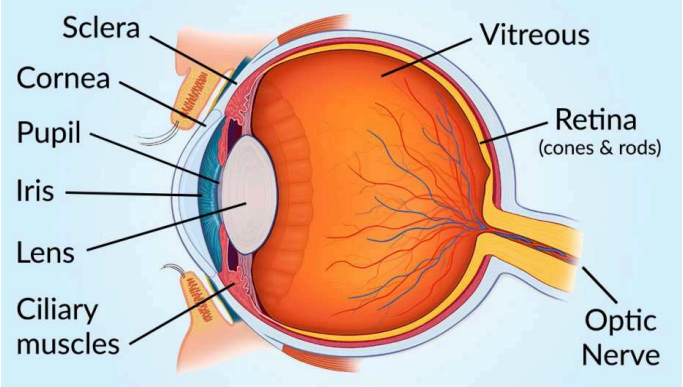
Events at a synapse

1. An impulse stimulates the release of neurotransmitter molecules from vesicles into the synaptic gap
2. The neurotransmitter molecules diffuse across the gap
3. Neurotransmitter molecules bind with receptor proteins on the next neurone
4. An impulse is then stimulated in the next neurone

Synapses ensure that impulses travel in one direction only as they only have receptors on one end of the synapse.

14.2 Sense organs

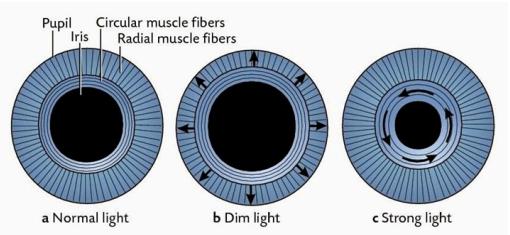
Sense organs – groups of receptor cells responding to specific stimuli: light, sound, touch, temperature and chemicals



Structure	Function
Cornea	Refracts light
Iris	Controls how much light enters the pupil
Lens	Focuses light onto the retina
Retina	Contains light receptors (rods & cones)
Optic Nerve	Carries impulses to the brain
Fovea	Central part of retina where cones are concentrated.

Bright light: Circular muscles contracts, radial muscles relax -> pupil reduces in size -> reduces amount of light reaching retina

Dim light: Circular muscle relax, radial muscles contracts -> pupil increase in size -> increase the amount of light reaching retina



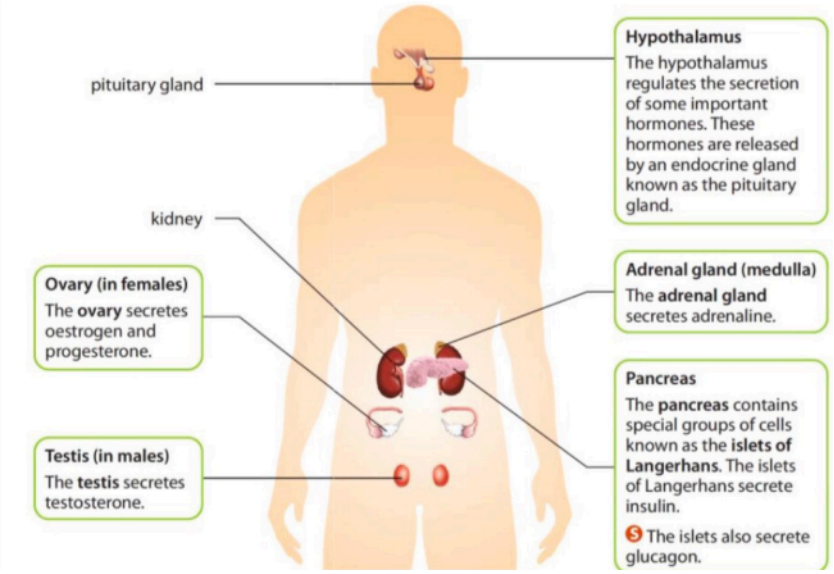
Rods	Cones
Black & white images Sensitive in dim light Low detail	Colour images Works in high light intensity High detail 3 types: red, green, blue

Accommodation:

- **Near objects**: ciliary muscles contract, suspensory ligaments relax -> lens becomes thicker
- **Distant objects**: ciliary muscles relax, suspensory ligaments contracts-> lens becomes thinner

14.3 Hormones

Hormone – A chemical substance, produced by a gland and carried by the blood, which alters the activity of one or more specific target organs.



Adrenaline – The hormone secreted in 'fight or flight' situations and is released from adrenal glands.

Adrenaline effects:

- Increased breathing rate (for more oxygen to be absorbed for energy)
- Increased heart rate (so blood moves faster and delivers more oxygen for energy)
- Increased pupil diameter (to see clearer)
- Increasing the blood glucose concentration (used in respiration for energy)

	Hormonal control	Nervous control
Form of info	Hormones / glands	Nerves (neurons), brain, spinal cord
Type of message	Chemical hormone	Electrical impulse
Transmission	Hormones transported by blood	Impulses transmitted by neurons
Speed of response	Slower	Very fast
Duration of effect	Short (adrenaline) or long (growth hormone) - until hormone is broken down	Short - until nerve impulses stop
Area of response	May affect more than one target organ	Usually localised

14.4 Homeostasis

Homeostasis – Maintenance of constant internal environment.

Positive feedback - Body adds to the action being experienced by your body. E.g. uterine contraction during labour to increase the contraction to facilitate childbirth
Negative feedback - Body counteracts the action being experienced by your body to bring it back to normal conditions. E.g. thermoregulation, osmoregulation, glucoregulation.

Blood glucose level is detected at the islets of Langerhans in the pancreas and controlled by these two hormones: Insulin & glucagon.

Insulin

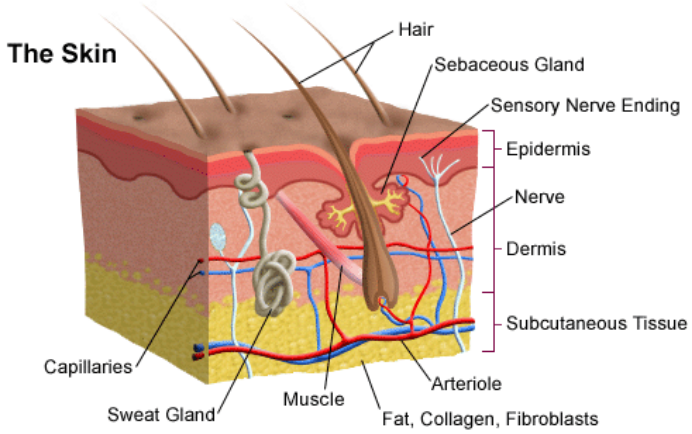
1. Blood glucose level gets too high
2. Stimulates enzyme production in pancreas
3. Insulin stimulates liver to change glucose to glycogen
4. Blood glucose concentration decreases
5. Glycogen stored for energy

Glucagon

1. Blood glucose level gets too low
2. Stimulates enzyme production in pancreas
3. Glucagon stimulates liver to change glycogen back to glucose
4. Blood glucose concentration increases

Type 1 diabetes

- No/little insulin in blood, so cells can't take glucose.
- Treatment: Regular monitoring of blood glucose levels (up to 6x/day), lifelong insulin injections (up to 6x/day), healthy diet, regular exercise



Maintenance constant internal body temperature:

Hot	Cold
Receptors detect change in temperature and carry impulses to hypothalamus.	
Sweating (cools body via evaporation). Blood vessels dilate (to release heat). Muscles relax - hair is flat (so no air is trapped to provide insulation).	No sweating. Blood vessels constrict (to reduce heat loss). Muscles contract - hairs erect. Shivering Vasoconstriction.

Vasodilation	Vasoconstriction
1. Arterioles dilate, shunt vessels constrict 2. More blood flows to skin through capillaries 3. Heat is taken to surface 4. Blood carries heat 5. Heat lost from skin	1. Arterioles constrict, shunt vessels dilate 2. Less blood flows to skin through capillaries 3. Heat loss is reduced

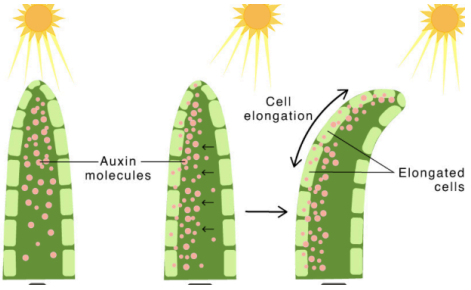
14.5 Tropic Responses

Tropism – a growth response in which parts of a plant respond to the direction of a stimulus (moving towards or away)

Gravitropism – response where parts of plants grow towards/away from gravity
Phototropism – response where parts of plants grow towards/away from direction of light source

Auxin - a family of growth hormones that control cell elongation.

1. Auxin made in shoot tip
2. Diffuses through plant from shoot tip
3. Unequally distributed in response to light/gravity
4. Stimulates cell elongation



In phototropism auxin moves to the shade, stimulating cell elongation and bending the plant towards the light

15. Drugs

15.1 Antibiotic Resistance

Drugs - any chemical substance taken into the body that modifies or affects chemical reactions in the body.

Antibiotics – used for the treatment of bacterial infections. They kill/stop growth of bacteria/other microbes) They are effective against bacteria but NOT AGAINST viruses.

Antibiotic resistance

1. Overuse of antibiotics.
2. Resistant bacteria will survive.
3. Antibiotic no longer effective.

16. Reproduction

16.1 Asexual Reproduction

Asexual reproduction – a process resulting in genetically identical offspring from one parent.

Advantages	Disadvantages
Saves more time & energy. Can exploit suitable environments quickly. Population can increase rapidly.	Less genetic variation. Vulnerable to changes in conditions. Diseases can affect the whole population.

16.1 Sexual Reproduction

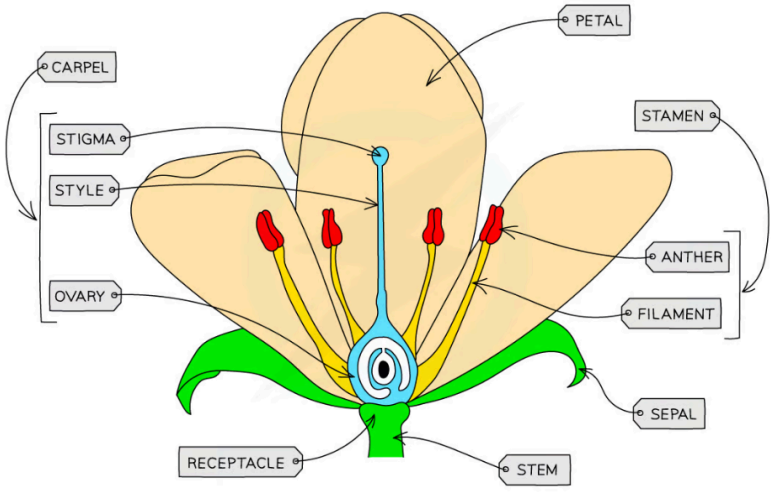
Sexual reproduction - a process involving the fusion of the nuclei of two gametes to form a zygote and offspring that are genetically different from each other.

Advantages	Disadvantages
More genetic variation. Able to adapt. Less likely to be affected by diseases.	Takes more time & energy. Difficult for isolated members to reproduce.

Fertilisation – fusion of nuclei of gametes

Nuclei of gametes are haploid (contain only 1 set of chromosomes)
Nuclei of zygotes are diploid (contains 2 sets of chromosomes)

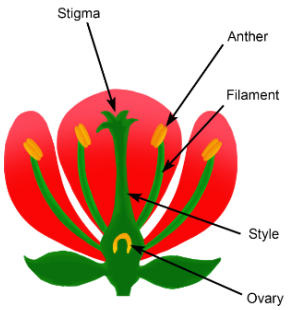
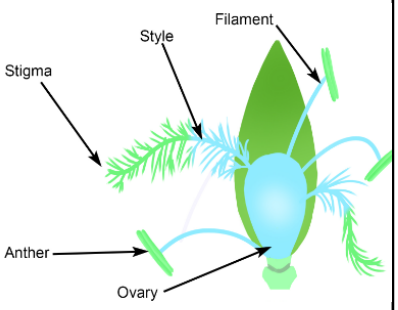
16.3 Sexual reproduction in plants



Stigma - sticky or feathery end where the pollen lands/deposited
Style - supports the stigma
Ovary - produces female sex cells contained in ovules
Sepals - a leaf-like structure that encloses and protect the bud of a flower

Pistil - female part of flower (stigma, style, ovary, ovule)
Ovule - contains female sex cells (ovum)
Anther - site where the male gametes (pollen) are produced
Filament - supports the anther
Stamen - male part of flower (anther, filament)
Petals - a plain or colourful leaf-like structure of some flowers
Nectary - site where nectar is found (usually present in insect pollinated flowers)
Pollen grains - male sex cells

Pollination – The transfer of pollen grains from an anther to a stigma.

Insect pollinated flowers		Wind pollinated flowers
Inside flower & stiff	**Anthers**	Outside flower
Inside flower & sticky	**Stigma**	Outside flower & feathery
Larger, heavier, spiky	**Pollen grains**	Small, lightweight, smooth
Small amounts	**Number of pollen grains**	Large amounts
Large & brightly coloured	**Petals**	Small & dull
	**Diagram**	

Self-pollination – The transfer of pollen grains from the anther of a flower to the stigma of the same flower or a different flower on the same plant.

Advantages	Disadvantages
Only one parent is required.	Less genetic variation.
Beneficial qualities are more likely to be passed on the offspring.	Less adapted to changes in the environment.
Does not depend on external factors (wind.insects)	Less resistant to diseases.
Less pollen and energy are wasted.	
More chance of fertilisation.	

Cross-pollination – The transfer of pollen grains from the anther of a flower to the stigma of a flower on a different plant of the same species.

Advantages	Disadvantages
Offspring may inherit good qualities from both parents.	Two parent plants are required.
More varieties are produced.	Depends on external factors (wind/insects).
Increases chance of species surviving environmental changes.	There is low probability that pollination will occur.
More viable seeds produced.	More pollen wasted.

Fertilisation occurs when a pollen nucleus fuses with a nucleus in an ovule

1. A pollen tube grows
2. The nucleus of pollen grain slips down the tube as it grows down the style towards the ovary.
3. The ovary contains one or more ovules which each contain a female nucleus that a male pollen nucleus can fuse with.
4. The pollen tube enters the ovule through a small hole - the micropyle.

After fertilisation,

1. The stamen, petals and sepals wither and fall off.
2. Each ovule now contains a zygote, which is formed at fertilisation.
3. The zygote divides by mitosis to form an embryo.
4. The ovule is now a seed, while the ovary forms the fruit.

Germination is the development of a new plant from the embryo in a seed. Conditions to germinate:

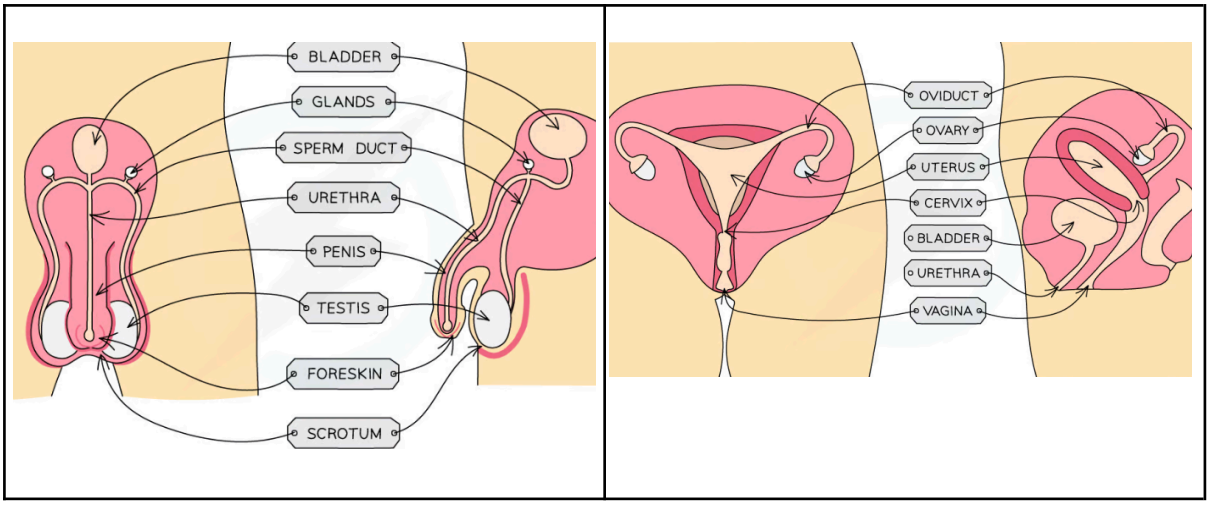
Water - activate enzymes which digest stored food.
- allows the seed to swell up.

Oxygen - needed for aerobic respiration to release energy needed for germination

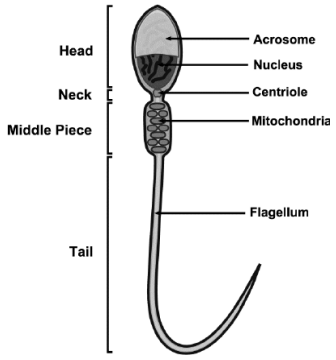
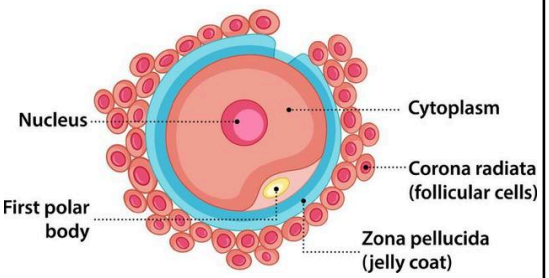
Warmth - needed for the enzymes to work effectively at their optimum temperature

16.4 Sexual reproduction of humans

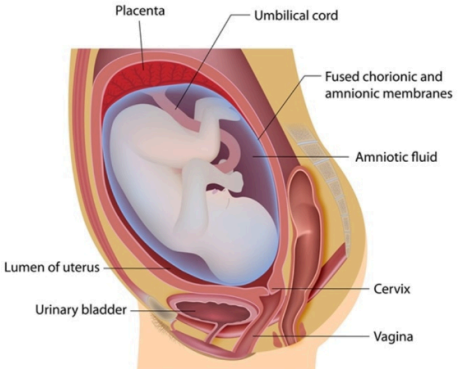
Males	Females
Testes: produces sperm & testosterone. **Scrotum**: sac supporting the testes. **Prostate gland**: produces semen. **Urethra**: a tube carrying out urine or semen. **Penis**: passes urine out of body and allows semen to pass into vagina during sexual intercourse.	**Ovaries**: contains ova. **Oviducts**: connects ovary to uterus. Fertilisation occurs here. **Uterus**: where fertilised egg is implanted. **Cervix**: keeps fetus in place during pregnancy. **Vagina**: where penis enters during sexual intercourse.



Fertilisation – the fusion of the nuclei from a male gamete (sperm) and a female gamete (egg cell)

Sperm		Egg
Small (0.05cm)	**Size**	Larger (2cm)
	**Structure**	
Mobile	**Mobility**	Not mobile
525 billion	**Number**	70000

In early development, the zygote forms an embryo which is a ball of cells that implants into the lining of the uterus.



Umbilical cord: allows exchange of dissolved nutrients, gases and excretory products between the blood of the mother and the blood of the fetus.
Placenta: provides oxygen & nutrients to fetus, and removes excretory products.
Amniotic sac: protect fetus from mechanical damage,
Amniotic fluid: protect fetus from mechanical damage, maintains temperature and fetal drinking

Some pathogens and toxins can pass across the placenta and affect the fetus.

Oesteogen → stimulates the development of sex organs and sexual characteristics in girl's body.
Progesterone → prepares the uterus so that it is ready to receive an embryo in the case of a pregnancy.

Fetal development:

- Fertilisation takes place in the oviduct
- The fertilised egg is now referred to as Zygote.
- Zygote will continue dividing and becomes embryo (a ball of cells that implants (implantation) into uterus lining to grow & develop)
- Major development of organs takes place in first 12 weeks, where the embryo gets nutrients from the mother by diffusion through the uterus lining.
- After this point the organs are all in place, the placenta has formed and the embryo is now called a fetus.
- Fetus develops and grows by gaining dissolved nutrients (glucose, amino acids, fats, water and oxygen).
- The fetus's blood connects to the placenta by the umbilical cord
- The mother's blood absorbs the waste (CO_2, urea are removed so it won't build up to dangerous levels) from the fetus's blood in the placenta.

16.5 Sexual hormones in humans

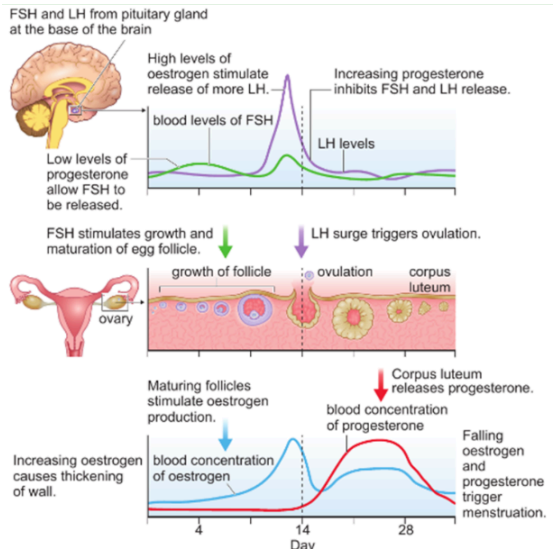
Testosterone – development and regulation of secondary sexual characteristics during puberty in males.
Oestrogen – development and regulation of secondary sexual characteristics during puberty in females.

Menstrual cycle:
Day 1 – 7: First day of a woman's period. Lining of the uterus comes away and exits through the vagina as blood.
Day 7 - 13: Lining of the uterus begins to build up again. An egg starts to mature in one of the ovaries.
Day 14: An egg is released by an ovary into the oviduct.
Day 14 - 17: The egg can last up to 3 days after release from ovary. The egg travels down the oviduct and into the uterus hoping to be fertilised.
Day 18 - 28: If not fertilised, uterus lining begins to break down.
The cycle repeats

FSH & LH is produced in the pituitary gland.
Oestrogen & progesterone is produced in the ovaries, but placenta during pregnancy.

FSH: Stimulates growth & maturation of egg, causes the release of oestrogen.
Oestrogen: Thickening of uterus lining, stops release of FSH, stimulates release of LH.

LH: Ovulation.
Progesterone: Maintains the lining of the uterus, Inhibits LH and FSH release.



16.6 Sexually transmitted infections

Sexually transmitted infection (STI) - an infection transmitted through sexual contact.

Human Immunodeficiency Virus (HIV) - a pathogen that causes an STI. It attacks white blood cells. There is no cure, but it is treatable with medicine. It can lead to AIDs.

Transmission of HIV: sexual contact, pregnancy, childbirth, breastfeeding, injection, blood transfusion, etc.

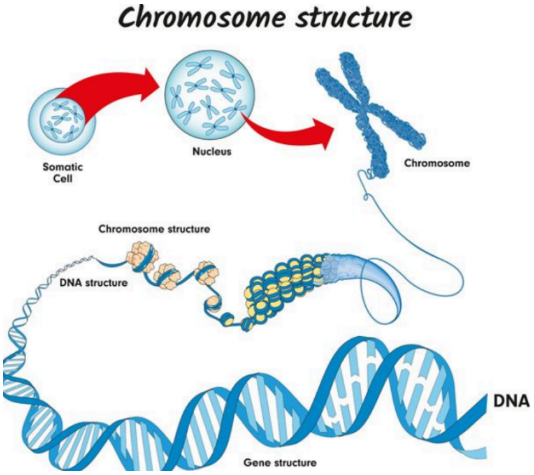
How to prevent?

- Use condoms
- Have only 1 sex partner
- Only sterile drug injection equipment and water, and never share your equipment with others.
- Education programmes to make people aware of HIV, etc
- Zidovudine (ZDV), is an antiviral medication that delays the development of problems that result from AIDS/HIV.

17. Inheritance

17.1 Chromosomes, genes and proteins

Chromosomes –Made of DNA, which contains genetic information in the form of genes.



Gene – A length of DNA that codes for a protein
Allele – An alternative form of a gene

Male = XY, female = XX

The sequence of bases in a gene determines the sequence of amino acids used to make a specific protein. Different sequences of amino acids give different shapes to protein molecules

DNA controls cell function by controlling the production of proteins, including enzymes, membrane carriers and receptors for neurotransmitters.

How a protein is made:

1. Gene coding for the protein remains in the nucleus.
2. Messenger RNA (mRNA) is a copy of a gene.
3. mRNA molecules are made in the nucleus and move to the cytoplasm.
4. The mRNA passes through ribosomes.
5. The ribosome assembles amino acids into protein molecules.
6. The specific sequence of amino acids is determined by the sequence of bases in the mRNA.

Most body cells in an organism contain the same genes, but many genes in a particular cell are not expressed because the cell only makes the specific proteins it needs.

Haploid nucleus – A nucleus containing a single set of chromosomes
Diploid nucleus – A nucleus containing two sets of chromosomes

In a diploid cell, there is a pair of each type of chromosome and in a human diploid cell there are 23 pairs.

Function of DNA

- Store genetic information / genes
- DNA codes for making proteins
- The sequence of bases in DNA codes for sequence of amino acids
- DNA transfer information to daughter cells
- DNA copied as mRNA

17.2 Mitosis

Mitosis – Nuclear division giving rise to genetically identical cells.

Mitosis is used in: growth, repair of damaged tissues, replacement of cells and asexual reproduction.

Stem cells - unspecialised cells that divide by mitosis to produce daughter cells that can become specialised for specific functions. Examples:

- Basal cells of the skin which keep dividing to make new skin cells. These stem cells produce more cells to repair the damage.
- Stem cells in bone marrow produce red blood cells and white blood cells.

Process of mitosis:

1. Exact replication of chromosomes occurs before mitosis.
2. During mitosis, the copies of chromosomes separate.
3. The chromosome number in each daughter cell maintains the same as the start.
4. Two daughter cells are produced.

17.3 Meiosis

Meiosis - reduction division in which the chromosome number is halved from diploid to haploid resulting in genetically different cells.

Meiosis is used in: production of gametes.

Process of meiosis:

1. Each chromosome makes identical copies of itself.
2. In each pair, one is inherited from father, and one is from mother.
3. First division: chromosomes pair up along the centre of the cell. Recombination occurs. Each new cell will have one of each recombinant chromosome pair.
4. Second division: A total of four haploid daughter cells will be produced.
5. The chromosome number in each daughter cell is halved as from the start

17.4 Monohybrid inheritance

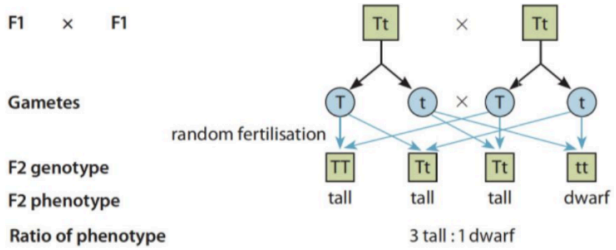
Inheritance – The transmission of genetic information from generation to generation
Genotype – The genetic make-up of an organism and in terms of the alleles present
Phenotype – The observable features of an organism

Homozygous have two identical alleles of a particular gene.
2 identical homozygous individuals that breed together will be pure-breeding.

Heterozygous have two different alleles of a particular gene.
A heterozygous individual will not be pure-breeding.

Dominant allele – an allele that is expressed if it is present in the genotype.

Recessive allele – an allele that is only expressed when there is no dominant allele of the gene present in the genotype.



Another way of presenting the results is to use a **Punnett square**.

Tt × Tt		
Gametes	T	t
T	TT tall	Tt tall
t	Tt tall	tt dwarf

Ratio of phenotype 3 tall : 1 dwarf

Examples of Monohybrid Inheritance: height (short or tall), single or double eyelids, straight or curly hair, attached or detached earlobes.

Codominance – A situation in which both alleles in heterozygous organisms contribute to the phenotype.

Phenotypes of ABO blood groups are A, B, AB and O blood groups
Alleles are I^A , I^B and I^O

Sex-linked characteristic – A feature in which the gene responsible is located on a sex chromosome. This makes the characteristic more common in one sex than in the other. E.g. red-green colorblindness, found on the X allele.

Females have the alleles XX
Males have the alleles XY

Haemophilia (Sex-linked characteristics):

Haemophilia (female)

1) two H alleles (X^HX^H)
   → normal clotting factor
1) two h alleles (X^hX^h)
   → develop haemophilia
1) Both H and h alleles (X^HX^h)
   → Known as carrier of haemophilia gene

Haemophilia (male)

(X^HY)
→ normal clotting factor

(X^hY)
→ develop haemophilia

18. Variation

18.1 Variation

Variation – Differences between individuals of the same species

Continuous variation	Discontinuous variation
Results in a range of phenotypes between two extremes. E.g. body length and body mass.	Results in a limited number of phenotypes with no intermediates.
Caused by both genes and the environment.	Usually caused by genes.
E.g. body length and body mass.	E.g. ABO blood groups, seed shape in peas and seed colour in peas.

Mutation – Genetic change. It is the way in which new alleles are formed. ionising radiation and some chemicals increase the rate of mutation.

Gene mutation – A random change in the base sequence of DNA.

Many mutations can cause adverse effects but some are beneficial.
E.g. feather colours in birds (more attractive to other sex), albinism (doesn't produce melanin)

Sources of genetic variation: Mutation, meiosis, random mating and random fertilisation

18.2 Adaptive features

An adaptive feature – An inherited feature that helps an organism to survive and reproduce in its environment.

Hydrophytes (plants adapted to live around excess water)	Xerophytes (plants adapated to water scarcity)
Numerous stomata on the upper side of their leaves Large air sac to float Large leaves	Small or compound leaves Rolling of leaves Densely packed spongy mesophyll Deep root systems Thick waxy cuticle Stomata adaptations Hairs

18.3 Selection

Natural selection:

1. There is genetic variation within populations.
2. Production of many offspring.
3. This causes a struggle for survival and competition for resources.
4. Individuals with better adaptations will reproduce.
5. These individuals pass on their alleles to the next generation.

Selective breeding:

1. Selection by humans of individuals with desirable features.
2. Crossing these individuals to produce the next generation.
3. Offsprings show desirable features.

Selective breeding by artificial selection is carried out over many generations to improve crop plants and domesticated animals.

Adaptation – The process, resulting from natural selection, by which populations become more suited to their environment over many generations.

Examples of natural selection:

- Antibiotic resistant bacteria

19. Organisms and their environment

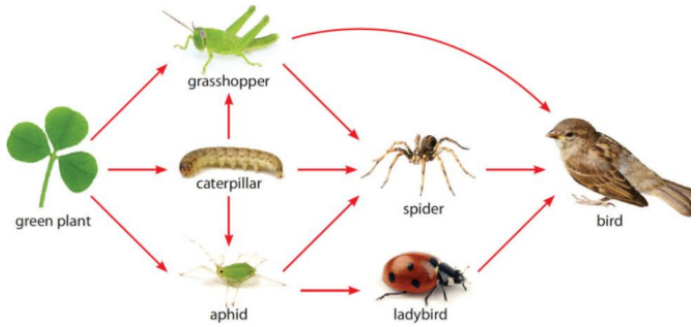
19.1 Energy flow

The Sun is the principal source of energy input to biological systems.

Flow of energy: light energy from the Sun -> chemical energy in organisms -> energy transferred to the environment.

19.2 Food chains and food webs

A food chain shows the transfer of energy from one organism to the next, beginning with a producer

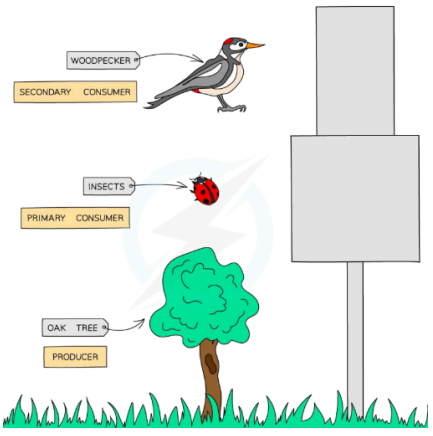


Food web – A network of interconnected food chains and interpret food webs.

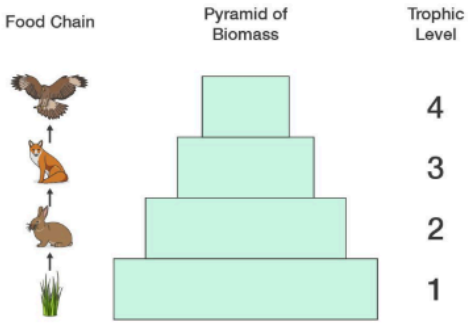
Producer – An organism that makes its own organic nutrients, usually using energy from sunlight, through photosynthesis.
Consumer – An organism that gets its energy by feeding on other organisms.
Herbivore – An animal that gets its energy by eating plants.
Carnivore – An animal that gets its energy by eating other animals.
Decomposer – An organism that gets its energy from dead or waste organic material

Consumers may be classed as primary, secondary, tertiary and quaternary according to their position in a food chain.

A pyramid of numbers shows how many organisms we are talking about at each level of a food chain. It does not consider the size & mass of organisms or whether the organism is an adult/juvenile.

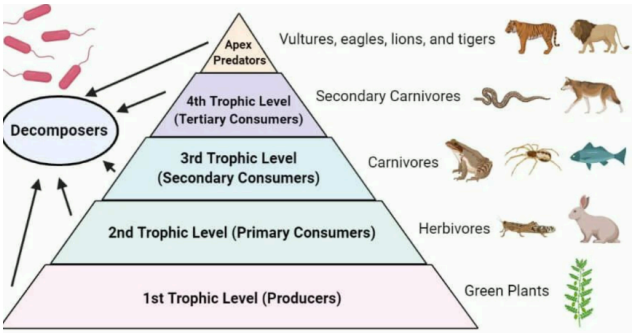


Pyramid of biomass
It shows the total amount of living tissues & amount of energy available for the next trophic level.



Trophic level – The position of an organism in a food chain, food web or ecological pyramid
Supplement

Pyramid of energy



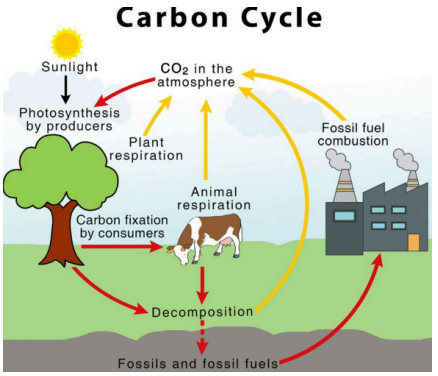
Producers – Make all their own nutrients using energy from sunlight. (Green plants)
Primary consumer – A consumer eats another organism. (herbivores & omnivores)
Secondary consumer – Eat primary consumer. (omnivores & carnivores)
Tertiary consumer – A secondary carnivore that eats a secondary consumer. It is bigger than the others.

Transfer of energy

- In order for the energy to be passed on, it has to be eaten.
- Not all of the energy grass plants receive goes into making new cells that can be eaten.
- Food chains usually have fewer than five trophic levels, as there is very little usable energy after four or five trophic levels.
- It is more energy efficient for humans to eat crop plants than to eat livestock that have been fed on crop plants, as there is more energy.

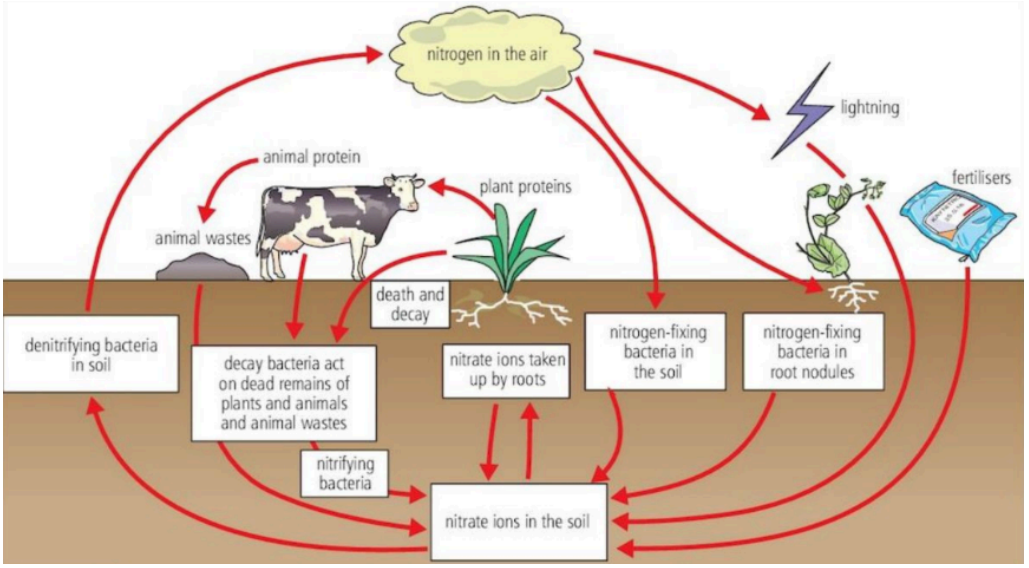
19.3 Nutrient cycles

Carbon cycle



1. Carbon is taken by plants for photosynthesis.
2. It is passed on to animals by feeding.
3. It is returned to the atmosphere by plants, animals and microorganisms from respiration.
4. Decomposers use decaying material for respiration, releasing carbon dioxide.
5. If animals and plants die, the carbon in their bodies can be converted into fossil fuels. When fossil fuels are burned, CO2 is released into atmosphere.
6. Mass deforestation is reducing the amount of producers available to take carbon dioxide out of the atmosphere by photosynthesis.

Nitrogen cycle



Nitrogen fixing bacteria

- Nitrogen fixing bacteria in soil convert nitrogen gas to compounds of nitrogen (nitrates)
- When bacteria die and decompose, this fixed nitrogen is available to plants.
- Nitrogen-fixing bacteria are also in the root nodules of certain legumes plants (peas, beans, clover) These bacteria change nitrogen gas to ammonia for plants to make amino acids.

Lightning

- Lightning splitting the bond between the two atoms
- Causes nitrogen & oxygen to react together at high temperatures to form nitrogen oxides
- These nitrogen oxides are washed into soil by rain where they form nitrate ions.

Denitrifying bacteria

- Denitrifying bacteria change nitrate ions to nitrogen gas.

Decomposers

- Decomposers break down dead animals, releasing ammonium ions into soil.
- Bacteria also break down urea to ammonium ions.

Nitrifying bacteria

- Convert ammonium to nitrates, which can be absorbed by plants.

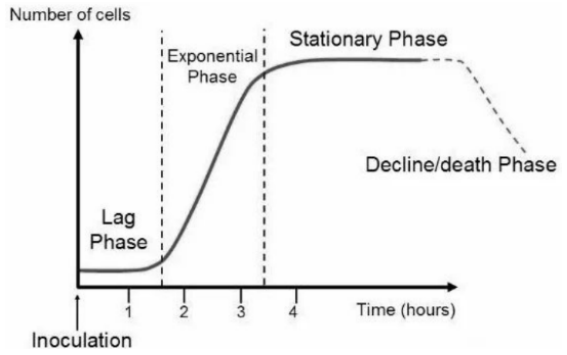
Uses of nitrate ions

- To make amino acids in leaves of plants.
- Excess of amino acids are broken down → ammonia (deamination)

19.4 Populations

Population - a group of organisms of one species, living in the same area at the same time
Community - all of the populations of different species in an ecosystem.
Ecosystem - a unit containing the community of organisms and their environment, interacting together. (biotic & abiotic)

Population growth factors: Food supply, predation, disease, competition, immigration



Lag phase - organisms are adapting to the environment before they are able to reproduce.
Exponential phase - food supply is abundant, birth rate > death rate.
Stationary phase - birth rate and death rate are equal. Nutrients are limited or waste products are building up.
Death phase - death rate > birth rate. Food supply is short or metabolic wastes produced by the population have built up to toxic levels.

20. Human influences on ecosystems

20.1 Food supply

Increasing food production

- **Agricultural machinery** to improve efficiency, because they have the ability to farm much larger areas of land.
- **Chemical fertilisers** -> increase the amount of nutrients in soil → plants grow larger & produce more fruit
- **Insecticides & herbicides** -> kill off unwanted insects and weed species → less damage done to plants & fruit lost to insects (insecticides) → reducing competition from other plant species (herbicides)
- **Selective breeding** -> animals and crop plants which produce a large yield are selectively bred to produce breeds that reliably produce high yields.

Large-scale monocultures of crop plants

Advantages	Disadvantages
Ease of management. Reduced Labour and Operational Costs. High yield. Higher revenues from specialised production.	Biodiversity is much lower -> increase in pest populations. Herbicides and pesticides kill plant and insect species that are harmless. Continuous use of chemicals causes pests to become resistant to them.

Intensive livestock production

Advantages	Disadvantages
Increases yield. More animals can be reared on a small area of field. Products are easily available & cheaper.	Pesticides & insecticides used. Animals are reared in cramped, confined areas -> more infections and diseases. Cattle generate lots of methane. Urine and faeces can cause eutrophication.

20.2 Habitat destruction

Biodiversity – The number of different species that live in an area

Reasons for habitat destruction

- Increased area for housing, crop plant production & livestock production
- Extraction of natural resources

- Freshwater/marine pollution

Through altering food webs and food chains, humans can have a negative impact on habitats.

Deforestation effects:

- **Extinction** - Many species are only found in specific areas. Destroyed habitats cause the loss of large number of plants and animals
- **Loss of soil** - Tree roots help to stabilise the soil. Without trees, nutrients in soil will be washed away into rivers and it'll be difficult for the trees to regrow.
- **Flooding** - Without the trees, water is not absorbed by plants and transported into the atmosphere.
- **Increased CO2** - Less trees = less photosynthesis -> more CO2 -> global warming

20.3 Pollution

Untreated Sewage

- Encourages the growth of bacteria that feed on organic matter -> bacteria uses up lots of oxygen -> freshwater organisms cannot survive.

Excess fertiliser

- Encourage the growth of algae.
- Pesticides concentrated in tissues of some shellfish.
- Radioactive chemicals are found in higher concentrations around coastal nuclear power stations.
- Toxic metals (mercury, copper & lead) found in tissues of marine organisms.

Effects of Non-Biodegradable materials

- Pose threats to aquatic life. Sea turtles swallow plastic bags & get entangled.
- Can cause pollution, block drains
- Harm the animals

Pollutants

- **CO2**: Sources - burning fossil fuels. Effects - greenhouse effects
- **Methane**: Sources - cattle/ paddy fields. Effects - greenhouse effects

Eutrophication

1. Rain washes fertiliser (nitrate) into the water.
2. The water's mineral content shoots up and algae multiplies very rapidly.
3. Algae covers the surface of water, reducing the light reaching the plants at the bottom
4. These plants die
5. Increased decomposition
6. increased aerobic respiration by decomposers caused reduction of dissolved oxygen.
7. Death of organisms requiring dissolved oxygen in water (such as fish)

20.4 Conservation

Sustainable resource – produced as rapidly as it is removed from the environment so that it does not run out.

Some resources can be conserved and managed sustainably. E.g. forests and fish stocks.

Why organisms become endangered or extinct: climate change, habitat destruction, hunting, overharvesting, pollution, introduced species.

How **endangered species** can be conserved: monitoring and protecting species and habitats, education, captive breeding programmes, seed banks

How **forests** can be conserved: educating the population
, protecting areas, quotas, replanting

How **fish stocks** can be conserved: educating the population, closed seasons, protected areas, controlled net types and mesh size so only grown fish are caught, quotas and monitoring.

Reasons for conservation programmes: maintaining or increasing biodiversity, reducing extinction, protecting vulnerable ecosystems, maintaining ecosystem functions.

Artificial insemination (AI), fertilising the egg cell in the vagina through placement of a sperm cell, and in vitro fertilisation (IVF), taking out the egg cell and externally fertilising it before placing it back into the uterus, are used in captive breeding programmes.

21. Biotechnology and genetic modification

21.1 Biotechnology and genetic modification

Bacteria are useful in biotechnology and genetic modification due to their rapid reproduction rate and their ability to make complex molecules.

Bacteria are useful, as they have few ethical concerns over their manipulation, they reproduce rapidly and have plasmids.

21.2 Biotechnology

Yeast anaerobically respires in the production of ethanol for biofuels.

Bread making with yeast:

1. Bread is made from dough. Flour is mixed with water, salt and yeast.
2. The dough is left aside under optimum temperature.
3. Amylase breaks down some starch in dough to sugar.
4. Yeast cells use sugar for anaerobic respiration, producing carbon dioxide.
5. The bubbles of carbon dioxide are trapped inside the dough and make it rise.

Fruit juice with pectinase:

1. Adding **pectinase** to the chopped up fruit releases more juice.
2. It breaks down a chemical called pectin that is found in plant cell walls.

Biological washing powders with enzymes:

- Detergents can remove stains, but it can take a lot of time/effort & need high temperatures.
- Biological washing powders contain enzymes that help to break down large food molecules.
    - Proteases → break down protein stains
    - Lipases → Breaks down grease stain
    - Amylase → break down starch
    - Cellulase → break down cellulose fibre on the outside of cotton fabrics to remove the dirt
- Advantages:
    - Quickly breaks down large, insoluble molecules & smaller, soluble ones
    - Effective at lower temperatures
    - Can be used to clean delicate fabrics that would not be suitable for washing at high temperatures

Milk with lactase:

1. Lactose is the sugar found in milk.
2. Some people are lactose intolerant.

3. Milk can be made lactose free by adding the enzyme **lactase** to allow the enzyme to break down the lactose.

Fermenters can be used for the large-scale production of useful products by bacteria and fungi, including insulin, penicillin and mycoprotein.

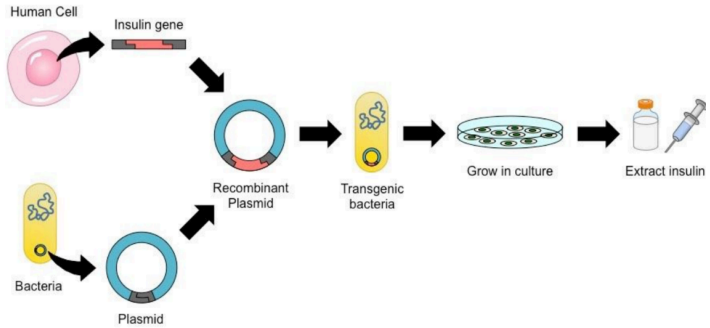
1. The fermenter is inoculated with suitable fungus.
2. Fermentation vessel is filled with nutrients.
3. Sugars provide energy for respiration.
4. Ammonium salts are used by fungus to make proteins.
5. Stirrer keeps microorganisms suspended so they always have access to nutrients & oxygen.
6. Air supply provides oxygen for aerobic respiration of fungus.
7. Water (cooled jacket) removes heat produced by fermentation to keep constant temperature of 26°C.
8. Probes monitor temperature & make sure pH is constant at 6.5.

21.3 Genetic modification

Genetic modification – Changing the genetic material of an organism by removing, changing or inserting individual genes.

Process of genetic modification:

1. Isolation of the DNA making up a human gene using restriction enzymes, forming sticky ends.
2. Cutting of bacterial plasmid DNA with the same restriction enzymes, forming complementary sticky ends.
3. Insertion of human DNA into bacterial plasmid DNA, using DNA ligase to form a recombinant plasmid.
4. Insertion of recombinant plasmids into bacteria.
5. Multiplication of bacteria containing recombinant plasmids.
6. Expression in bacteria of the human gene to make the human protein.



Examples of genetic modification:

- Insertion of human genes into bacteria to produce human proteins.
- Insertion of genes into crop plants to confer resistance to herbicides.
- Insertion of genes into crop plants to confer resistance to insect pests.

- Insertion of genes into crop plants to improve nutritional qualities.

Genetically modifying crops

Advantages	Disadvantages
Increase crop yield Environmentally friendly Consumer benefits	Risk of inserted genes being transferred to wild plants by pollination could reduce the usefulness of the GM crop New gene combinations -> unknown effects -> harmful substances produced -> health risks Reduce genetic variation Not affordable

Notes by: Vernice