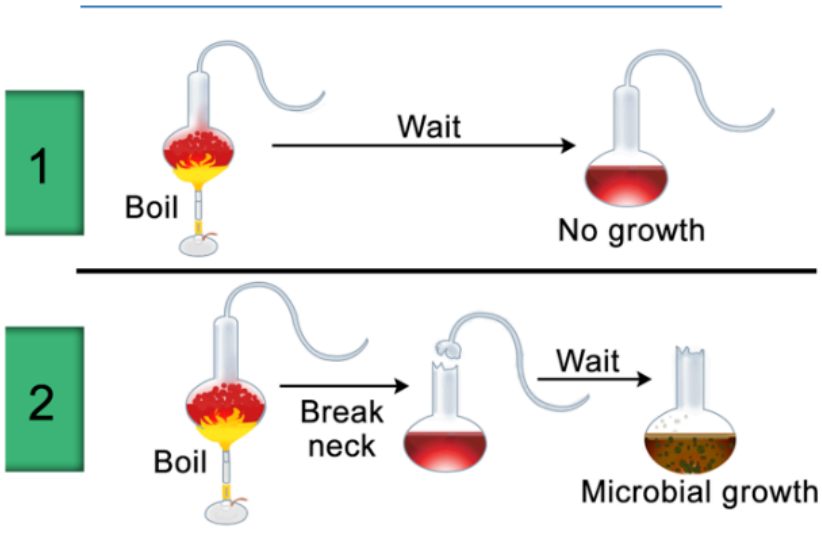
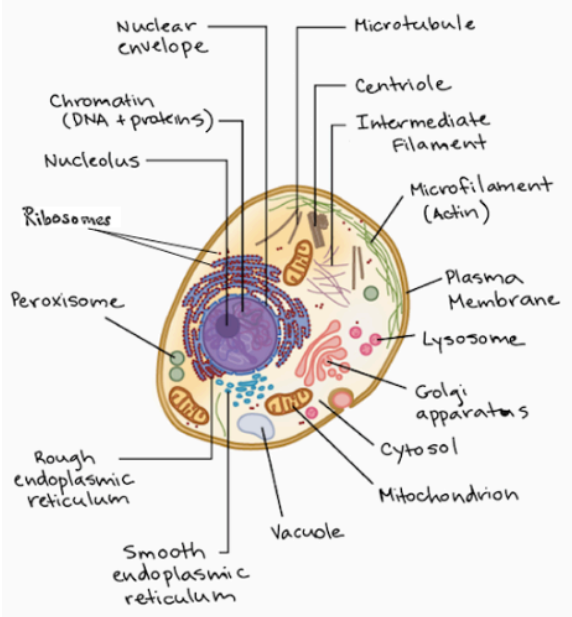
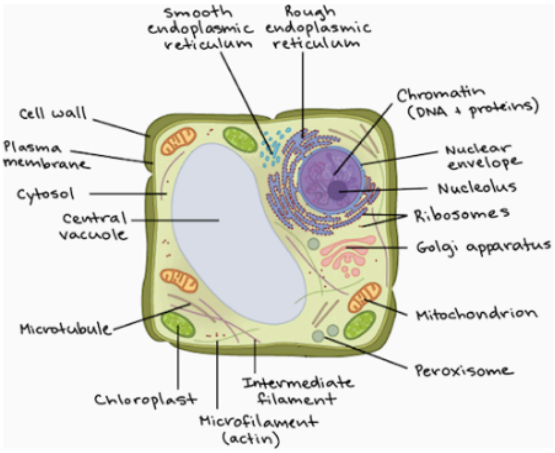
Biology

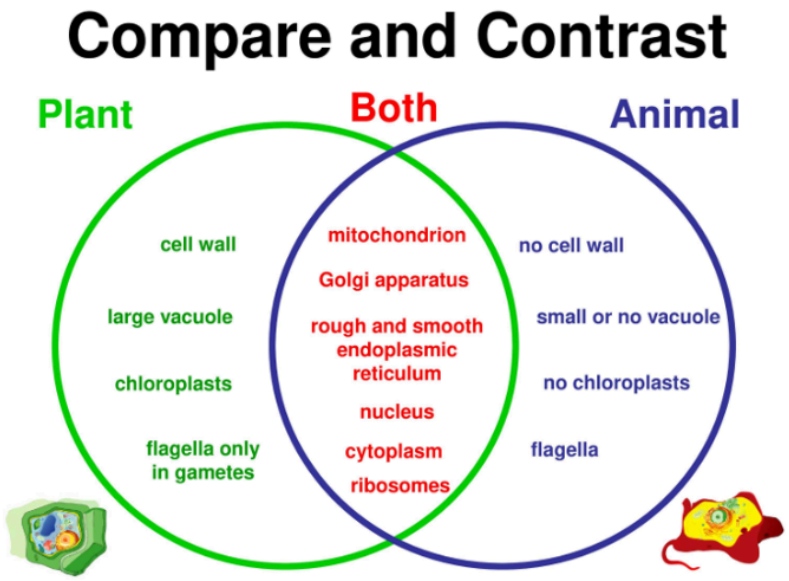
Chapter 1: How is life organised?

- **State the 3 aspects of the cell theory**
  - All organisms are made up of **one** or **more cells**.
  - **All cells** come from **pre-existing cells**.
  - The cell is the **basic unit of life**.
- **Outline the 7 characteristics of living things**
  - **Metabolism**: refers to all the chemical reactions an organism uses to take in and transform energy from the environment.
  - **Reproduction**: transfers hereditary information to offspring.
  - **Homeostasis**: the maintenance of a stable level of internal conditions.
  - **Growth**: living organisms increase in size and/or number of cells
  - **Response**: can be the result of a physical or chemical change in the environment. This change produces a purposeful response.
  - **Excretion**: the removal of bodily waste, which results from normal life processes.
  - **Nutrition**: the intake and use of raw materials for growth and repair.
- **Deduce whether or not viruses are living things**
  - Viruses **aren't made of cells**, they **can't** maintain **homeostasis**, they **don't grow** and **cannot** make their own **energy**. Even though they definitely **replicate and adapt to their environment,** viruses are more like **androids** than real living organisms.
- **Describe Pasteur's experiment**
  - 

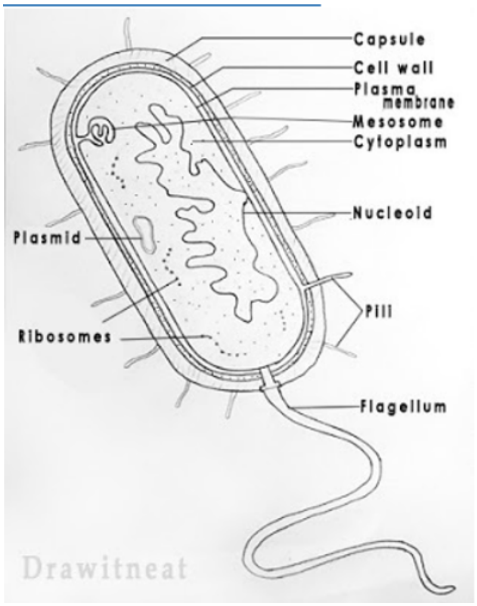
- **Draw and label eukaryotic cells (animal and plant)**
  - **Eukaryotic cells-** They are cells that contain a nucleus and organelles, enclosed by a plasma membrane. Organisms which have this type of cell include protozoa, fungi, plants and animals. Domain: Eukaryota
  - 

  - 

- **Compare and contrast animal/plant cells**



- **Draw and label a prokaryotic (bacterial) cell**
  - **Prokaryotic cells**- **Single-celled** organisms that **lack** a **nucleus** and **membrane-bound organelles**. They are not divided up in the inside, like eukaryotic cells, by membrane walls but consist of a **single open space** instead.

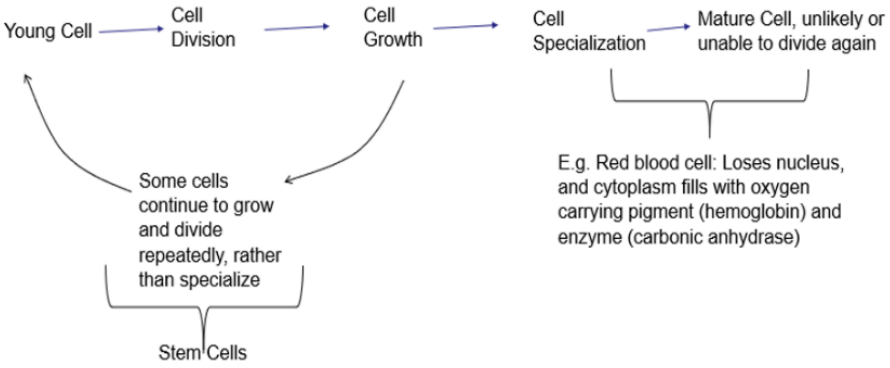


Comparing cell types

	Eukaryotic cell	Prokaryotic cell
Size	Most are 5 µm – 100 µm	Most are 0.2 µm – 2.0 µm
Outer layers of cell	Cell membrane - surrounded by cell wall in plants and fungi	Cell membrane - surrounded by cell wall
Cell contents	Cytoplasm, cell organelles include mitochondria, chloroplasts in plants and ribosomes	Cytoplasm, ribosomes, no mitochondria or chloroplasts
Genetic material	DNA in a nucleus - plasmids are found in a few simple eukaryotic organisms	DNA is a single molecule, found free in the cytoplasm - additional DNA is found on one or more rings called plasmids
Type of cell division	Mitosis	Binary fission

- **Describe the functions of cell organelles**
  - **Nucleus**: It holds and protects the cell's DNA. DNA is the genetic material for the cell. DNA carries the information and instructions that direct the cell.
  - **Mitochondria**: This produces ATP. ATP is cellular energy & to make ATP, the mitochondria needs to take in glucose and oxygen. The powerhouse of the cell.
  - **Vacuole**: Cell storage (of water mostly, but also food waste).
  - **Chloroplast**: Contains chlorophyll to conduct photosynthesis.
  - **Cell Wall:** Supports and protects the cell.
  - **Cell Membrane**: The plasma membrane is the boundary that surrounds all cells. It regulates what enters and leaves, ensuring it maintains homeostasis.
  - **Cytoplasm**: This is the gel-like fluid inside the cell. It is the medium for chemical reactions, providing a platform which other organelles can operate within the cell.
  - **Ribosomes**: produce protein.
  - **Golgi apparatus:** site for protein and lipid processes and packaging.
  - **Lysosome**: membrane bound containing digestive enzymes.
  - **Smooth endoplasmic reticulum:** synthesis of essential lipids + hormones.
  - **Rough ER:** protein production, folding and quality control.
  - **Cytoskeleton**: maintains the cell shape and internal organisation.
- **Define the terms: embryonic stem cells, hierarchy, multicellular, organisation, physical, unicellular, differentiation**
  - **Stem cell:** cells which can adapt and change into a wide range of other cells.
  - **Embryonic stem cells**: A type of cell found in the embryo, capable of dividing into almost any cell type. Kingdom - Domain, etc.
  - **Hierarchy:** Taxonomic classification of living organisms in a level by level format.

- **Multicellular**: This is an organism that has more than one cell.
- **Unicellular**: An organism that only has one cell.
- **Differentiation**: when an unspecialised cell becomes a more specialised type.

- **Outline with a flow diagram the life of a cell**
  - 

- **Explain examples of specialised cells**
  - **Red blood cells:**
    - Contain haemoglobin, which carries oxygen.
    - No nucleus present, allowing more space to carry oxygen.
    - These cells are shaped bi-conclave, giving them a large surface area, and the best chance of absorbing as much oxygen as they can.
  - **Nerve Cells**
    - Thin and can be more than 1 metre long. They can carry messages up and down the body over large distances.
    - Nerve cells have branched connections at each end. These join to other nerve cells, ensuring messages are transmitted around the body.
    - There are fatty (myelin) sheaths that surround these cells. The sheath helps increase the speed at which the message can travel.
  - Muscle Cells
  - **Sperm Cells**
    - Flagellum/tail that allows them to navigate the fallopian tubes easily.
    - Lots of mitochondria for energy to swim to the egg cell
    - Stream-line shape for better manoeuvrability and swimming
    - Lots of digestive enzymes at their tip to better crack open and penetrate the egg cell

- **Compare different organ systems**
  - **Structure**: Skeletal, Muscular, Cardiovascular, Nervous
  - **Regulation**: Endocrine, Urinary, Lymphatic (*immune*)

    - **Energy**: Respiratory, Digestive
    - **Reproductive**: Reproductive
- **Summarise the levels of organisation of life**
    - **Organelles**: nucleus, mitochondria, etc...
    - **Cells**: animal cell, plant cell
    - **Tissue**: cardiac muscle tissue, guard cell
    - **Organs**: heart, leaf
    - **Organ Systems**: Circulatory system, etc
    - **Organisms**: HUMAN & PLANT
    - **Species**: *genus, family, order, class, phylum, kingdom, domain*
    - **Population**
    - **Community**
    - **Ecosystems**
    - **Biome**
    - **Biosphere**
- **Define classification**
    - **Classification**, in biology, is the establishment of a **hierarchical system of categories** on the basis of presumed natural relationships among organisms. The science of **biological classification** is called **taxonomy**.
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- **Describe features of each kingdom (protoctista, fungi, animal, plants, monera)**

FEATURE	KINGDOM				
	ANIMALS	PLANTS	FUNGI	PROTOCTISTA	BACTERIA
Cell Wall	NO	YES Cellulose	YES - Chitin	Usually no cell wall, although some forms may have one	YES - Peptidoglycan
True nucleus	YES	YES	YES	YES	NO
Number of cells	Multicellular	Multicellular	Multicellular	Most are unicellular	Unicellular
Chloroplasts	NO	YES	YES	SOME	MOST DON'T
Permanent Vacuole	NO	YES	YES	SOME	YES

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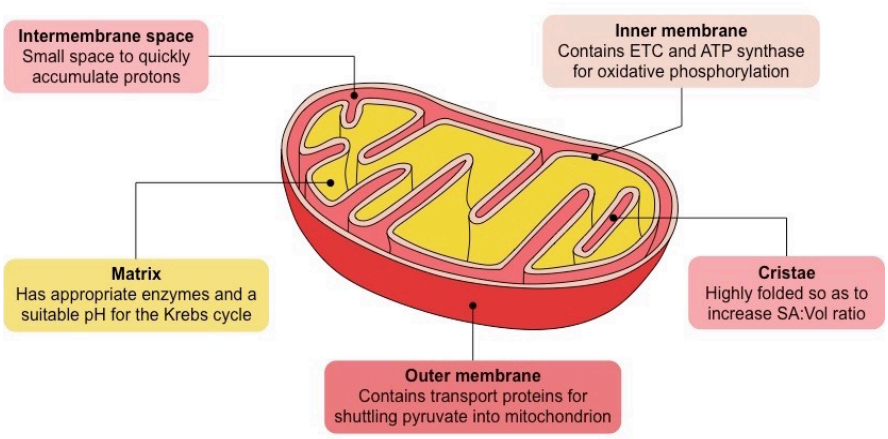
- **Distinguish between analogous and homologous features**

    - **Analogous Features: Similar** functions but origin and anatomy are **different**. *(e.g. bat wing and insect wing.)*
    - **Homologous Features: Different** functions but have a common origin and similar anatomy. *(e.g. bat wing and human arm.)*
- **Outline how organisms are named according to binomial nomenclature**
    - FOR SPECIFIC ANIMALS PUT THEIR ***GENUS*** **+** ***SPECIES*** NAME
- **List the stages of the hierarchy of life (Kingdom, Phylum etc.)**
    - ***D****ainty* ***K****oalas* ***P****ack* ***C****andy* ***O****minously* ***F****or* ***G****ambling* ***S****orcerers.*
    - **D**omain, **K**ingdom, **P**hylum, **C**lass, **O**rder, **F**amily, **G**enus, **S**pecies
- Discuss the possibility of creating artificial life
- Suggest ethical issues of creating artificial life

Chapter 2: What chemical processes support life?

- **Define the term: metabolic**
    - **Metabolism**: It is the sum of all biological transformations of energy and matter in an organism
    - **Metabolic**: It is the term that means "related to metabolism." *E.G- A disease can have metabolic causes, or metabolic effects.*
- **Distinguish between anabolic and catabolic reactions**
- **State examples of anabolic and catabolic reactions**
    - **Anabolic Reactions**: Energy + Smaller molecules → larger molecule
        - *Building muscles (making proteins)*
        - *Photosynthesis*
    - **Catabolic Reactions:** Larger molecule → energy + smaller molecules
        - *Digestion*
        - *Cellular respiration*
- **Discuss factors affecting rates of reaction**
    - Concentration, surface area, temperature, and the presence of a catalyst. *(check chem too)*
- **State the word and balanced chemical equation for aerobic respiration**
    - **$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$**
    - **Glucose + Oxygen → Carbon Dioxide + Water**
- **State the word equation for anaerobic respiration**
    - **Glucose → ethanol + carbon dioxide + energy (ATP)**

- **Label the structure of a mitochondrion and describe the functions of the parts**

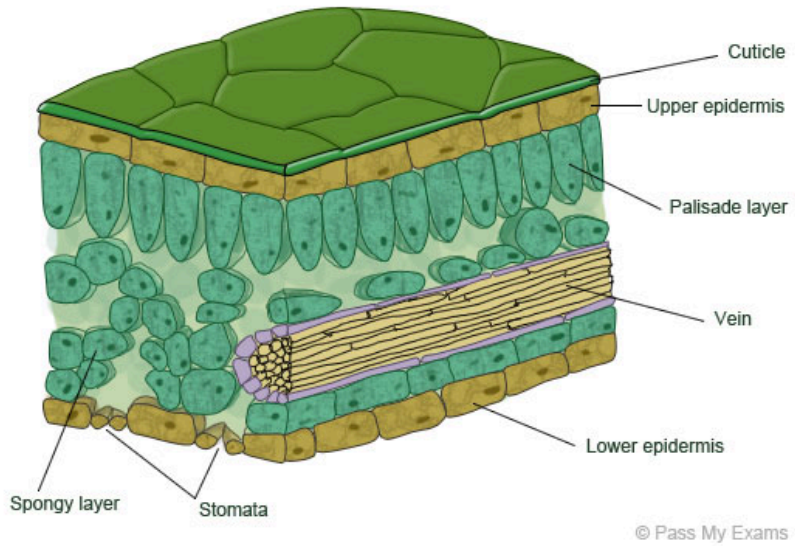


  - **Inner membrane folds** → **larger surface area** → more places for reaction → more usable energy.
- **Outline the process of respiration**
  - **Respiration**: This is the chemical process of breaking down food particles in the cells in presence of oxygen and releasing energy. There are two stages - *inspiration and expiration*.
  - **Inspiration**: taking in air rich in oxygen. During inspiration, the ribs are lifted up and the diaphragm flattens. This increases the volume of the thoracic cavity, helping the inhalation of oxygen.
  - **Expiration**: giving out carbon dioxide. During expiration, the ribs move downward and back to its original position and the diaphragm moves upward back to its dome shape. This decreases the volume of the thoracic cavity and pumps out carbon dioxide into the atmosphere from the lungs.
- **Compare aerobic and anaerobic respiration**

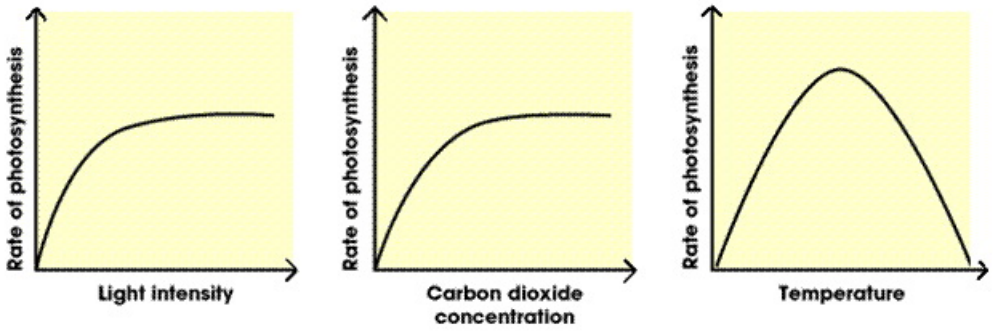
	Anaerobic	**Aerobic**
reactants	glucose	Glucose and oxygen
combustion	incomplete	complete
energy yield	Low (2 ATP)	High (36-38 ATP)
products	Animals: Lactic acid	CO2 & H2O

	Yeast: Ethanol + CO_2	
location	cytoplasm	Cytoplasm and mitochondria
stages	Glycolysis Fermentation	Glycolysis Link reaction Krebs cycle Electron transport chain

- **Suggest uses of anaerobic respiration in industry**
- **Define photosynthesis**
    - **Photosynthesis**: the process is which light energy is converted to chemical energy in the forms of sugars.
- **State the word and balanced chemical equation for photosynthesis**
    - **$6CO_2+6H_2O \rightarrow C_6H_{12}O_6+6O_2$**
    - **Carbon dioxide + water → glucose + oxygen**
- **Discuss the limiting factors that affect the rate of photosynthesis**
    - Light intensity
    - Carbon dioxide concentration
    - Temperature
- **Draw and label the structure of a leaf**

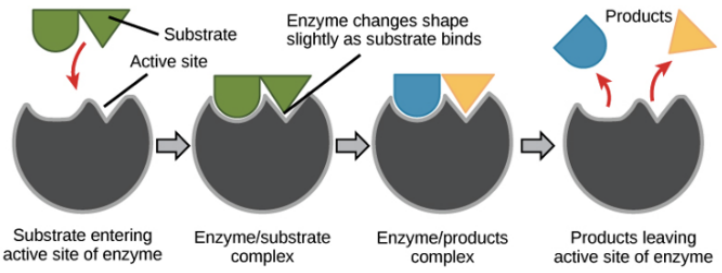


- **Sketch graphs to show the effect of limiting factors on photosynthesis**



- **Light intensity**: rapidly increases to a certain point. It stays relatively the same throughout the rest of the graph. Start at the origin.
- **Carbon dioxide concentration:** Rapidly increases then stays relatively the same afterwards. Also starts at the origin.
- **Temperature:** Rapidly increases, reaching its peak, then rapidly decreases. Start at the origin.

- **Define the terms: catalyst, kinetic, limiting factor, transfer, yield, active site**
  - **Catalyst**: A substance that increases the speed of a reaction without being changed or used in the process.
  - **Active site:** Region of the enzyme with a specific shape to the substrate molecules.
- **Describe the structure and function of enzymes**
  - **Structure**: They're basically large proteins/a chain of amino acids
  - **Function**: They are biological catalysts that speed up the rate of reaction.
- **Explain what is meant by the lock and key theory**
  - In the **lock and key hypothesis**, the **shape** of the **active site** matches the shape of its substrate molecules. This makes enzymes **highly specific** and that each type of enzyme can usually catalyse **only one** type of reaction. (some may do more though)
- **Distinguish between substrate, enzyme, product and enzyme-substrate complex**
  - **Substrate**: A reactant used in an enzyme
  - **Enzyme**: Biological catalysts to increase speed in reactions
  - **Product**: substances after a biological process has occurred.
  - **Enzyme-substrate complex:**



- **Outline limiting factors of enzyme activity**
    - Concentration of the enzyme
    - Concentration of the substrate
    - Temperature
    - The pH
- **List 3 enzymes that function within the human body**
    - Amylase break down starches
    - Lipase breaks down fats
    - Lactase- breaks down sugar Lactose

Chapter 3: How do organisms sustain themselves?

- **Outline the main nutrients required by an organism with the functions**
    - Lipids, Proteins, Carbohydrates
- **List examples of foods containing the major nutrients**
    - Carbohydrates: Wheat, Barley
    - Lipidds: Butter, Coconut oil
    - Proteins: Lentils, Fish
    - Nucleic acids: Anything living
- **State the monomers of carbohydrates, lipids and proteins**
    - Carbohydrates: Monosaccharides
    - Lipids: Fatty acids and glycerol
    - Proteins: Amino acids
- **Distinguish between saturated and unsaturated fats**

	Saturated Fats	Unsaturated Fats
Structure:	They have no double bonds between carbon molecules, because they are saturated with the hydrogen molecules	have one, or more double or triple bonds between the molecules.
Physical state:	They are typically solid at room temperature	They are liquid at room temperature and exist in an oil form, but can also occur in solid foods.
Impact on health	They are not that good for our bodies because consuming foods containing saturated fats increases the level of cholesterol in our blood. The high level of cholesterol can increase the risk of cardiac diseases.	They are much better for our health than saturated fats. Monounsaturated fats can help to lower the risk of cardiovascular diseases. Polyunsaturated fats are essential for our bodies to function as they help with blood clotting and muscle movement. These are Omega 3 and Omega 6 acids, which are also beneficial for the health of our hearts.

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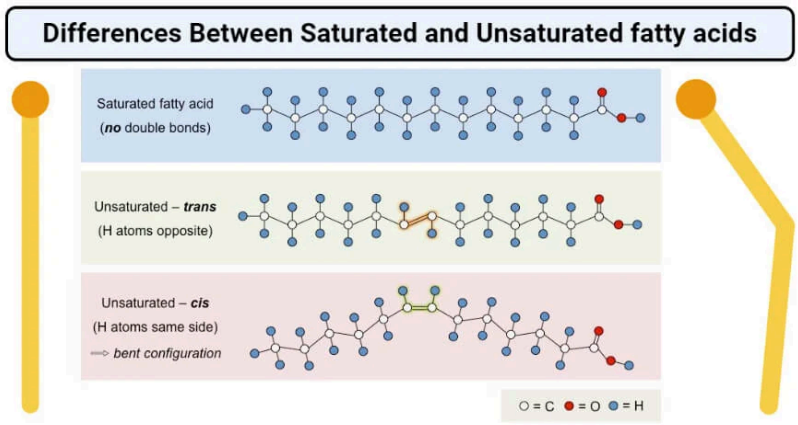
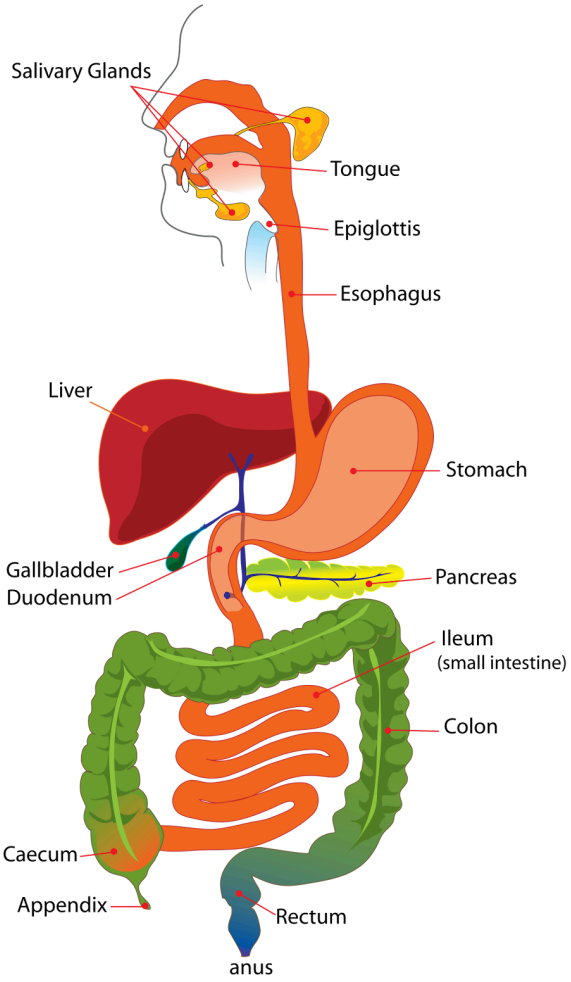


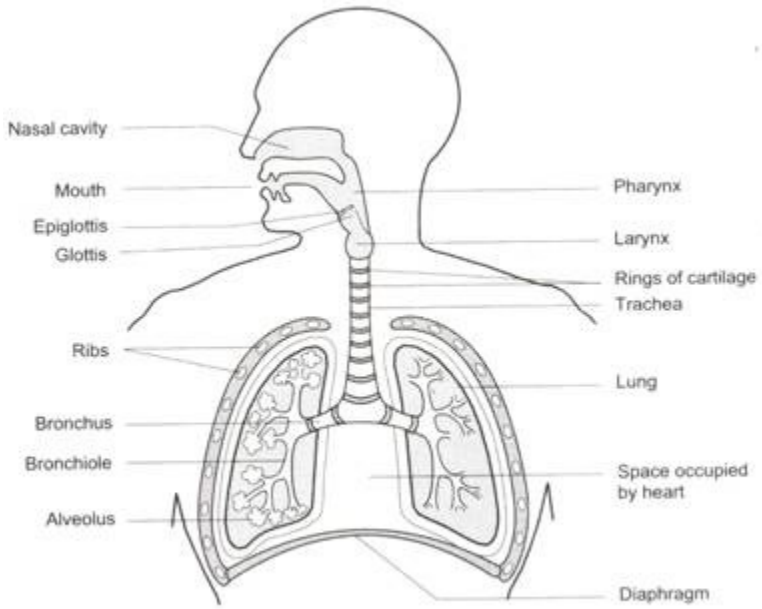
- **Label the parts of the digestive system**



- **Describe the functions of the parts of the digestive system**
  - **Ingestion**: food is taken into the body
  - **Digestion**: breakdown of complex food substances into smaller soluble food substances

- **Absorption**: digested food is absorbed into body cells.
- **Assimilation**: absorbed food is used to provide energy.
- **Egestion**: removal of undigested foods.

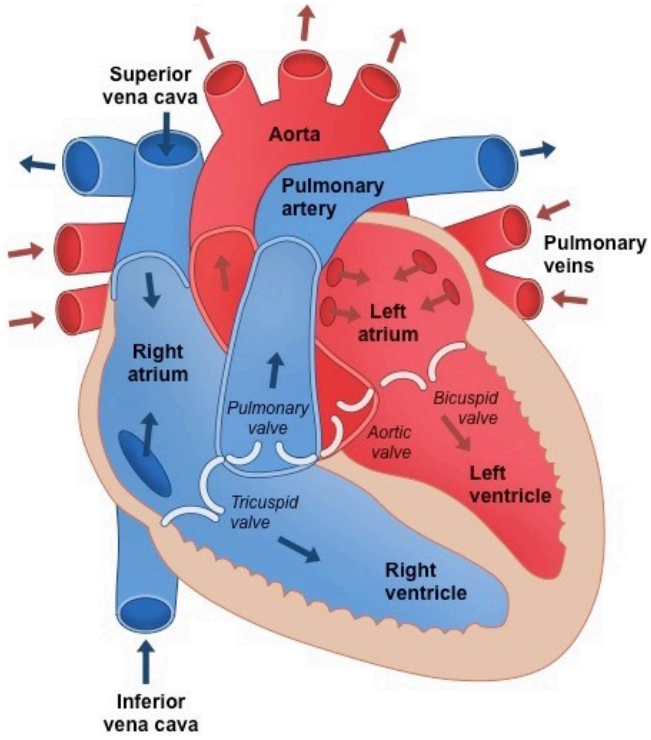
- **Liver**: produces bile.
- **Gallbladder**: stores bile.
- **Pancreas**: produces juices for digestion, neutralises the acidic stuff in your stomach.

- **Outline the function of bile**
  - Bile is the greenish-yellow fluid *(consisting of waste products, bile salts and cholesterol)* which is produced by the liver. It does **two functions**:
    - **Carry away waste**
    - **Break down fats during digestion**
- **State the location and pH requirements of the digestive enzymes????**
  - **Pepsin** works in the **highly acidic** conditions of the stomach. It has an optimum **pH** of about **1.5**. On the other hand, **trypsin** works in the **small intestine**, parts of which have a **pH** of around **7.5. Trypsin's optimum pH is about 8.**
- **Distinguish between mechanical and chemical digestion**
  - **Mechanical/physical**: muscles in the body break down food.
  - **Chemical**: food is broken down via a chemical reaction.
- **Draw and label the structure of the breathing system**
  - 

    Human respiratory system

    - **Order: Nose & Mouth → *Trachea → Bronchi → Bronchiole → Alveoli* → Red blood cells**
- **Explain the mechanism of ventilation**
    - **Inhalation**: Diaphragm contracts + moves down
    - **Exhalation**: Diaphragm relaxes, curves + muscle relaxes
- **Suggest how the alveoli are adapted for gas exchange**
    - **One cell thick, thin walls** → decreases diffusion distance
    - **Moist walls** → gases dissolve in the moisture and are able to diffuse more quickly
    - **High oxygen concentration, large diffusion gradient** → O2 concentration is higher in alveoli so that oxygen will diffuse down the concentration gradient into the bloodstream.

    - Oxygen **diffuses** down a **concentration gradient** *(from high to low).* The oxygen gets picked up by **red blood cells** in the **capillary** which takes it to the heart so it can be pumped to the rest of the body.
    - *This same thing is done in reverse from capillaries to alveoli with CO2.*
- **State that gases are exchanged by diffusion.**
- **Define: deoxygenated, oxygenated, vessel**
    - **Deoxygenated**: there is a low concentration of oxygen in the blood.
    - **Oxygenated**: high concentration of oxygen in the blood.
    - **Vessel**: Blood vessels are **channels** that **carry blood** throughout your body. They form a closed loop, like a circuit, that **begins and ends at your heart**. *Together, the heart vessels and blood vessels form your circulatory system.*
- **Label the structure of the heart**

- 

- **Outline the flow of blood through the heart**
  - *Lungs, superior/inferior vena cava, right atrium, right ventricle, pulmonary artery, pulmonary veins, left atrium, left ventricle, aorta, other organs.*
- **Compare and contrast arteries, veins, capillaries**
  - **Arteries**: Strong, muscular walls, carry oxygenated blood away from the heart to your organs, small lumen.
  - **Veins**: Thin walls due to less pressure, valves to prevent backflow, carry deoxygenated blood to the heart and lungs, large lumen.
  - **Capillaries**: Very thin walls, single-cell thick, very small lumen and lets oxygen diffuse into organs.
- **Define: concentration gradient**
  - **Concentration Gradient:** molecules diffuse down a concentration gradient from high concentration to a low concentration.
- **Define: Diffusion**
  - **Diffusion**: The **passive movement** of particles from a region of **higher** concentration to a region of **lower** concentration (*passive transport: no energy)* until **equilibrium** is reached.
  - **Osmosis**: The **diffusion of water** across a **permeable membrane** from an area of **higher water** concentration to an area of **lower water** concentration. Solutes dissolve in water. More

solute, less water and less solute, more water.

HYPERTONIC = Higher in solute

HYPOTONIC = Lower in solute

ISOTONIC = Equal in solute

Osmosis is the diffusion of water across a membrane from an area of lower solute concentration to an area of higher solute concentration.

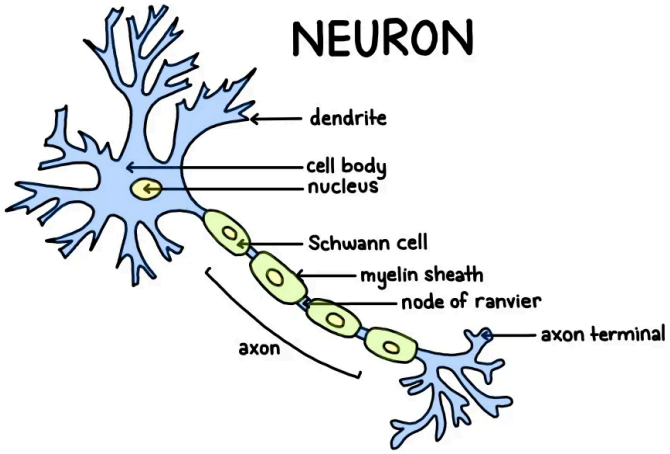
- **Active transport:** Requires ATP to occur. This is the movement of a substance against its concentration gradient (*from low to high*).

- **Outline examples of where the transport types occur**
  - **Diffusion**: *alveoli*
  - **Osmosis**: *small and large intestines*
  - **Active transport:** *gut wall* (sugars are transported from low con to high con in the blood, letting it be absorbed. The glucose is used for respiration).
- **Outline the factors that speed up the rate of diffusion**
  - **Temperature**: increased temperature increases diffusion rate.
  - **Concentration Gradient change**: greater concentration gradient increases diffusion rate.
  - **Surface Area:** large surface area of the membrane, the higher the rate of diffusion.

Chapter 4: What factors affect human health? (not yet completed)

- Define: Homeostasis, vasodilation, vasoconstriction, piloerection
- **Define: stimulus, reflex, neurons, neurotransmitter**
- **Describe what is meant by a reflex arc**
  - **Stimulus**: A change in the environment/internally that triggers a response
  - **Reflex (action)**: an involuntary sequence or action that is a nearly instantaneous response to a stimulus.
  - **Neurons**: fundamental units of the brain and nervous system.
  - **Neurotransmitter**: chemical messengers that carry chemical signals (“messages”) from one neuron to the next cell.
  - **Reflex arc:** pathway for a reflex action.
    - *Stimulus → receptor → sensory neuron → relay neuron → motor neuron → effector → response*
- **Distinguish between the CNS and PNS**
  - **CNS (central nervous system)**: includes only two organs- *the brain and spinal cord.*
  - **PNS (peripheral nervous system)**: everything else which includes *nerves*.

- **Draw and label a motor neuron (done in book gr.9)**



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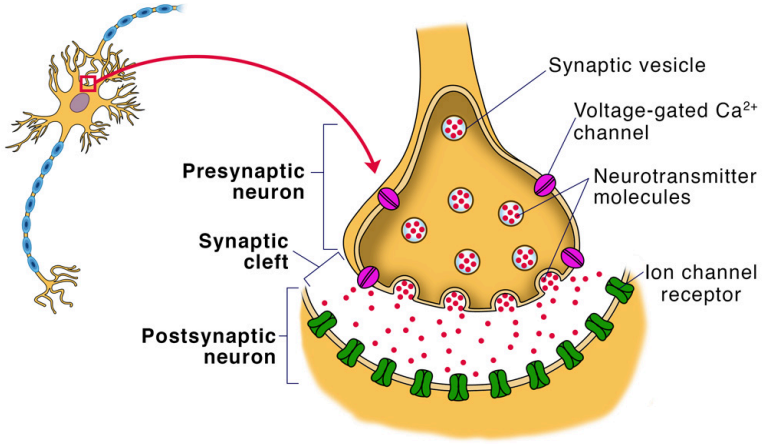
- **Outline the difference between sensory, relay and motor neurons**
  - **Sensory neurons**: carry electric impulses from sensory organs (receptors) to the CNS.
  - **Relay neurons**: found in the brain and spinal cord and allow sensory + motor neurons to communicate.
  - **Motor neurons:** carry electron impulses from the CNS to specific effectors.
  - **Effectors**: parts of the body- such as muscles and glands- that produce a response to a detected stimulus.
- **Explain how a synapse functions**



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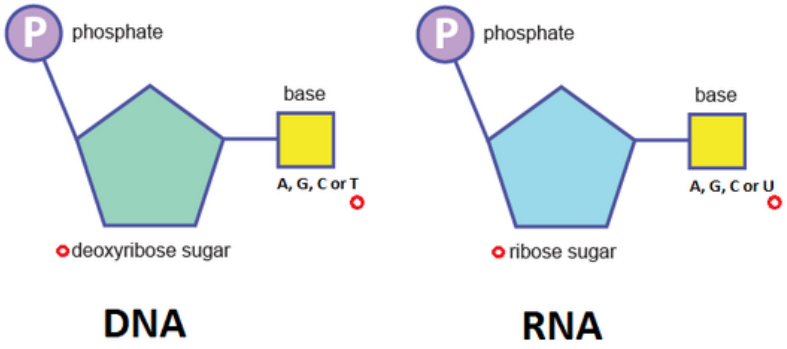
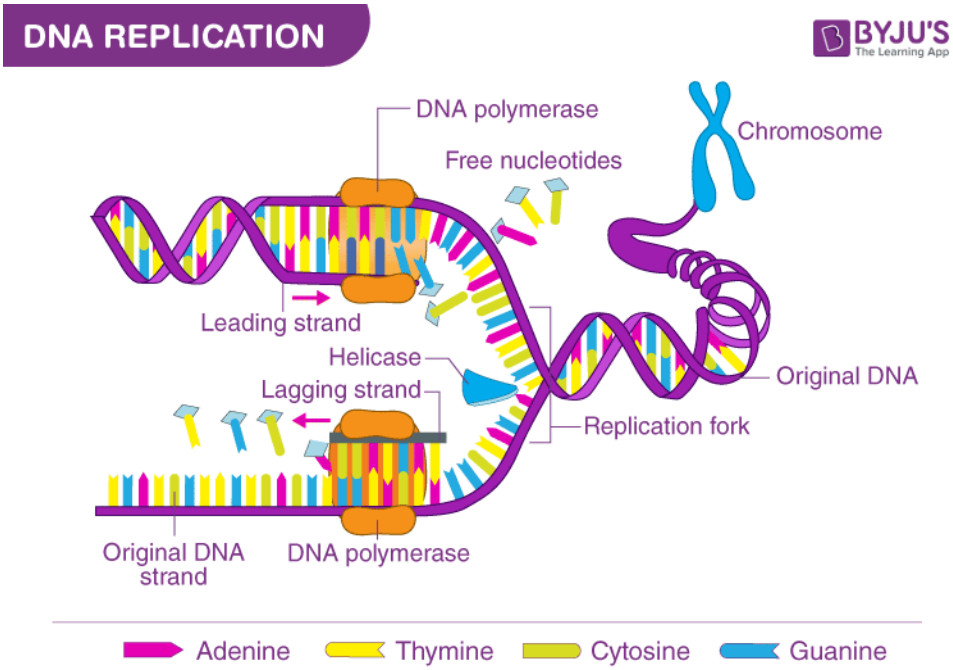
- **Identify different types of stimuli that cause a response**
  - **Pain & touch**
  - **Vision**
  - **Taste**
  - **Sounds**

    - **Smells**
- **State the different types of receptors and where they're located**
    - **Receptors**: groups of specialised cells. They detect change in the environment (*stimuli*) and trigger electrical impulses in response.
        - **Mechanoreceptors**: mechanical forces- *skin, ear*
        - **Chemoreceptors**: chemicals- *tongue, nose*
        - **Thermoreceptors**: temperature- *skin*
        - **Photoreceptors**: light- *eyes*

Chapter 5: How do characteristics pass from one generation to another

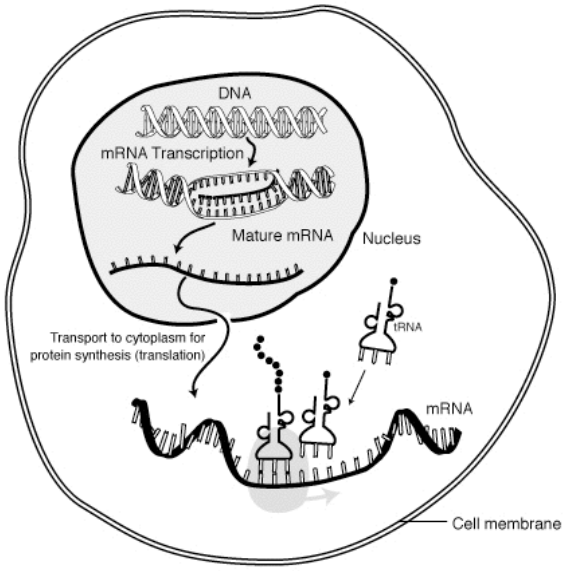
- Define: replication, heredity, DNA helix, genome.
- **Identify the components of a nucleotide.**
- **Draw simple diagrams of the structure of single nucleotides of DNA and RNA, using circles, pentagons, and rectangles to represent phosphates, pentoses and bases.**
    - Phosphate, Pento-sugar, Nitrogen base
    - 

- **Identify the four base pairs**
    - Adenine, Thymine (*In RNA is Uracil*), Guanine, Cytosine
- **Outline the process of DNA replication.**



- **Helicase -** Unzips the DNA strand into two
- **Primase -** Adds primer to the ends of the DNA strands
- **Polymerase III -** Synthesises the new DNA strand
- **Polymerase I -** Removes the primers on the end and replaces them with proper bases
- **Ligase -** Repairs any damages and Okazaki fragments, ensuring the DNA is stable

- Compare and contrast DNA, genes and chromosomes.
- **Explain how a gene codes for the formation of protein (DNA -> RNA -> Protein) (PROTEIN SYNTHESIS)**
  - **Transcription** - The copying of a gene to make mRNA. DNA must unzip for this process to occur.
  - **Translation** - The *mRNA* travels to the *Ribosome* (site of protein synthesis) and the tRNA then pairs a protein using a codon and anticodon. The protein is made this way (length + order of amino acids will determine the type of protein).
  - **Codon**: Triplet of bases on mRNA.
  - *!!! Amino acid chains all have peptide bonds between amino acids !!!*

- 

Selective Breeding / Artificial Selection

- **Definition**: Selective breeding, also known as artificial selection, is when humans intentionally choose specific organisms with desired traits (like size, color, or resistance to disease) to reproduce, aiming to produce offspring with these traits.
- **Examples in Plants**:
    - **Crop Improvement**: Farmers select plants with desirable traits (e.g., wheat that resists disease or corn with larger kernels) and breed them over multiple generations. This makes crops more productive and resilient.
    - **Flower Breeding**: Gardeners breed flowers like roses or tulips for specific colors or petal shapes, creating unique varieties.
- **Examples in Animals**:
    - **Livestock**: Cattle are often bred for high milk production or faster growth, creating animals better suited to farming needs.
    - **Dogs**: Different dog breeds (e.g., Labradors, Poodles) have been selectively bred for traits like size, temperament, or coat type.
- **Methods of Artificial Selection**:
    - **Crossbreeding**: Mating two individuals from different breeds or varieties (like a beef cow and a dairy cow) to combine desirable traits.
    - **Hybridization**: Crossing individuals from different species to create a hybrid (e.g., mule, a horse-donkey hybrid).

- **Advantages**:
    - Produces high-yield crops or animals
    - Can improve disease resistance or growth rates
    - Enhances specific, desired traits (e.g., flavor, appearance)
- **Disadvantages**:
    - **Reduced Genetic Diversity**: Less genetic variation, which can make populations more vulnerable to disease or environmental changes.
    - **Inbreeding Risks**: Breeding similar individuals can lead to health problems (e.g., genetic disorders in dog breeds).

Evidence of Evolution

- **Fossil Evidence**:
    - Fossils are the preserved remains of ancient organisms found in layers of rock. By studying fossils, scientists can see how organisms have changed over time.
    - **Transitional Fossils**: Fossils showing intermediate stages between ancient species and modern ones (e.g., Archaeopteryx, showing traits of both dinosaurs and birds).
    - **Fossil Record**: This is the history of life documented by fossils, showing a timeline of gradual change and helping to map the evolution of life forms.
- **Comparative Anatomy**:
    - **Homologous Structures**: Similar body parts in different species, like the limb bones in humans, cats, whales, and bats, which all have similar bone structures due to shared ancestry.
    - **Vestigial Structures**: Parts that have lost their original function over time, like the human appendix or tailbone, indicating evolutionary change.
- **Comparative Embryology**: Studies similarities in embryos of different species. For example, human, chicken, and fish embryos look very similar at early stages, suggesting a common ancestor.
- **Molecular Evidence**:
    - **DNA Sequencing**: Comparing DNA sequences of different organisms reveals genetic similarities. For example, humans share a high percentage of their DNA with chimpanzees, showing close evolutionary ties.
    - **Genetic Similarities**: Genes that are highly similar between species provide evidence for common ancestry.
- **Biogeography**:

    - The study of species distribution across the planet. Isolated islands, like the Galápagos, have unique species (e.g., Galápagos tortoises), demonstrating how location influences evolution.

Natural Selection

- **Definition**: Natural selection is the process by which individuals with traits that are better suited to their environment survive and reproduce more successfully, passing on those traits to the next generation.
- **Darwin's Theory**: Charles Darwin proposed that natural selection drives evolution. Key ideas include:
    - **Variation**: Individuals in a species vary in traits.
    - **Competition**: Organisms compete for resources.
    - **Survival of the Fittest**: Traits that improve survival and reproduction are passed down.
- **Examples**:
    - **Peppered Moth**: During the Industrial Revolution, pollution darkened tree bark, so darker moths blended in and survived better. Over time, the population became mostly dark-colored.
    - **Antibiotic Resistance**: Bacteria can evolve to resist antibiotics, leading to stronger bacteria that survive and spread.
- **Factors Affecting Natural Selection**:
    - **Variation**: Genetic differences within a population.
    - **Competition**: Limited resources drive competition.
    - **Selection Pressures**: Environmental challenges (e.g., predators, climate) that affect survival.

Speciation

- **Definition**: Speciation is the process by which one species splits into two or more distinct species, usually due to genetic changes and isolation.
- **Mechanisms**:
    - **Allopatric Speciation**: Occurs when a population is geographically separated, leading each group to evolve differently (e.g., river divides).
    - **Sympatric Speciation**: New species arise in the same location, often due to different ecological niches (e.g., insects adapting to different food sources).
- **Examples**:

    - **Galápagos Finches**: Different species of finches on the Galápagos Islands evolved unique beaks suited to specific food sources.
    - **Cichlid Fishes**: In African lakes, different species evolved within the same lake by specializing in unique food sources or habitats.
- **Role of Isolation**: Physical or reproductive isolation prevents gene flow, allowing populations to evolve independently.

Heritable Variation

- **Definition**: Heritable variation refers to genetic differences that can be passed from parents to offspring.
- **Sources**:
    - **Mutations**: Random changes in DNA can create new traits.
    - **Genetic Recombination**: During sexual reproduction, gene combinations shuffle, creating unique genetic mixes.
- **Importance**: Genetic variation is critical for evolution, as it provides the material for selection to act upon.
- **Types**:
    - **Single Nucleotide Polymorphisms (SNPs)**: Variations in a single DNA base.
    - **Gene Duplications**: Entire genes can duplicate, sometimes leading to new functions.

Antibiotics

- **Definition**: Antibiotics are drugs used to kill or inhibit the growth of bacteria, treating bacterial infections.
- **Mechanisms of Action**:
    - **Cell Wall Targeting**: Penicillin stops bacteria from building cell walls.
    - **Protein Synthesis Inhibition**: Some antibiotics disrupt bacterial protein creation.
    - **DNA Replication Disruption**: Other antibiotics interfere with bacterial DNA replication.
- **Antibiotic Resistance**: Overuse of antibiotics can lead to bacteria evolving resistance, making infections harder to treat.
- **Strategies to Combat Resistance**:

    - Limiting unnecessary antibiotic use.
    - Developing new antibiotics.
    - Using combination therapies to attack bacteria in multiple ways.

Interacting with the Environment

- **Adaptations**: Traits that increase an organism's ability to survive in its environment.
- **Behavioral Adaptations**: Actions organisms take to survive, like birds migrating seasonally.
- **Physiological Adaptations**: Internal processes like producing antifreeze proteins in Arctic fish to survive cold temperatures.
- **Impact of Environmental Change**: Changes like climate shifts can alter food availability, habitats, and survival rates, forcing organisms to adapt or risk extinction.

Specialized Structures

- **Definition**: Specialized structures are body parts adapted for specific functions.
- **Examples**:
    - **Plants**: Cacti have spines that reduce water loss.
    - **Animals**: Birds have wings adapted for flight; giraffes have long necks for reaching high leaves.
- **Relationship to Adaptation**: Specialized structures evolve to meet specific survival needs, enhancing fitness in their environment.

Comparing Adaptations

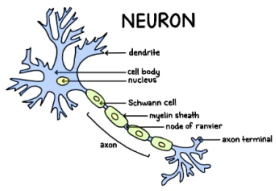
- **Environmental Adaptations**: Species evolve unique traits suited to their specific environments, like desert animals conserving water.
- **Analogous vs. Homologous Structures**:
    - **Analogous Structures**: Different origins but similar functions (e.g., wings of birds and insects).
    - **Homologous Structures**: Shared origin but may have different functions (e.g., human and whale forelimbs).

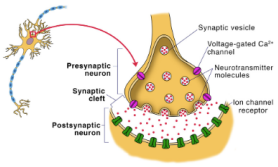
Extinction

- **Definition**: Extinction is the complete loss of a species from the planet.
- **Causes**: Habitat destruction, overhunting, climate change, invasive species, and disease.
- **Mass Extinctions**: Events where large numbers of species die out (e.g., dinosaurs 66 million years ago).
- **Current Extinction Rates and Conservation**: Human activity is accelerating extinction rates, and conservation efforts aim to protect endangered species through habitat preservation, legal protection, and breeding programs.

Knowt

Chapter 4: Nervous and Immune system

Define **Stimulus**	A change in the environment/internally that triggers a response
Define **Reflex (action)**	An involuntary sequence or action that is a nearly instantaneous response to a stimulus
Define **Neurons**	fundamental units (cells) of the brain and nervous system.
Define **Neurotransmitter**	chemical messengers that carry chemical signals from one neuron to the next cell
Distinguish between the **CNS** and **PNS**	• **CNS (central nervous system)**: includes only two organs- *the brain and spinal cord*. • **PNS (peripheral nervous system)**: everything else which includes *nerves* and sensory organs
Define **Reflex arc**	pathway for a reflex action. • *Stimulus → receptor → sensory neuron → relay neuron → motor neuron → effector → response*
Draw and label a motor neuron	
Outline the difference between sensory, relay and motor neurones	• **Sensory neurons**: carry electric impulses from sensory organs (receptors) to the CNS. • **Relay neurons**: found in the brain and spinal cord and allow sensory + motor

	neurons to communicate. • **Motor neurons:** carry electron impulses from the CNS to specific effectors.
Identify different types of **stimuli** that cause a **response**	• **Pain & touch** • **Vision** • **Taste** • **Sounds** • **Smells**
State the **different** types of **receptors** and **where they're located**	• **Receptors**: groups of specialised cells. They detect change in the environment (*stimuli*) and trigger electrical impulses in response. ◦ **Mechanoreceptors**: mechanical forces- *skin, ear* ◦ **Chemoreceptors**: chemicals- *tongue, nose* ◦ **Thermoreceptors**: temperature- *skin* ◦ **Photoreceptors**: light- *eyes*
Synapse Function	
reflex action	a way for the body to quickly and efficiently respond to a change in stimuli
receptors	groups of specialised cells that detect changes in the environment
effectors	parts of the body- such as muscles and glands- that produce a response to a detected stimulus.
not all bacteria are harmful	like probiotics which colonise your digestive system

pathogens	microorganisms that can cause disease
parasite	symbiote that benefits at host's expense
host	organism that provides nourishment or shelter to another organism at its own expense
budding	asexual repro by an outgrowth from the parents body
asexual reproduction	producing offspring (identical to parents) without gametes
types of pathogens	bacteria, viruses, protozoa, fungi
how the body prevents pathogenic entry	physical: skin and mucous membrane immune: cells, tissues, organs to neutralise and eliminate threats chemical: stomach acid (pH of 2) hostile environment: inflammation
steps of viral replication	attachment→ penetration → replication → assembly → release
toxins caused by pathogenic bacteria	• can cause cell damage and illness by interfering with cellular processes • disrupts bodily processes and triggers auto-immune responses that result in inflammation and tissue damage
antibody	produced by the immune system in response to an antigen (recognises and neutralises it)
antibiotics	medications used to treat bacterial infections by killing or inhibiting bacterial growth
vaccination	weakened form of pathogen introduced to immune system to stimulate anti-body creation

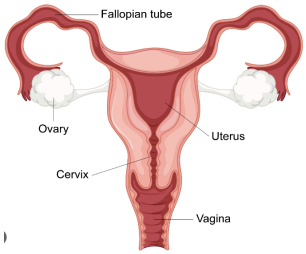
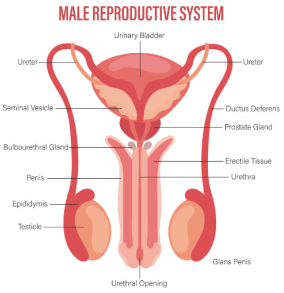
alexander fleming	1928- penicillin (1st anti-biotic) accidental petri dish left over the summer discovery mould that inhibited microbial growth
edward jenner	1st successful smallpox vaccine 1796- milkmaids inoculation through cowpox scabs
herd immunity	reduced spread of the disease when majority of a population is immune; indirect protection
epidemic	sudden increase in number of cases of a disease ina. specific community or region (exceeding what's considered normal)
inherited diseases	pased from arent to offspring through genetic mutations
transmitted diseases	caused by infectious agents transmitted by either direct or indirect contact air or vector borne
how does bacterial resistance occur	mutation: genetic mutation of resistance, horizontal gene transfer (acquiring resistant gene from other bacteria), misuse of antibiotics (exposure to antibiotics creates selection pressure, favours resistant one's survival)

Knowt

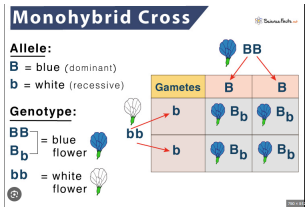
Chapter 5 - How do characteristics pass from one generation to another

Define **Replication**	the action or process of **reproducing** or **duplicating**. Replication of DNA
define **Hereditary**	Passing, or capable of passing, naturally from **parent to offspring** through **genes.**
Define **Genome**	**The complete set of DNA (genetic material) in an organism**. The genome contains all of the information needed for a person to develop and grow.
DNA structure	Double helix
Nucleotide comprises of what	Nitrogen base, pentose sugar, phosphate
Identify the **four base pairs**	**Adenine, Thymine** (*In RNA is Uracil*), **Guanine, Cytosine**
Outline the enzymes involved in **DNA replication.**	• **Helicase - Unzips the DNA strand into two** • **Primase - Adds primer to the ends of the DNA strands** • **Polymerase III - Synthesises the new DNA strand** • **Polymerase I - Removes the primers on the end and replaces them with proper bases** • **Ligase -** Repairs any damages and Okazaki fragments, ensuring the DNA is stable
Compare & Contrast: DNA, genes and chromosomes	Chromosomes **carry DNA in cells**

	DNA is responsible for **building** and **maintaining** your human **structure**. Genes are **segments** of your **DNA**, giving you **physical characteristics** that differ between person to person.
Explain how a gene codes for the formation of protein (DNA -> RNA -> Protein) (PROTEIN SYNTHESIS)	• **Transcription** - The copying of a gene to make *mRNA*. DNA must unzip for this process to occur. • **Translation** - The *mRNA* travels to the *Ribosome* (site of protein synthesis) and the *tRNA* then pairs a protein using a codon and anticodon. The protein is made this way (length + order of amino acids will determine the type of protein). • **Codon**: Triplet of bases on *mRNA*. • *!!! Amino acid chains all have peptide bonds between amino acids !!!*
What is the **role of DNA** within the body?	DNA contains the instructions needed for an organism to develop, survive and reproduce.
sexual reproduction (+ pros & cons)	gametes, requires fertilization cell division: meiosis advantages: allows for genetic variation & likely survival in new environments (adaptability) disadvantages: time-consuming + mating seasons. less rapid population growth
Asexual Reproduction	1 parent Offspring are a complete clone of the parent (genetically similar) Cell division: Binary fission, Mitosis Advantages: Efficient

	Disadvantages: Can't adapt to environmental changes Examples: Budding, fragmentation, parthogenesis
Gametes of plants	Pollen & Eggs
Female Reproduction System	
Male Reproduction System	
Define Mitosis & Meiosis	***Meiosis*** *is a type of cell division that results in the formation of* ***four daughter cells*** *each with* ***half the number of chromosomes*** *as the parent cell.* ***Mitosis*** *is the type of cell division that results in the formation of* ***two daughter cells*** *each with the* ***same number and kind of chromosomes as the parent cell.*** ***(****IMPORTANT FOR GROWTH AND REPAIR****)***
Mitosis: Interphase	DNA replication, growth and normal cell function
Mitosis: Prophase	Chromosomes condense
Mitosis: Metaphase	Chromosomes line up in the middle of the cell (equator)
Mitosis: Anaphase	

Mitosis: Telophase	
Mitosis: Cytokinesis	Plasma membrane and cytoplasm separate
Meiosis 1: Prophase	Chromosomes condense and become visible, while the nucleus disintegrates. Homologous chromosomes pair up (TETRAD). Then the homologous chromosomes exchange genetic information (crossing over)
Meiosis 1: Metaphase	Line up in the middle of the cell (equator)
Meiosis 1: Anaphase	They split up and move towards the opposite ends of the cell.
Meiosis 1: Telophase	Two independent cells begin to form.
Meiosis 1: Cytokinesis	This happens normally during telophase, where it divides the cytoplasm to form two new cells. **THE NEW CELLS ARE HAPLOID** as they have **half** the chromosomes of the parent cell.
Meiosis 2: Prophase	No pairing of chromosomes, but the nucleus still disintegrates
Meiosis 2: Metaphase	Chromosomes line up single file down the middle of the cell (NO PAIRING UP)
Meiosis 2: Anaphase	Sister chromatids separate
Meiosis 2: Telophase	4 haploid daughter cells are being formed, these are called gametes. The nucleus reforms. Chromosomes uncoil to become chromatin once again.
Meiosis 2: Cytokinesis	Cytoplasm and plasma membrane split to form 4 haploid cells
Gamete	organisms produce sex cells called gametes. Needed for reproduction.
chromosome	Thread-like structures located inside the nucleus of animal and plants cells that contain

	genetic information.
gene	The basic unit of heredity passed from parent to child. Genes are made up of sequences of DNA and are arranged, one after another. Segment of DNA.
allele/variant	singular trait/make-up
dominant	A dominant allele produces a dominant phenotype in individuals who have one copy of the allele
recessive	A recessive allele to produce a recessive phenotype, the individual must have two copies, one from each parent.
homozygous	two copies of the same allele
heterozygous	different alleles
genonome	the entire genetic material of an organism
phenotype	the appearance of an organism
monohybrid crosses	
The process of **Crossing Over**	Crossing over happens during **Prophase I**. Homologous chromosomes **trade genetic information.** Crossing over is a **random event**, so it doesn't always happen
Explain how meiosis **increases genetic variation.**	Specifically, **meiosis creates new combinations of genetic material in each of the four daughter cells**. These new combinations result from the exchange of DNA between paired chromosomes. Such exchange means that the gametes produced through

	meiosis exhibit an amazing range of genetic variation.
Types of Mutations	**Missense mutations:** The amino acid is changed (protein is changed) **Nonsenses mutations:** Results with 'STOP' on the codon chart. **Silent Mutations:** The mRNA code is changed, but the amino acid is the same.
How do mutations occur?	Mutations result either from **errors in DNA replication** or from the damaging effects of mutagens, such as chemicals and radiation, which react with DNA and change the structures of individual nucleotides. Another way is **NON DISJUNCTION** where there is an abnormal number of chromosomes in the 4 haploid gametes during meiosis.

Knowt

Chapter 6 - How have different forms of life arisen?

Selective Breeding & Artificial Selection: ideal answer	1. Variation exists within the population 2. Select organisms with desired traits 3. Only let those selected organisms with desired traits reproduce with one another 4. If the trait is heritable, then the offspring will have the desired trait 5. Over many generations, the proportion of the population of the desirable trait in the population will increase.
heritable variation (and causes)	difference in traits passed down from parent to offspring through genetic inheritance due to genetic mutations, genetic recombination and gene flow
selective breeding	process of intentionally rearing organism w desire features; artificial selection
pros for selective breeding	disease/fire/drought resistant, high yeild crops, ideal pet characteristics
cons for selective breeding	high risk of genetic disease, reduction of genetic diversity
natural selection: ideal answer	1. There is genetic variation within the population 2. More offspring will be produced that can survive. Organisms with the traits best suited to their environment are

	more likely to survive (SURVIVAL OF THE FITTEST) 3. The organisms that are more likely to survive are more likely to reproduce 4. If the trait is heritable, then the offspring will have the advantageous trait 5. Over many generations, the proportion of the population with the advantageous trait will increase
Darwin's **three main principles** of natural selection	Darwin's **three main principles** of natural selection state that, in order for the process to occur, • most characteristics in the population must be inherited • more offspring must be produced than can survive • the fittest offspring must be more likely to survive and reproduce.
Factors affecting natural selection *(e.g., variation, competition, selection pressures)*	**Competition** —> Two organisms fight for the same resources, such as food or mates **Predation** —>A consumer (predator) eats another consumer (prey) **Availability of resources** **Climate** **Selection Pressure:** Biotic & Abiotic
specialised structures	enhance an organism's fitness by performing specific functions for survival and reproduction
How can we determine how old a fossil is?	The **deeper** a fossil in within the ground, the older it is.

proof of evolution (list)	fossil evidence, comparative anatomy, comparative embryology
fossil evidence	transitional fossils (showing intermediate characteristics between species) fossil record (chronological sequence of fossils that shows evolutionary change over time
comparative anatomy	homologous structures vestigial structures (shit we have but do not need)
comparative embryology	similarities in embryonic development between species which suggests common ancestry
Speciation	the process by which a new species forms from a single ancestral species. • when a species splits into two or more due to isolation and natural barriers. • for speciation to occur, there must first be isolation and then natural selection.
Mechanisms of Speciation	Allopatric: geographical isolation (islands and mountains prevent gene flow) Sympatric: species don't interbreed due to other reproductive barriers/reproductive isolation.
role of isolation in speciation	prevents gene flow which allows for genetic diversity and accumulation of reproductive barriers
Species	A group of organisms that can interbreed and produce fertile offspring. Their offspring must also be able to interbreed.

Population	members of a particular species living in the same place at the same time.
Importance of genetic variation in species survival	Variation allows some individuals within a population to adapt to the changing environment. Because natural selection acts directly only on phenotypes, more genetic variation within a population usually enables more phenotypic variation. This could increase the likelihood of a species' survival.
Antibiotics	a medicine (such as penicillin or its derivatives) that inhibits the growth of or destroys microorganisms
Antibiotic resistance (superbugs)	Antibiotic resistance is **when bacteria change to resist antibiotics that used to effectively treat them**. This makes certain bacterial infections difficult to treat. Overuse and misuse of antibiotics cause antibiotic resistance.
Natural selection occurs in a population that has...	Variation Heritability some kind of selection pressure (competition, predation, disease, etc)
Fitness of a population	How well they can reproduce Increase fitness within a population = adaptation
Evolution	change in the traits of a population over time
Allele frequency	When some alleles become more common over time, evolution has occurred. This is a change in the frequency.
3 Major ways a population can evolve	**Gene flow:** Allele frequency is changed when individuals move populations

	Genetic Drift: When disease or natural disaster kills a lot of individuals. Or, when a few leave, they start a new population, thus creating the founder effect. **Natural Selection:** Population evolves due to selective pressures.
extinction	When a population of a species cease to exist.
Mass extinction	A drastic change in the number and variety of organisms at the same time (enormous number)
Behavioural adaptations	**Something an animal does usually in response to some type of external stimulus in order to survive. Hibernating** during winter is an example of a behavioral adaptation.
Physiological adaptations	Physiological adaptation is **an internal body process to regulate and maintain homeostasis for an organism to survive in the environment in which it exists**. Examples include temperature regulation, release of toxins or poisons, releasing antifreeze proteins to avoid freezing in cold environments
Structural Adaptations	**Physical features** of an **organism** that enable it to survive in its environment *(e.g. a penguin has blubber to protect itself from freezing temperatures)*.
Solo vs Social Behaviour	**Social Advantages:** Childcare is easier, protection from predators **Solo Advantages:** Easier to deal with disease (won't spread within a group of people), competition for food is less, territory disputes are less too

carbon cycle	photosynthesis, respiration, decomposition, fossil fuel consumption, decaying organisms, carbon sequestration
symbiosis types	mutualism, commensalism, parasitism
keystone species	disproportionate impact on ecosystem as compared to their abundance
how do humans destroy the environment	H- habitat destruction I- invasive species P- pollution C- climate change O- overconsumption P- population