The Perfect Answer Revision Guide To...

BIOLOGY

By SwH Learning

CAMBRIDGE IGCSE

0970 / 0610

Core & Extended Assessment

2nd Edition

HAZEL LINDSEY &
MARTIN BAILEY

SwH LEARNING

NEW SPECIFICATION
FOR EXAMS IN 2023 ONWARDS

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About SwH Learning

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About The Authors

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Hazel is the creator of the Science with Hazel YouTube channel and a professional science tutor. She specialises in GCSE and IGCSE biology, chemistry and physics across all exam boards.

A qualified secondary school science teacher, Hazel graduated with a degree in Pre-Clinical Veterinary Sciences from St. John's College, University of Cambridge, where she subsequently completed her PGCE (Post-Graduate Certificate of Education).

Through her tuition and YouTube channel, Hazel is responsible for helping hundreds of thousands of students from around the globe achieve their dream results in their GCSEs, IGCSEs, A Levels and IB examinations.

Martin Bailey

Martin is the co-founder of SwH Learning. Together, he and Hazel create and edit numerous science revision videos, write and publish The Perfect Answer GCSE and IGCSE revision guides & workbooks, and run the SwH Learning revision courses.

Martin graduated with a degree in Natural Sciences from Trinity College, University of Cambridge. He has thousands of hours of experience tutoring students of all abilities, from GCSE up to degree level.

Whilst at Cambridge, Martin specialised in pathology and biological anthropology. He also studied chemistry, maths, geology and history & philosophy of science.

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Contents

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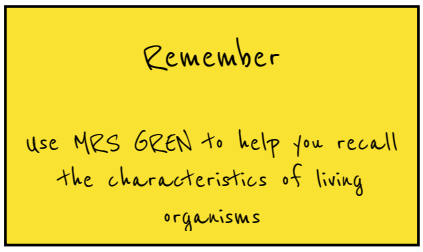
NOTE: Core content is given in this format (Grades 1-5). *Extended content is given in italics (grades 5-9)*

1. CHARACTERISTICS AND CLASSIFICATION OF LIVING ORGANISMS

1.1 Characteristics of living organisms

Characteristics all living organisms show:
- Movement
- Respiration
- Sensitivity
- Growth
- Reproduction
- Excretion
- Nutrition



Define movement
- Action by all (or part) of an organism
- Causes change in position or place

Define respiration
- Chemical reactions in cells
- Nutrient molecules broken down
- Energy released for metabolism

Define sensitivity
- Ability to detect and respond to changes in internal or external environment

Define growth
- Permanent increase in size and dry mass

Define reproduction
- Processes that make more of the same kind of organism

Define excretion
- Removal of waste products of metabolism and substances in excess of requirements

Define nutrition
- Taking in materials for energy, growth and development

1.2 Concepts and uses of classification systems

What is a classification system?
- System to classify organisms into groups by the features they share

What is a species?
- Group of organisms that can reproduce
- Produce fertile offspring

What is the binomial system?
- Internationally agreed system to classify organisms
- Two-part scientific names showing genus and species (e.g. *Canis lupus*)
  - *Canis* = genus
  - *lupus* = species

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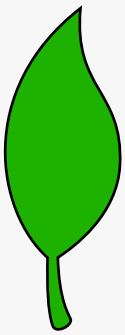
Using A Dichotomous Key



A

B

C

D

1	**a**	Leaf has smooth outline	Go to 2
	b	Leaf has jagged outline	*Acer pseudoplatanus*
2	**a**	Leaf divided into more than two distinct parts	Go to 3
	b	Leaf not divided into more than two distinct parts	*Magnolia grandiflora*
3	**a**	Leaf has variegated regions	*Trifolium repens*
	b	Leaf does not have variegated regions	*Pteridium aquilinum*

Leaf A: Smooth outline, not divided into two distinct parts → *M. grandiflora*

Leaf B: Smooth outline, divided into many distinct parts, no variegation → *P. aquilinum*

Leaf C: Jagged outline → *A. pseudoplatanus*

Leaf D: Smooth outline, divided into three distinct parts, variegation → *T. repens*

How are traditional classification systems designed?
- *Reflect evolutionary relationships*
- *Based on morphology and anatomy*

What is a more accurate way to classify organisms?
- *Sequence of bases in DNA*
- *Sequences of amino acids in proteins*

Explain how DNA sequence and ancestry are related
- *More recent ancestors share more similar base sequences in DNA*

1.3 Features of organisms

List the 5 Kingdoms
- Animals
- Plants
- Fungi
- Prokaryotes
- Protoctists

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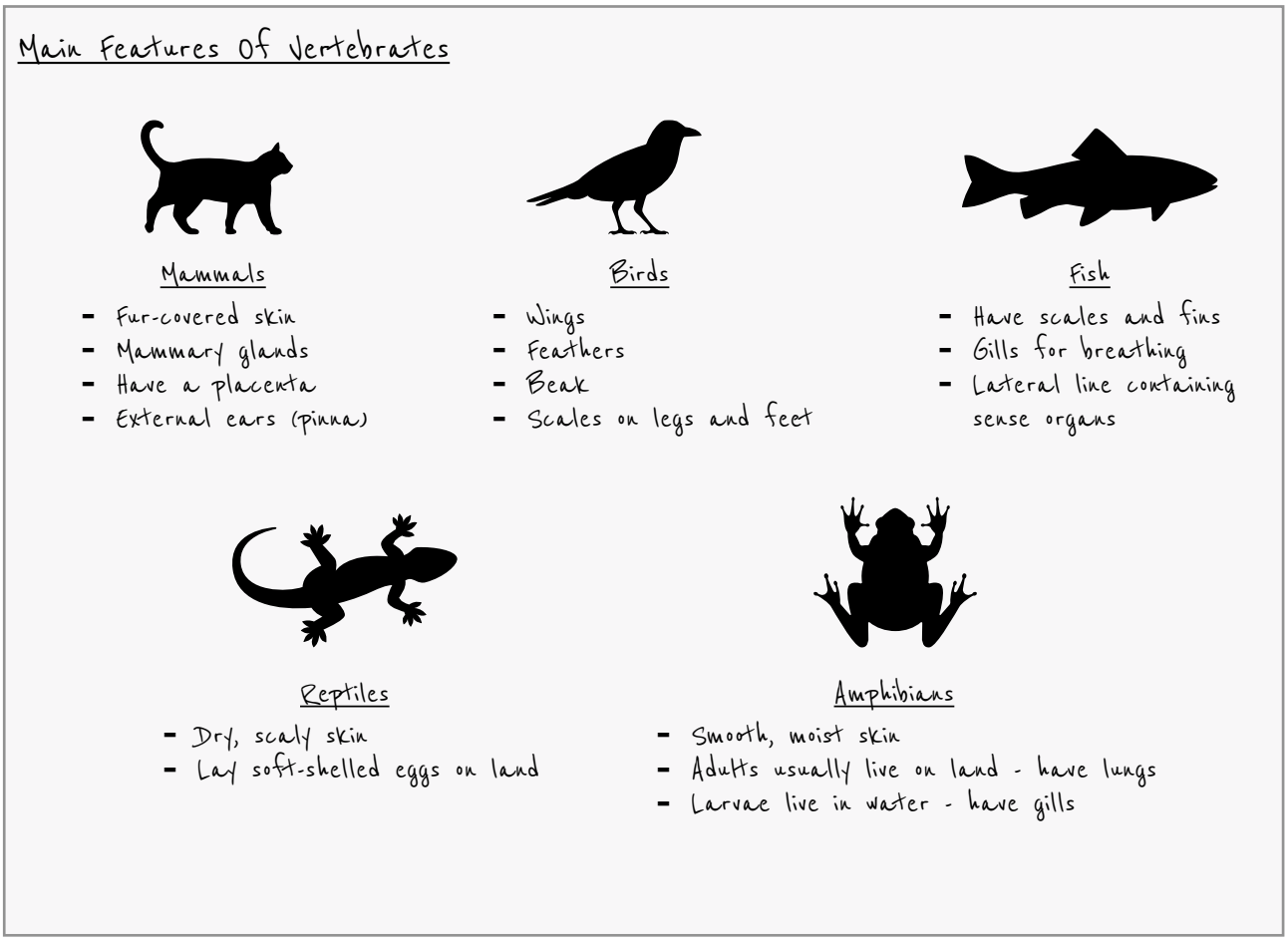
What does eukaryotic mean?
- Has membrane bound organelles
  - e.g. animal cell has mitochondria and a nucleus

What does prokaryotic mean?
- No membrane bound organelles
  - e.g. bacteria

Outline the main features of all animals
- Multicellular
- Cells contain a nucleus
  - Do not have cell walls
- Feed on organic substances made by other organisms
- Internal digestion process

Outline the main features of all plants
- Multicellular
- Cells contain a nucleus, chloroplasts (photosynthesising cells only), cell wall
  - Cell wall made from cellulose
- Produce food by photosynthesis

What is a vertebrate?
- Animal with a backbone



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Main Features Of Invertebrates

Myriapods

- Antennae
- Many body segments
- Each body segment contains at least one pair of legs
- Hard exoskeleton

Insects

- Compound eyes
- Three body segments (head, thorax, abdomen)
- Antennae
- Three pairs of legs

Arachnids

- Two body segments
- Simple eyes
- Four pairs of legs
- No antennae
- Powerful jaws

Crustaceans

- Claws with hard serrated edges
- More than four pairs of jointed limbs
- Gills under shell
- Two pairs of antennae

Outline the common features of microorganisms

	Bacteria (Prokaryotes)	***Protoctist***	***Fungi***
Structure	- *Cell wall* - *No distinct nucleus* - *Have circular chromosomes (nucleoid) and often plasmids*	- *Variable* - *Can be similar to animal cells (protozoa) or plant cells (algae)*	- *Cell wall made of chitin* - *Contain usual organelles (e.g. cytoplasm, cell membrane etc)* - *Made of strands called hyphae*
Unicellular or multicellular	- *Unicellular*	- *Can be either (most are unicellular)*	- *Can be either* - *Hyphae have many nuclei*
Pathogenic?	- *Sometimes*	- *Sometimes*	- *Sometimes*
Examples	- *Pneumococcus (causes pneumonia)* - *Lactobacillus bulgaricus (used in yoghurt making)*	- *Chlorella (have chloroplasts, plant-like)* - *Plasmodium (causes malaria)* - *Algae* - *Amoeba (more animal-like)*	- *Mushrooms* - *Mucor*
Extra notes			- *Use saprotrophic nutrition (feed by external digestion)*

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Give two different plant groups
- *Ferns*
- *Angiosperms (flowering plants)*

Outline the features used to classify a plant as a fern
- *Leaves called fronds*
- *Fronds carry sporangia*
  - *Sporangia release spores*
  - *Reproduction occurs through spores*
- *Have underground rhizomes*
- *Simple, true roots*

Outline the features used to classify a plant as an angiosperm
- *Produce flowers*
- *Produce fruit*
- *Reproduce sexually through pollen and stigma/ovaries*
- *Can be monocotyledons or dicotyledons*
- *Extensive root systems*

Describe the differences between monocotyledons and dicotyledons
- *Monocotyledons*
  - *Petals are in multiples of 3*
  - *Leaves have parallel veins*
  - *e.g. wheat plants*
- *Dicotyledons*
  - *Petals in multiples of 4 or 5*
  - *Have reticulated leaf veins*

What is a virus made up of?
- *Protein coat*
- *Genetic material*
  - *Either DNA or RNA*

Why is a virus non-living?
- *Does not excrete, respire, move etc.*
- *Requires host cell to replicate*

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2. ORGANISATION OF THE ORGANISM

2.1 Cell structure

Cells of all living organisms contain:
- Cytoplasm
- Cell membrane
- DNA (as genetic material)
- Ribosomes for protein synthesis
- Enzymes involved in respiration

Plant and animal cells both have:
- Nucleus
  - Contains genetic material (DNA)
  - Controls activities and characteristics of cell
- Cytoplasm
  - Contains water and dissolved substances
  - Contains all other organelles
- Mitochondria
  - Site of aerobic respiration
- Cell membrane
  - Surrounds cytoplasm
  - Controls entry and exit of dissolved substances
  - Forms barrier between cell and surroundings
- Ribosomes
  - Site of protein synthesis

Plants also have:
- Chloroplasts
  - Packed with chlorophyll
  - Contain enzymes to produce glucose through photosynthesis
- Vacuole
  - Contains water
  - Provides turgor pressure to maintain shape of cell
  - Filled with cell sap
- Cell wall
  - Protects and supports the cell
  - Made from cellulose

Bacterial cells have:
- Cell wall
  - Made from peptidoglycan (murein)
- Cell membrane
  - Controls entry and exit of dissolved substances
- Cytoplasm
  - Contains water and dissolved substances
- Ribosomes
  - Site of protein synthesis
- Circular DNA (nucleoid)
  - Not contained in nucleus
- Plasmids
  - Smaller, circular DNA
  - Often contain genes for antibiotic resistance

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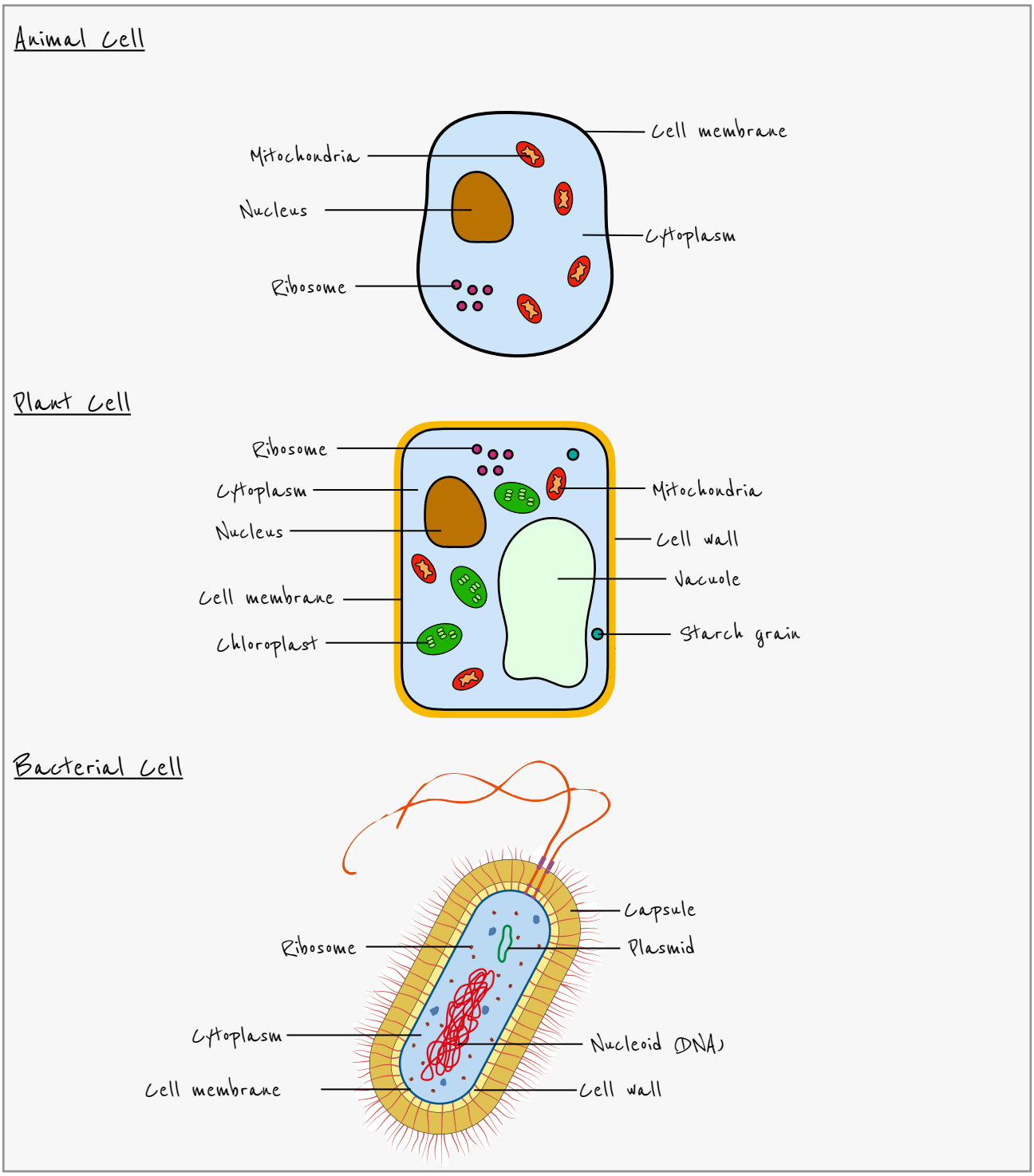

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How are carbohydrates stored in a) animals, b) plants, c) fungi?

a) As glycogen
b) As starch
c) As glycogen

How are new cells produced?

- By division of existing cells

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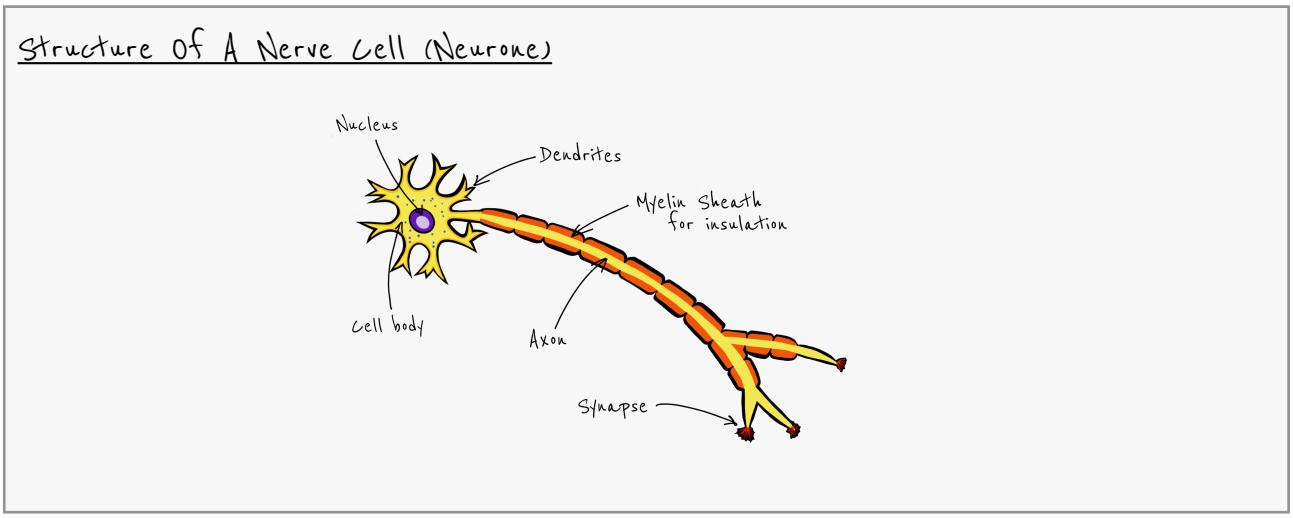
Describe the structure and function of the following specialised cells…

Ciliated cells
- Function: move mucus out of the trachea and bronchi
  - Have layer of tiny hairs (cilia)
  - Cilia move and push mucus towards mouth
  - Mucus traps dust and microbes
  - Mucus is expelled by coughing/sneezing or swallowed

Root hair cells
- Function: absorption
  - Long extension called root hair
  - Large surface area
  - For absorption of water by osmosis
  - For absorption of mineral ions by active transport

Palisade mesophyll cells
- Function: photosynthesis
  - Contains many chloroplasts to absorb light
  - Tall thin cells - densely packed
  - Maximises photosynthesis

Neurones
- Function: conduction of electrical impulses
  - Long fibre called an axon
  - Axon can carry electrical impulses
  - Axons have a fatty sheath to insulate
  - Many branched endings can connect with other cells



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Red blood cells
- Function: transport oxygen around the body for respiration
  - Contains haemoglobin which binds to oxygen forming oxyhaemoglobin
  - Biconcave disc shape increases surface area to volume ratio
  - Very flexible enabling it to pass through small vessels
  - No nucleus - more room for haemoglobin so more oxygen can then be transported

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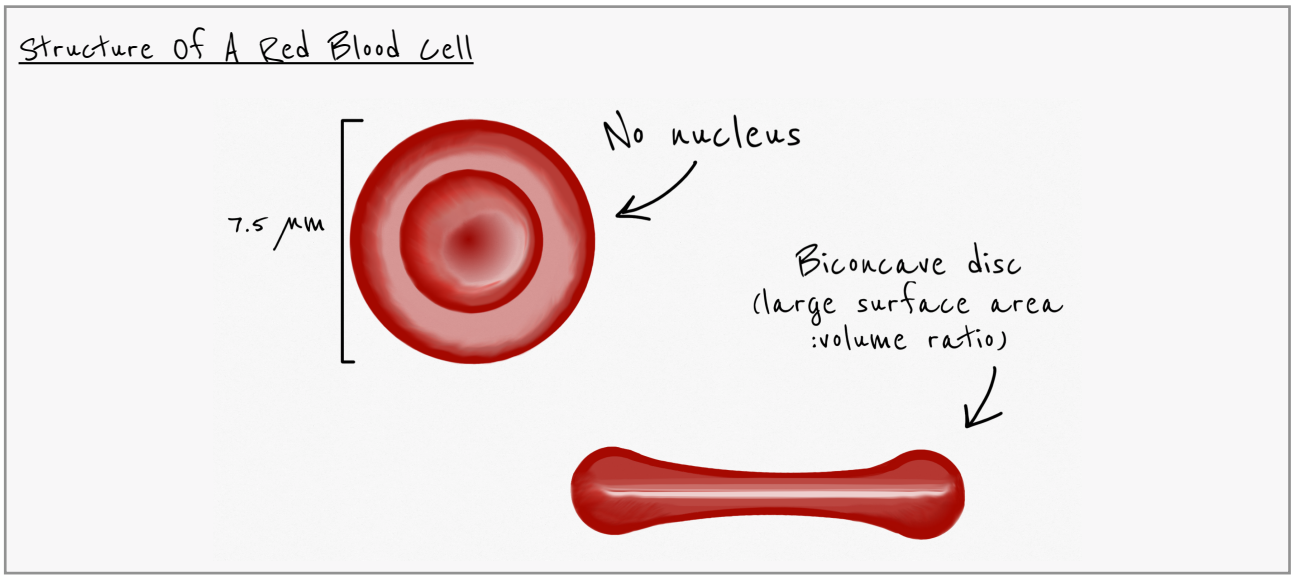

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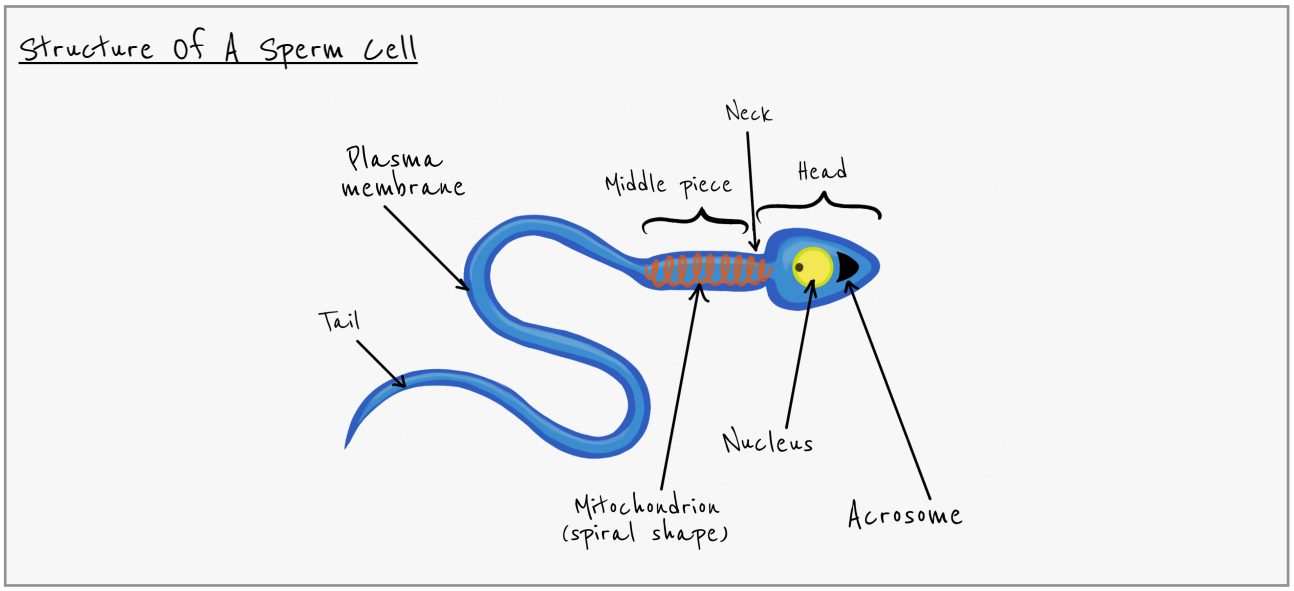
Sperm cells
- Function: reproduction
  - Haploid nucleus
  - Flagellum beats to swim cell towards ovum
  - Acrosome contains enzymes to penetrate egg cell
  - Mitochondria in cytoplasm release energy for movement



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Egg cells (ovum)
- Function: reproduction
  - Haploid nucleus
  - Jelly coat changes at fertilisation
  - Allows entry of male nucleus

What is a cell?
- Group of organelles working together to perform the same function

What is a tissue?
- Group of cells working together to perform the same function

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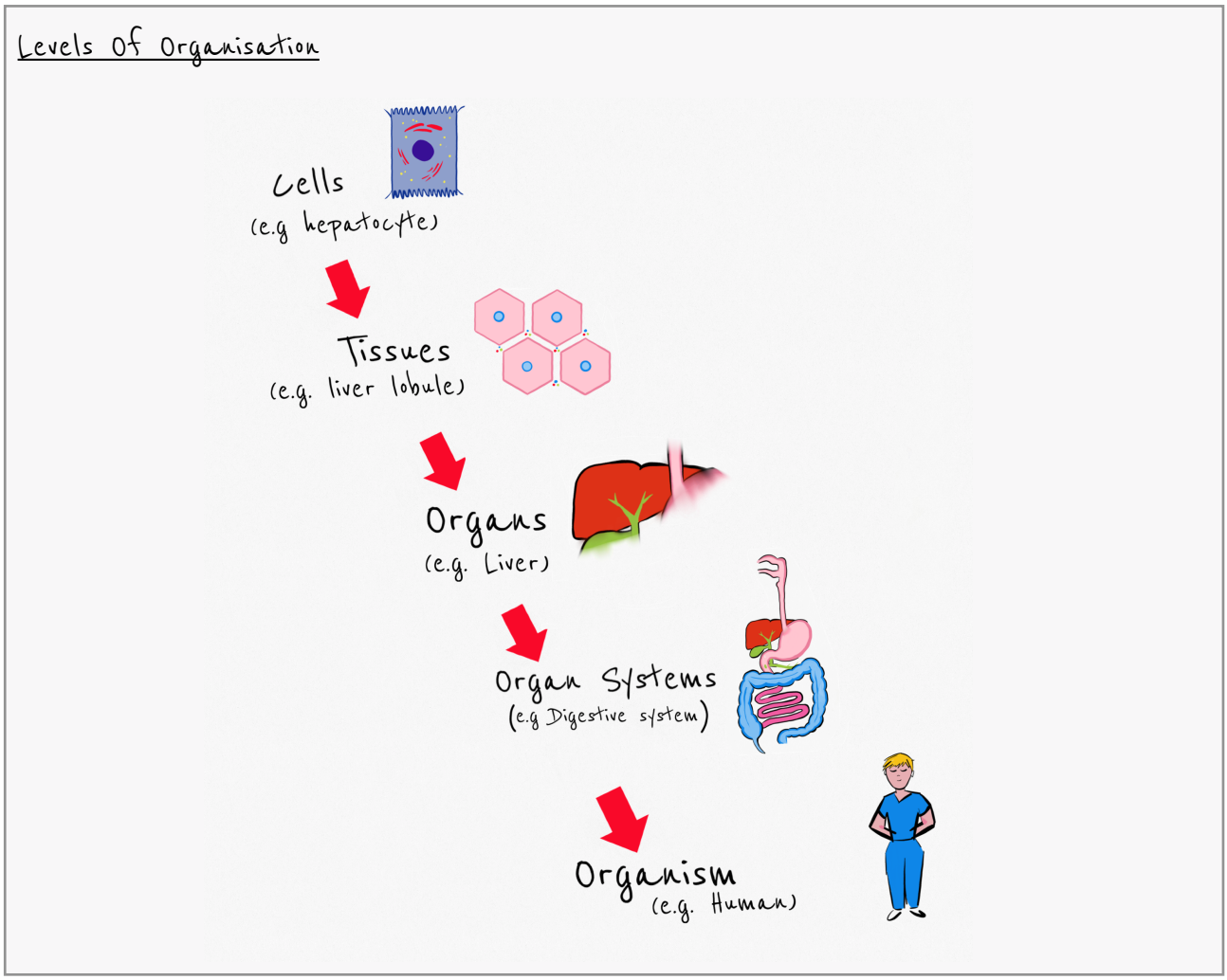
What is an organ?
- Group of tissues working together to perform the same function

What is an organ system?
- Group of organs working together to perform the same function



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What are the main organs in plants?
- Leaves
- Roots
- Stems
- Flowers

What are the 7 main organ systems found in humans?
- Reproductive system
- Circulatory system
- Digestive system
- Gas exchange system
- Nervous system
- Excretory system
- Endocrine system

List some organs found in the digestive system
- Oesophagus
- Stomach
- Small intestine
- Large intestine

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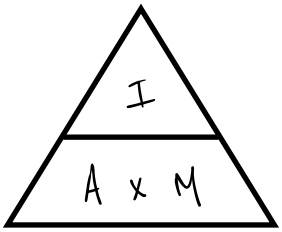
2.2 Size of specimens

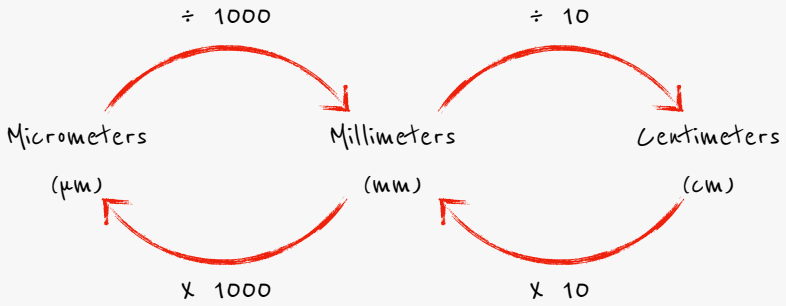
How do you calculate magnification?
- Magnification = image size ÷ actual size

How do you calculate actual (true) length?
- Actual size = image size ÷ magnification



Unit Conversions

Always make sure to convert the units before starting any calculations



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3. MOVEMENT INTO AND OUT OF CELLS

3.1 Diffusion

Define diffusion
- Net movement of particles from an area of high concentration to an area of low concentration
- Down a concentration gradient
- Due to random movement

Where does the energy for diffusion come from?
- Kinetic energy of random movement of molecules and ions

Outline the ways in which diffusion is important in living organisms
- Some substances move into and out of cells by diffusion
  - Through the cell membrane
- Oxygen diffuses from lungs to blood in capillaries
- Glucose and amino acids diffuse from small intestine cells to blood
- CO_2 from the atmosphere diffuses into cells in leaves

What factors affect the rate of diffusion?
- Concentration gradient
- Surface area to volume ratio
- Diffusion distance
- Temperature

What factors increase the rate of diffusion?
- Steep concentration gradient
- High surface area to volume ratio
- Shorter diffusion distance
- Higher temperature due to increased kinetic energy of particles

3.2 Osmosis

Why is water vital for living organisms?
- Water acts as solvent
- Allows metabolic reactions in cytoplasm to occur
- Dissolved substances can be transported around organism
  - e.g. digested food molecules from alimentary canal to other cells
  - e.g. urea can be removed from body in urine

Define high water potential
- Dilute solution (e.g. pure water)

Define low water potential
- Concentrated solution (e.g. salty water)

Define osmosis
- Diffusion of water through partially permeable membranes
- *Net movement of water molecules from region of high water potential to low water potential*
- *Through a partially permeable membrane*

How does water enter cells?
- By osmosis through the cell membrane

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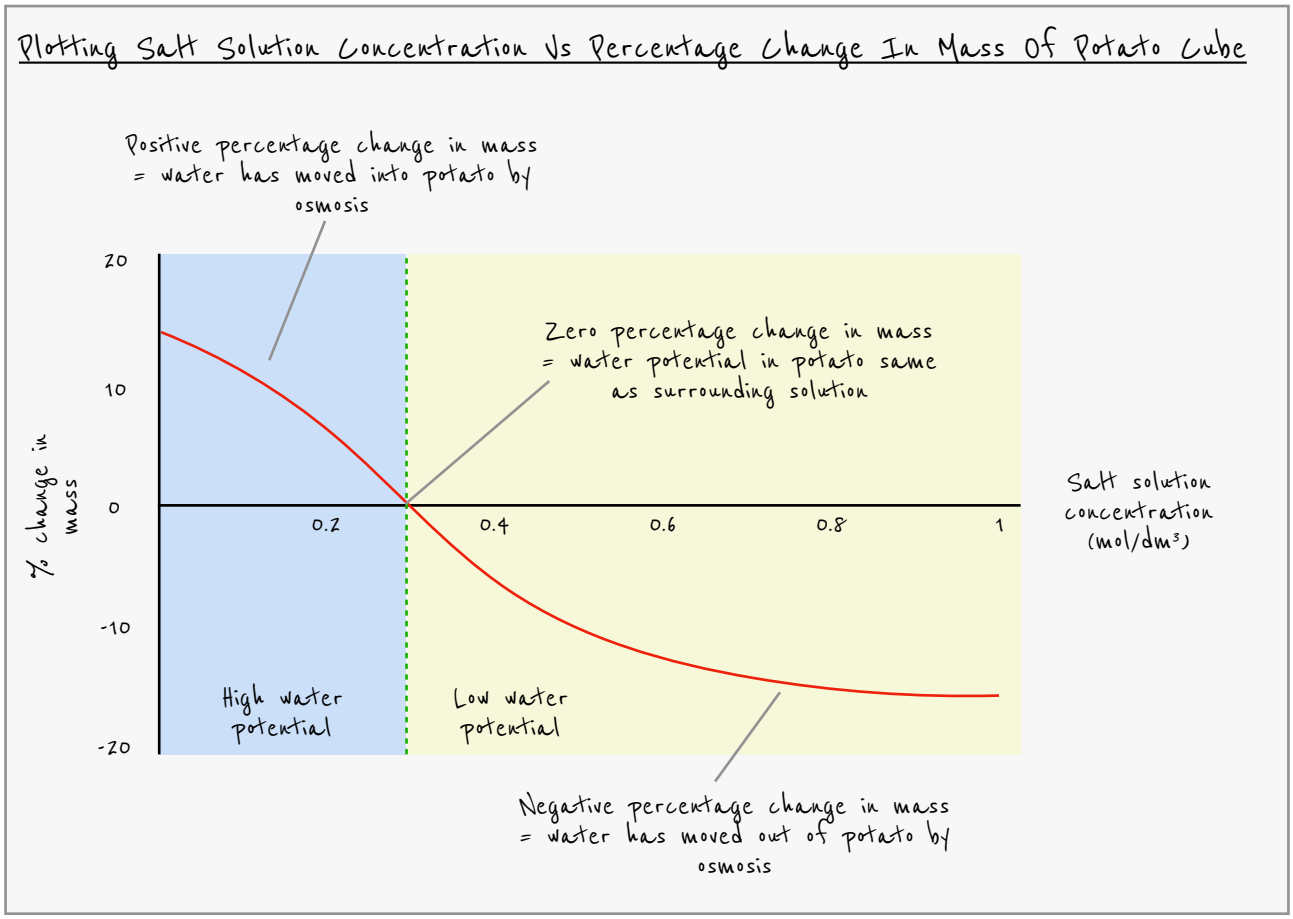
Outline a method to investigate the effects on plant tissues of immersing them in solutions of different concentrations

- Cut plant tissue (e.g potato) into equal sized cubes/cylinders
  - Use ruler to measure
- Measure initial mass of cubes/cylinders
  - Dry potato before measuring mass to ensure excess water not included
- Place each cube/cylinder in test tube of known salt concentration
- After 30 minutes, dry cubes/cylinders and measure mass
- Calculate percentage change in mass
- Repeat and calculate mean
- Plot results on graph



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Define turgor pressure

- Water pressure inside cells pushes outwards
- Water pressure acts against inelastic cell wall

Explain what happens to a plant cell placed in salty solution

- *Shrinks (becomes flaccid)*
  - *Cell membrane may eventually pull away from cell wall (plasmolysis)*
  - *Higher water potential in cell than surrounding solution*
  - *Water leaves cell by osmosis*

Explain what happens to a plant cell placed in pure water

- *Swells (becomes turgid)*
  - *Higher water potential in surrounding solution compared with inside the cell*
  - *Water enters cell by osmosis*
  - *Turgor pressure increases*
  - *Cell wall prevents bursting*

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Explain what happens to an animal cell placed in pure water
- *Bursts*
  - *Higher water potential in surrounding solution compared with inside the cell*
  - *Water enters cell by osmosis*
  - *No cell wall so bursts*

3.3 Active transport

Define active transport
- Net movement of particles from an area of low concentration to an area of high concentration
- Across a cell membrane
- Requires energy from ATP (released by respiration)

Why is active transport vital for living organisms?
- *Can move molecules up a concentration gradient*
  - e*.g.uptake of mineral ions into root hair cells*

Describe how active transport occurs
- *Protein carriers in cell membrane*
- *Carrier complementary to substance being transport*
- *Substance transported across membrane by carrier protein using energy (ATP)*
- *Substance released into cell*

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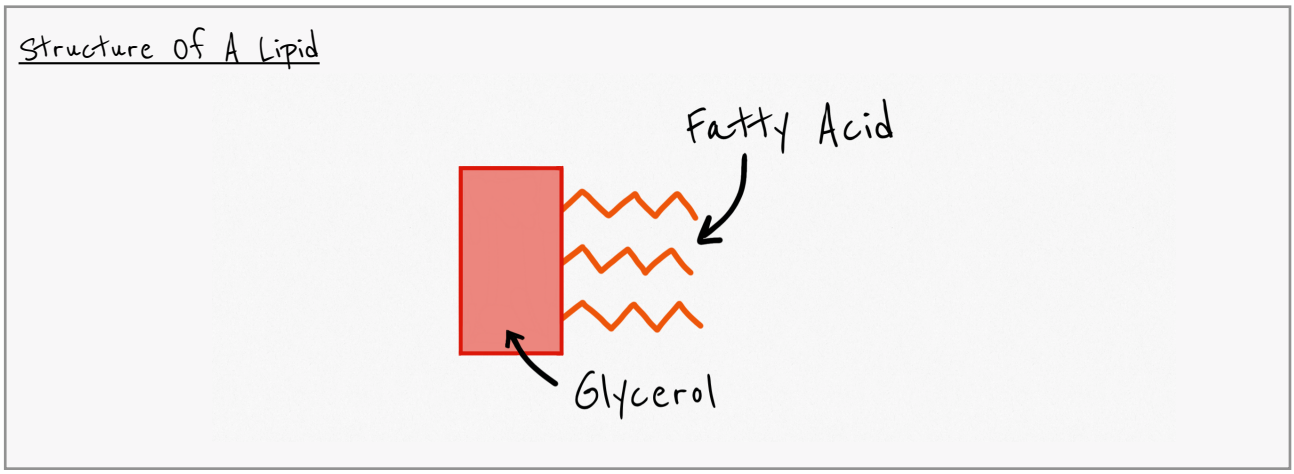
4. BIOLOGICAL MOLECULES

4.1 Biological molecules

Which elements are found in lipids (fats)?
- Carbon
- Hydrogen
- Oxygen

Describe the structure of a lipid
- 3 fatty acids
- 1 glycerol molecule



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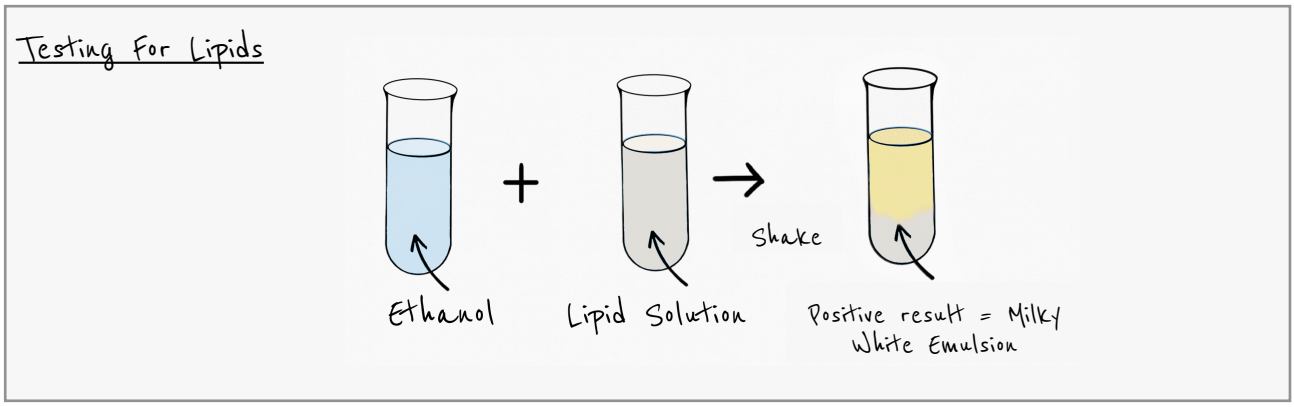
What are oils?
- Plant lipids
- Liquids at room temperature

What is the test for lipids?
- Add ethanol
- Add water and shake
- Positive result: milky white emulsion forms



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Which elements are found in proteins?
- Carbon
- Hydrogen
- Oxygen
- Nitrogen
- Sometimes sulfur

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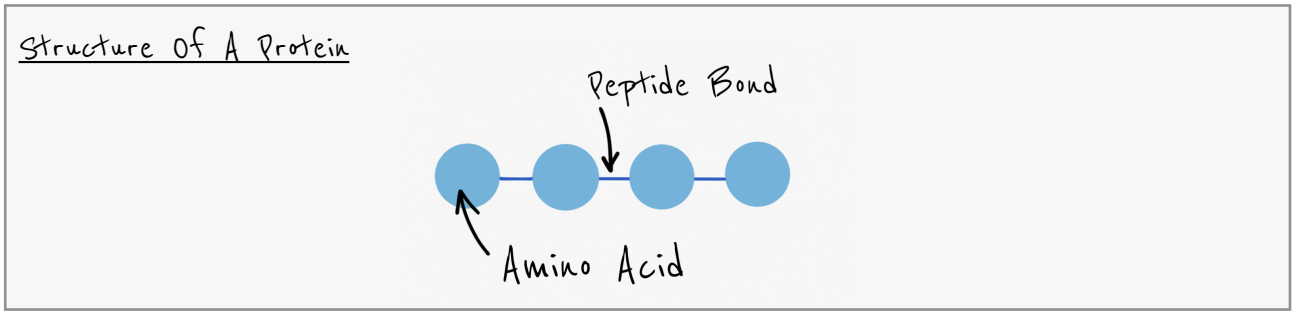
What are proteins made up of?
- Long chains of amino acids
- There are 20 different amino acids



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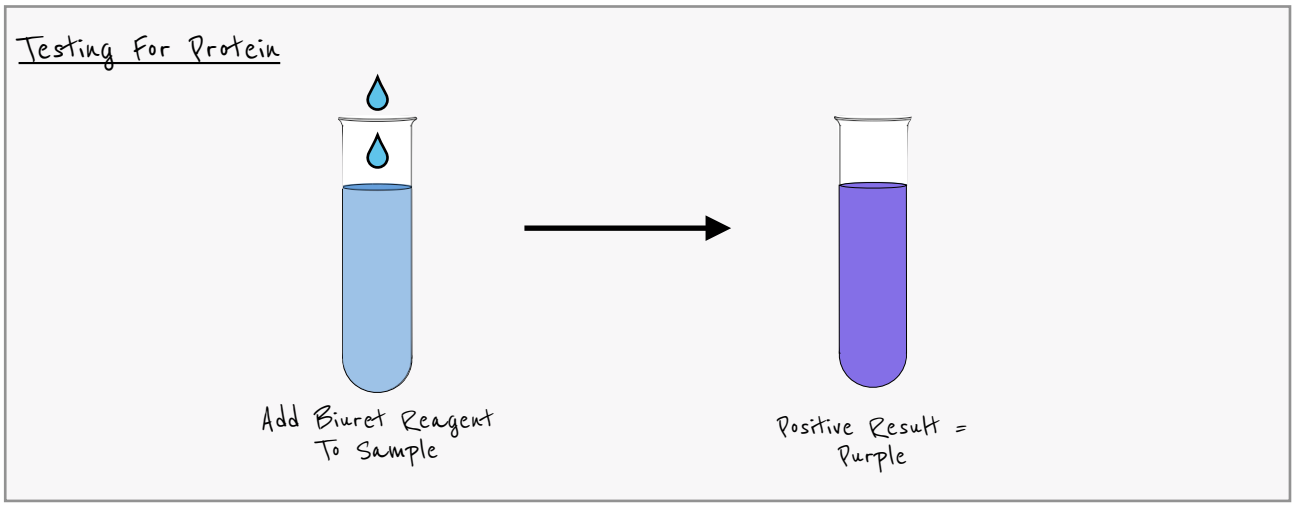
What is the test for protein?
- Add Biuret reagent
- Positive result: blue Biuret reagent turns purple



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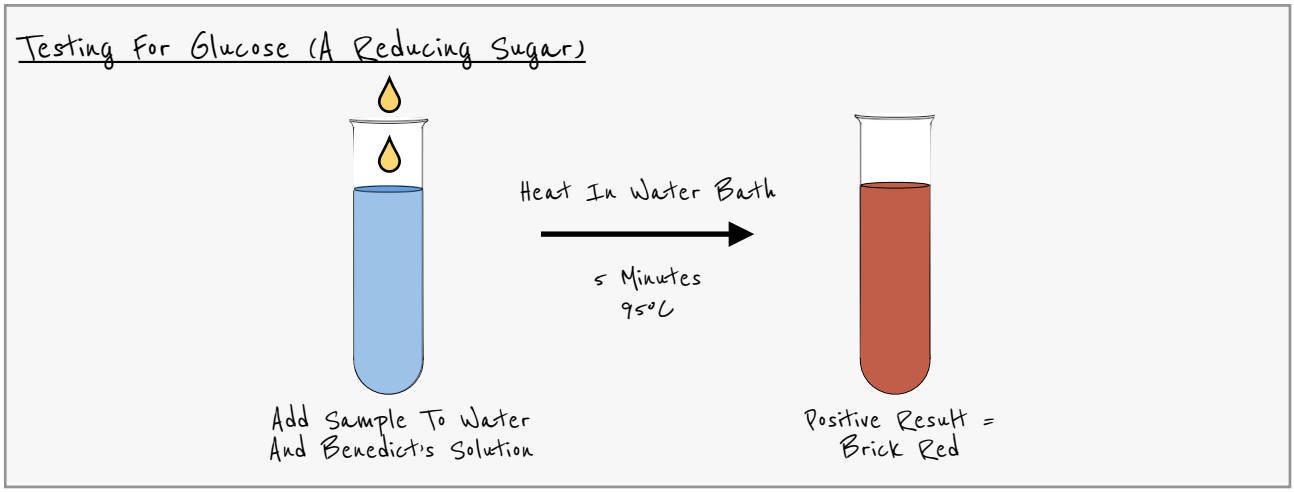
Which elements are found in carbohydrates?
- Carbon
- Hydrogen
- Oxygen

What is the test for reducing sugars (e.g. glucose)?
- Heat with water and Benedict's solution
- Positive result: brick red
  - Range of colours indicates concentration of reducing sugar
  - Blue (no reducing sugar) → Green → Yellow → Brick Red (lots of reducing sugars)



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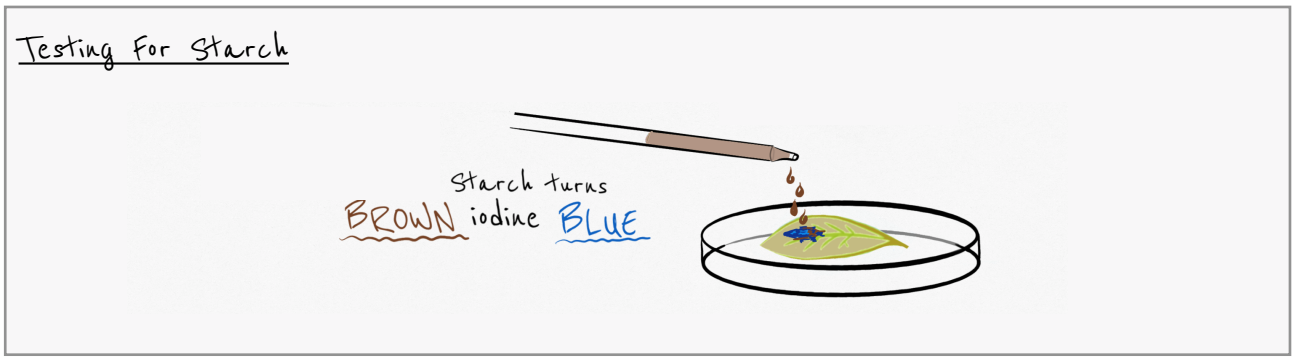
What are starch and glycogen made up of?
- Simple sugars (e.g. glucose) joined together

What is the test for starch?
- Add iodine
- Positive result: turns blue/black



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What is the test for Vitamin C?
- DCPIP dye
- Add vitamin C drop by drop
- Positive result: solution changes from dark blue to colourless
  - Few drops required = strong solution

What are the four DNA bases?
- *Adenine (A)*
- *Thymine (T)*
- *Cytosine (C)*
- *Guanine (G)*

Describe base pairing in DNA
- *Adenine (A) - Thymine (T)*
- *Cytosine (C) - Guanine (G)*

Describe the structure of DNA
- *Two strands coiled to form double helix*
- *Bonds between chemical bases hold strands together*
  - *A with T*
  - *C with G*

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5. ENZYMES

5.1 Enzymes

What is a catalyst?
- Substance that increases rate of chemical reaction
- Not changed or used up by the reaction

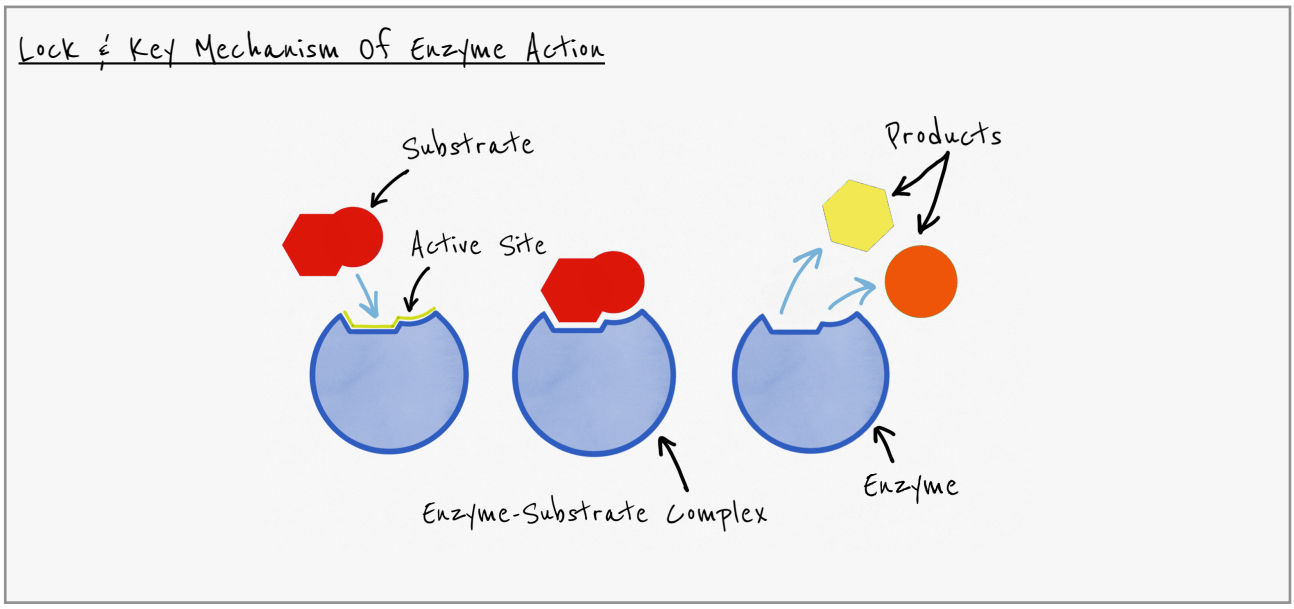
Define metabolism
- Rate at which chemical reactions take place in the body
- Metabolic reactions catalysed by enzymes

Define enzyme
- Protein that functions as a biological catalyst
- Involved in all metabolic reactions

Why are enzymes important?
- Speed up biochemical reactions
- High reaction rate necessary to sustain life

Key enzyme terms:
- Substrate - molecule an enzyme acts upon
- Active site - area on an enzyme where substrate attaches
- Optimum - temperature or pH at which enzyme activity rate is fastest
- Denature - when enzyme changes shape so substrate no longer fits active site

How does an enzyme work?
- Enzyme active site has complementary shape to substrate
- Substrate molecules bind to active site
- *Enzyme-substrate complex formed at active site*
- *Complementary shape of active site allows specificity*
- Product is produced
- Each enzyme is specific for one shape of substrate
- One reaction occurs each time substrate binds



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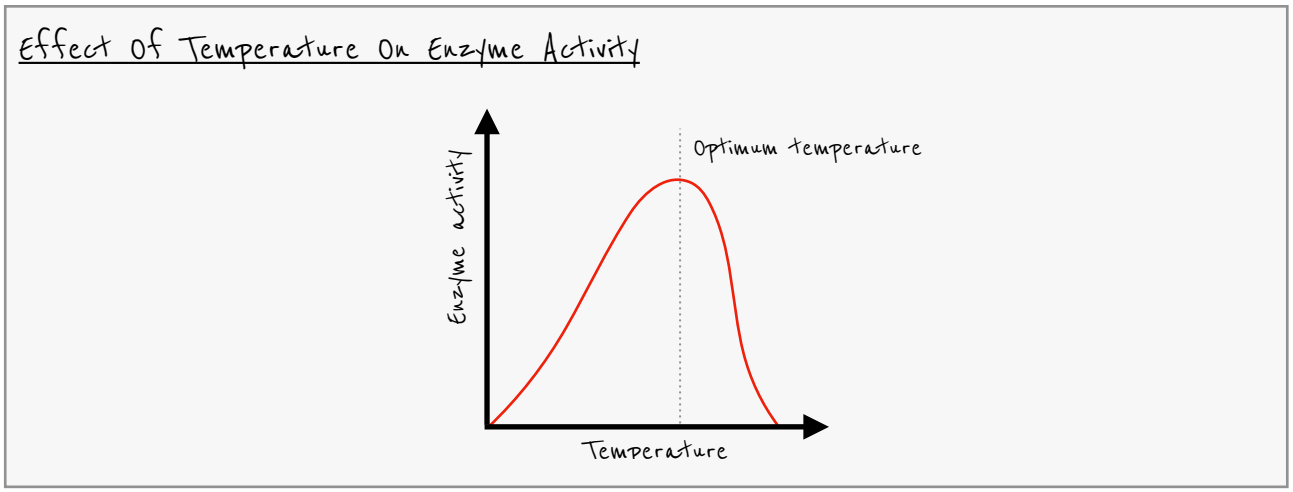
How does increasing temperature affect enzymes?
- *Up to optimum temperature: enzyme activity increases with increasing temperature*
  - *Enzymes and substrate have more kinetic energy*
  - *More likely to bind to active site due to more effective collisions*
- *Over optimum temperature: enzyme activity decreases with increasing temperature*
  - *Over optimum temperature enzyme loses shape - denatured*
  - *Denatured enzyme cannot bind substrate*

Describe and explain the effect of too high temperature on enzyme activity
- *Decreases activity*
- *Enzyme denatures and substrate can no longer fit the active site*

Why does decreasing the temperature below the optimum decrease enzyme activity?
- *Lower kinetic energy*
- *Fewer collisions between enzymes and substrates*



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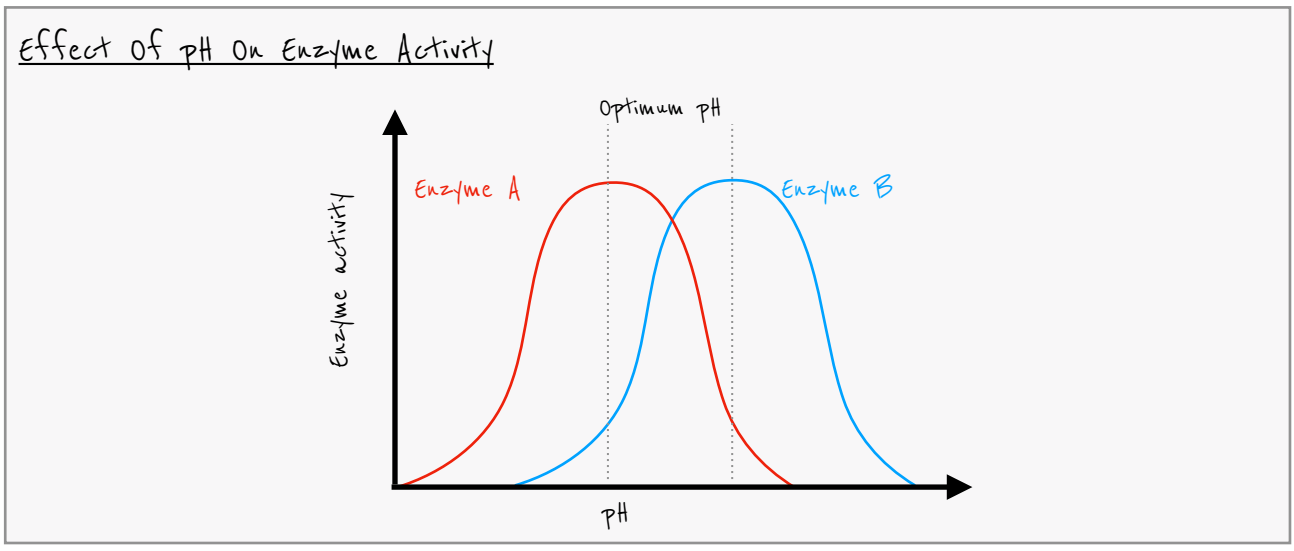
Why is it important that we control our internal temperature?
- *Too high - enzymes denature*
- *Too low - enzymes work too slowly (low kinetic energy)*

Describe and explain how a change in pH affects enzyme activity
- *Activity highest at optimum pH*
- *Above or below optimum, activity decreases*
- *Changes in pH alter 3D shape of enzyme*
- *If 3D shape changes, enzyme is denatured and substrate cannot fit*



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6. PLANT NUTRITION

6.1 Photosynthesis

What is photosynthesis?
- Process plants use to produce carbohydrates
- Uses energy from light

What is the word equation for photosynthesis?
- Carbon dioxide + Water → Glucose + Oxygen
  - Requires light and chlorophyll

What is the symbol equation for photosynthesis?
- $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$

What is chlorophyll?
- Green pigment
- Found in chloroplasts
- Required for photosynthesis

What is the function of chlorophyll?
- Transfers light energy to chemical energy
- Energy produced used for synthesis of carbohydrates

Outline the use and storage of carbohydrates made in photosynthesis
- Starch - used as energy store
  - Insoluble so does not affect osmosis
- Cellulose - forms cell walls
  - Long, strong chains provide strength
- Glucose - used in respiration to release energy
- Sucrose - transport in phloem
- Nectar - attracts insects for pollination

Give the role of nitrate and magnesium ions in plants

Mineral ion	Use	Deficiency symptom
Nitrate	Making amino acids and proteins Making DNA Growth	Stunted growth
Magnesium	Making chlorophyll	Yellow leaves

Describe how to test leaves for starch to show photosynthesis has taken place
- Remove leaf from plant
- Boil beaker of water using Bunsen burner
- Place leaf in boiling water for 20 seconds
- Remove leaf and place into boiling tube of ethanol
- Boil ethanol by placing boiling tube in beaker of very hot water
- Remove leaf when colourless
- Wash in cold water
- Place leaf on white tile and add dilute iodine solution with a pipette
- Any starch present will turn brown iodine solution blue/black

Why is the leaf placed in boiling water?
- To denature enzymes involved in cellular processes

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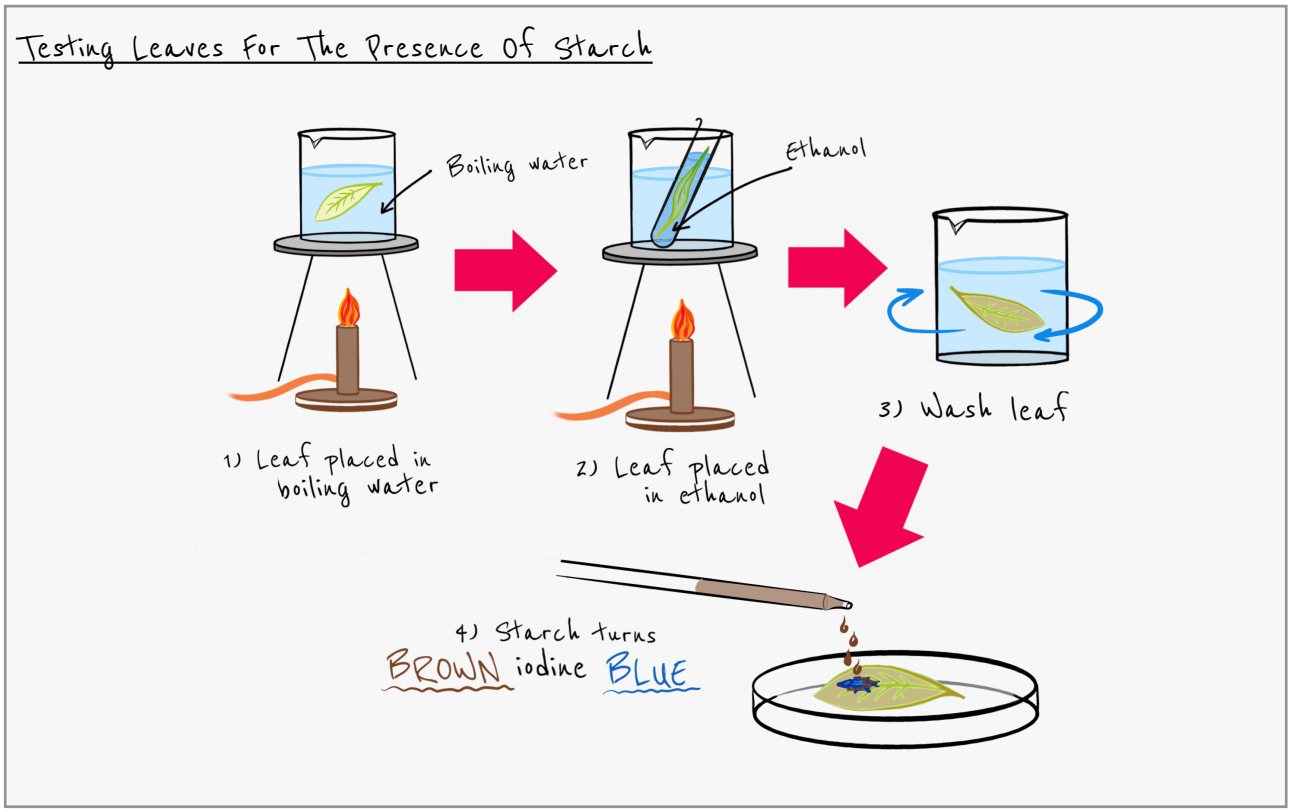
Why is the leaf placed in boiling ethanol before testing for presence of starch?
- To remove green pigment (chlorophyll) in leaf
  - Colour change can be seen when iodine added
- Removes waxy cuticle



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What safety precautions should be taken when boiling in ethanol?
- Use a water bath (do not heat with naked flame)
  - Ethanol is flammable
- Use forceps or tongs
  - Protects skin

Explain why chloroplasts appear green
- Chlorophyll absorbs red / blue light
- Reflects green light

Explain why different colours of light affect the rate of photosynthesis
- Green is reflected (not absorbed)
  - Results in low rate of photosynthesis
- Blue & red is absorbed
  - Results in faster rate of photosynthesis

What is a limiting factor?
- Factor in a reaction which is in shortest supply
- Lack of this factor is the reason why the rate of reaction no longer increases

What are the limiting factors of photosynthesis?
- Carbon dioxide
- Light intensity
- Temperature
- Increasing any of the above will increase the rate of photosynthesis until another factor becomes limiting

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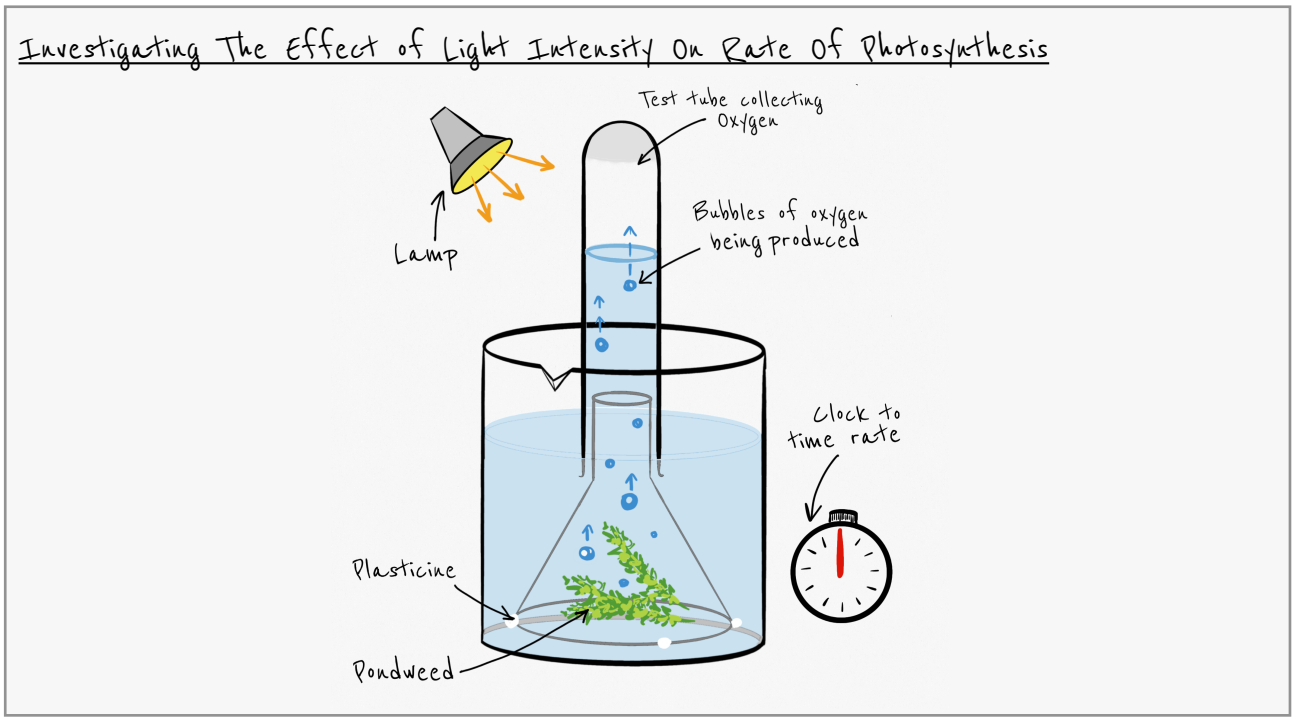
Design an investigation to measure the effect of light intensity on the rate of photosynthesis
- Use *Elodea* or *Camboba* pondweed
- Oxygen bubbles produced by photosynthesis released
- Count number of bubbles produced over one minute to record rate
  - More bubbles produced per minute = faster rate of photosynthesis
- Move a lamp different distances away from beaker to measure effect of light intensity
- Improve accuracy by collecting oxygen released in test tube over longer period of time



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Give the independent variable in this investigation
- Distance of lamp from pondweed

Give the dependent variable in this investigation
- Number of oxygen bubbles released per minute
- OR volume of oxygen collected
- OR carbon dioxide concentration
  - Measured using hydrogen carbonate indicator

What is the role of hydrogen carbonate indicator?
- Shows increase or decrease in carbon dioxide concentration
- Atmospheric carbon dioxide (0.04%) = red/orange
- High levels of carbon dioxide = yellow
- Low levels of carbon dioxide = purple

What colour would hydrogen carbonate indicator turn with high light intensity?
- Purple
  - Rate of photosynthesis is high
  - Faster than rate of respiration
  - CO_2 levels decrease

What colour would hydrogen carbonate indicator turn with low light intensity?
- Yellow
  - Rate of photosynthesis is low
  - Respiration occurring faster than photosynthesis
  - CO_2 levels increase

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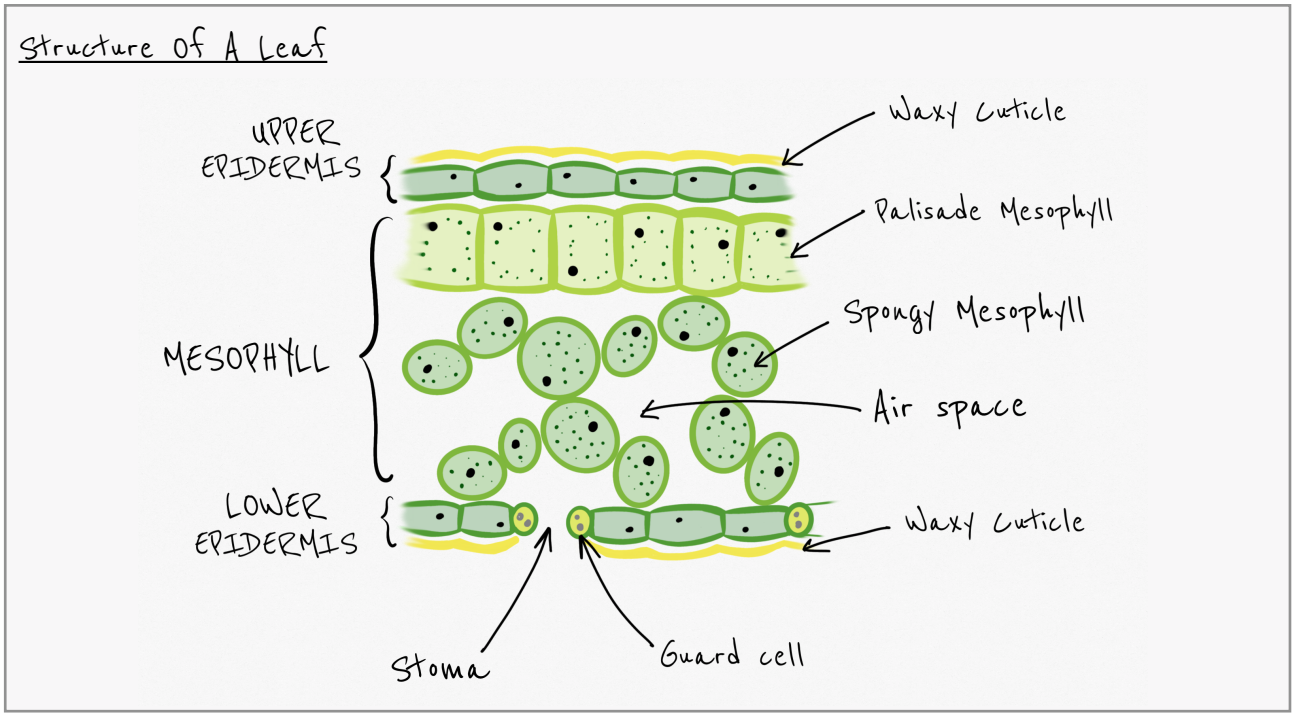
List some control variables in this investigation
- Species of pondweed used
- Number of leaves on pondweed
- Temperature of water
- Power of lamp
- Concentration of CO_2 in water
  - Controlled by dissolving sodium hydrogencarbonate

Why is the rate of photosynthesis low in the morning?
- *Temperature is the limiting factor*
- *Low temperatures inhibit enzyme activity*
- *Carbon dioxide levels are high*

Why is the rate of photosynthesis high at midday?
- *High temperature maximises enzyme activity*
- *Carbon dioxide is the limiting factor as it's in the shortest supply*

6.2 Leaf structure



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How is the leaf adapted for its role?
- Waxy cuticle - prevents evaporation of water and stops pathogen entry
- Upper epidermis - transparent to allow light to enter the leaf
- Palisade mesophyll - contains **lots** of chloroplasts for photosynthesis
- Air spaces in spongy mesophyll - allow gases to **diffuse**
- Xylem - allows entry of water and mineral ions by transpiration stream
- Guard cells - control opening and closure of stomata
- Stomata - allow carbon dioxide to enter, oxygen and water to leave
- Thin and broad (large surface area) - allow more light to hit surface and reach palisade mesophyll cells containing chloroplasts

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7. HUMAN NUTRITION

7.1 Diet

What is a balanced diet?
- Provides all the nutrients in correct amounts needed to carry out life processes

State the principal dietary sources and describe their importance

Nutrient	Dietary importance	Principal source	Deficiency disease
Carbohydrates	Energy store	Rice, potatoes, wheat, cereals	
Fats & oils	Insulation and concentrated energy store	Meat, eggs, milk, cheese	
Protein	Growth and repair of muscles, enzymes, hormones, antibodies	Meat, fish, eggs, legumes, mycoprotein	Kwashiorkor
Vitamin C	Sticks together cells lining the mouth	Citrus fruits, leafy greens	Scurvy - bleeding gums
Vitamin D	Strong bones and teeth	Liver, dairy products, eggs	Rickets
Calcium	Strong teeth and bones	Milk, cheese and fish	Weak bones, poor clotting, spasms, rickets
Iron	To make haemoglobin in red blood cells Required for transport of oxygen	Red meat, liver, leafy greens	Anaemia
Fibre (roughage)	Prevents constipation, encourages peristalsis		Constipation
Water	70% of body. Tissue fluid, cytoplasm, blood		Dehydration

7.2 Digestive system

Define ingestion
- When food/drink enters the body

Define digestion
- The breakdown of large, insoluble food molecules into smaller, soluble molecules

Define absorption
- Movement of nutrients from intestine into blood

Define assimilation
- Uptake and use of nutrients by cells

Define egestion
- Removal of faeces from the anus

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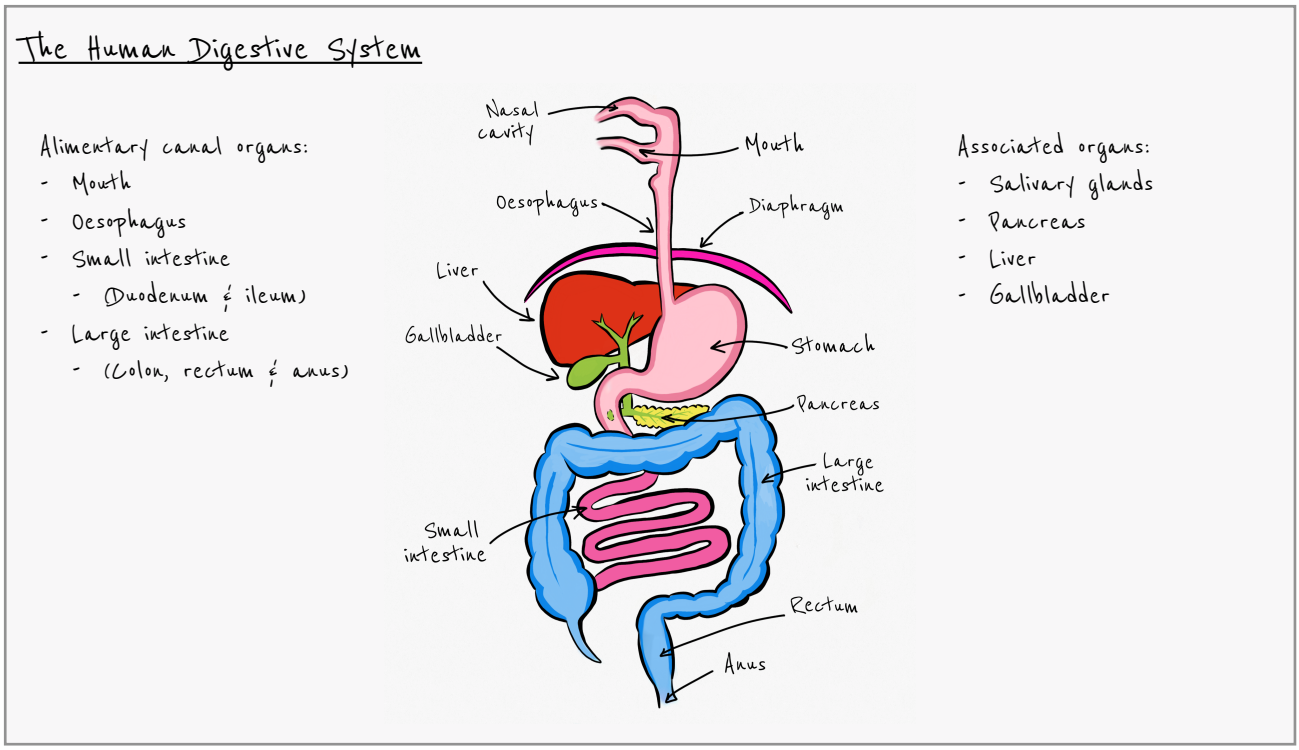
Define excretion

- Removal of waste products of metabolism
  - e.g. sweat (skin), carbon dioxide (lungs)



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Outline the functions of the organs in the digestive system

Organ	Function
Mouth	Food converted to bolus by teeth during mastication (chewing)
Salivary Glands	Produce saliva, transport to mouth by salivary ducts
Oesophagus	Food moves to stomach by peristalsis (contraction of circular muscles)
Stomach	Food mixes with hydrochloric acid - forms chyme
Small Intestine (Duodenum & ileum)	Covered in villi to increase absorption of digested food
Duodenum	Semi liquid food mixes with pancreatic juice
Ileum	Digested food absorbed into blood
Liver	Produces bile - neutralizes acid and emulsifies fat in the small intestine
Pancreas	Produces pancreatic juice, transported into small intestine by pancreatic duct
Gall Bladder	Stores bile - transported into duodenum by bile duct
Large Intestine (Colon)	Reabsorbs water
Rectum	Stores faeces
Anus	Exit for faeces (egestion)

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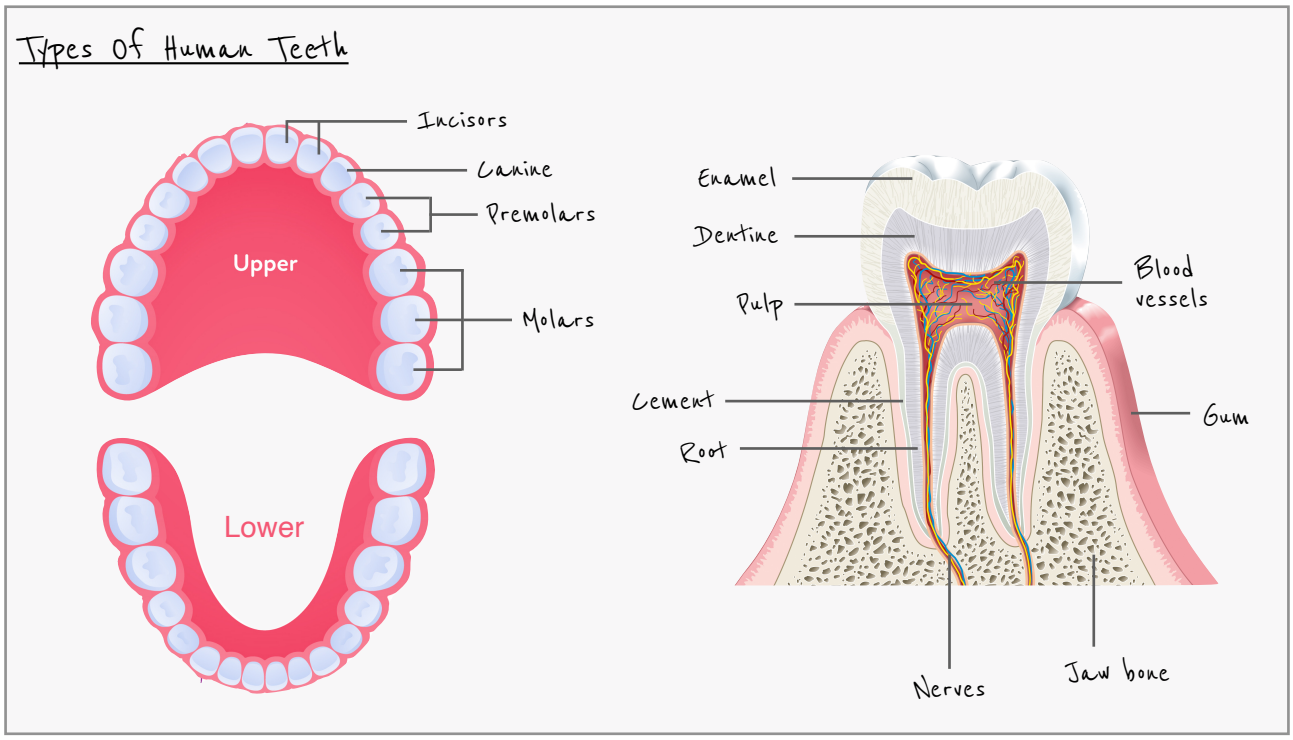
7.3 Physical digestion

Define physical digestion
- Breakdown of food to smaller pieces without chemical change
  - e.g. chewing, stomach muscles churning food

What is the role of physical digestion?
- Increases surface area of food
- Increases rate of enzyme action in chemical digestion



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Outline the structure and function of human teeth

Structure	Function
Root	Embedded in the gum to anchor the tooth in the mouth
Enamel	Hardest substances made by animals Covers tooth and provides tough surface for biting and chewing
Dentine	Bone-like structure under the enamel Contains cytoplasm running from pulp cavity filled with blood vessels and nerves
Pulp	Hollow middle of the tooth Contains nerves and blood vessels
Cement	Covers root of the tooth
Nerves	Allow teeth to sense pressure and pain
Blood vessels	Supply tooth with nutrients and oxygen

What is the function of the different types of teeth?
- Incisors - cut/bite
- Canines - hold/cut
- Premolars - crush and chew
- Molars - grind and chew

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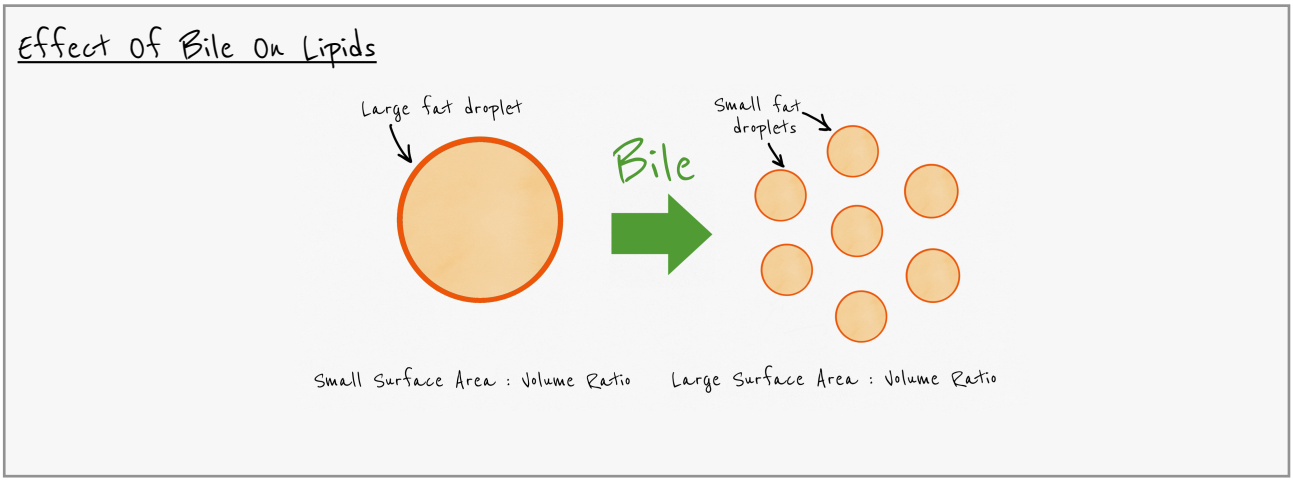
Describe the role of the stomach in physical digestion
- Muscular walls of stomach churn food
  - Food broken down further
  - Increases surface area for enzymes to act on

How does bile help physical digestion?
- *Emulsifies fats to increase surface area for chemical digestion*

Where is bile made, stored, and released into?
- *Made - liver*
- *Stored - gall bladder*
- *Released into - small intestine*



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7.4 Chemical digestion

Define chemical digestion
- Breakdown of large insoluble molecules to small soluble molecules
- By enzymes
  - e.g. amylase in saliva breaks down starch into simple sugars

What is the role of chemical digestion?
- Producing soluble small molecules that can be absorbed and assimilated

What is role of amylase?
- Breaks down starch into simpler sugars *(maltose)*

Where is amylase made?
- Salivary glands, pancreas

Where does amylase act?
- Mouth, small intestine

Why is starch not broken down in the stomach?
- Stomach is acidic (low pH)
- Amylase is denatured

Describe the action of maltase
- *Breaks down maltose into glucose*
- *Occurs on the membranes of small intestine epithelium*

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What is the role of proteases?
- Break down proteins into amino acids

Where are proteases secreted?
- Stomach
- Small intestine

Name two types of proteases
- *Pepsin*
- *Trypsin*

Where does pepsin act?
- *Stomach*
  - *Optimum pH is low (stomach is acidic)*

Where does trypsin act?
- *Small intestine*
  - *Optimum pH is neutral*

What is the role of lipase?
- Breaks down fats into fatty acids and glycerol

Where is lipase made?
- Pancreas
- Secreted with bile

Where does lipase act?
- Small intestine

Describe the functions of hydrochloric acid in the stomach
- Kills bacteria on food
  - Low pH denatures enzymes in harmful microorganisms
- Provides acidic pH for enzymes
  - Optimum pH for pepsin activity

How does bile provide a suitable pH for enzyme action in the small intestine?
- *Bile is an alkaline mixture*
- *Neutralises acidic food and gastric juices from stomach*
- *Provides suitable neutral pH for enzymes in small intestine*

7.5 Absorption

Where are nutrients absorbed?
- Small intestine

What is the purpose of villi and microvilli?
- *Absorb digested nutrients into blood*
- *Increase surface area for absorption*
  - *Increases rate at which nutrients can be absorbed*

Describe the structure of a villus
- *Contains a lacteal*
- *Surrounded by capillaries*
- *Thin epithelium*
- *Microvillii*

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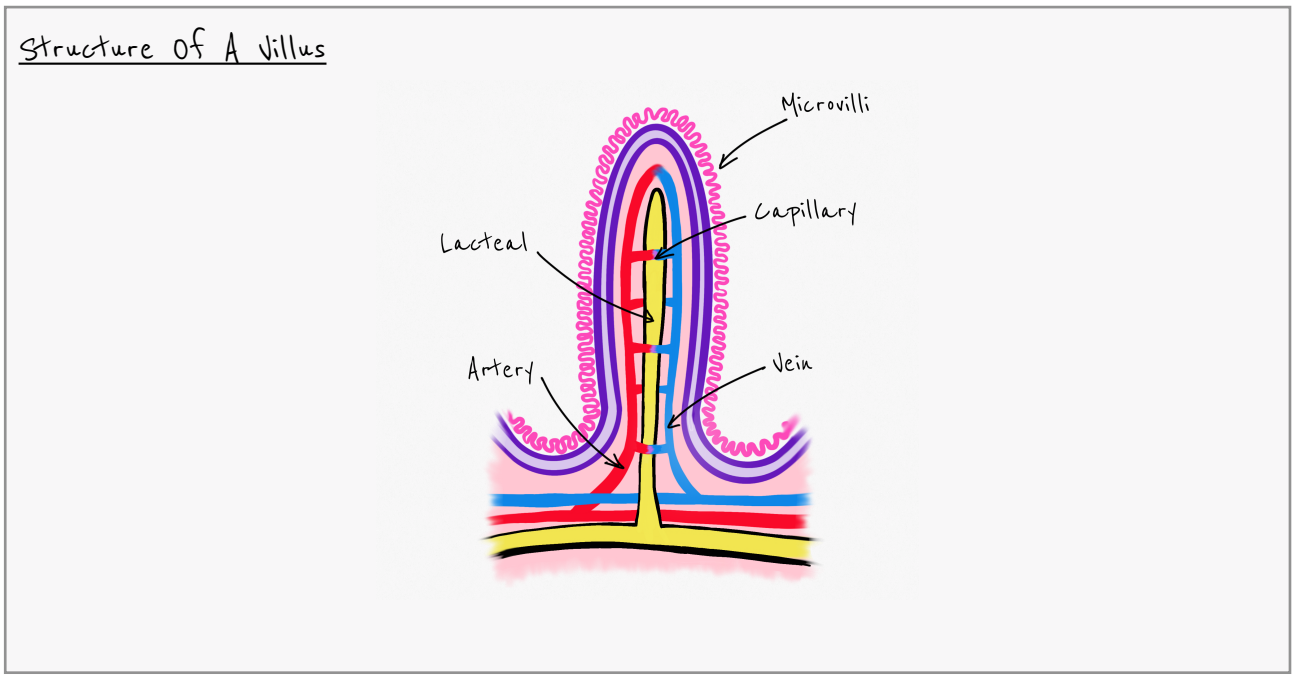

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How is the small intestine adapted for its function?

- *Large surface area provided by villi and microvilli*
- *Lots of capillaries - blood transports nutrients and maintains concentration gradient*
- *Thin wall - short diffusion distance*
- *Lacteals - absorbtion of fatty acids*

Where is water absorbed?

- Most from small intestine
- Some from colon (large intestine)

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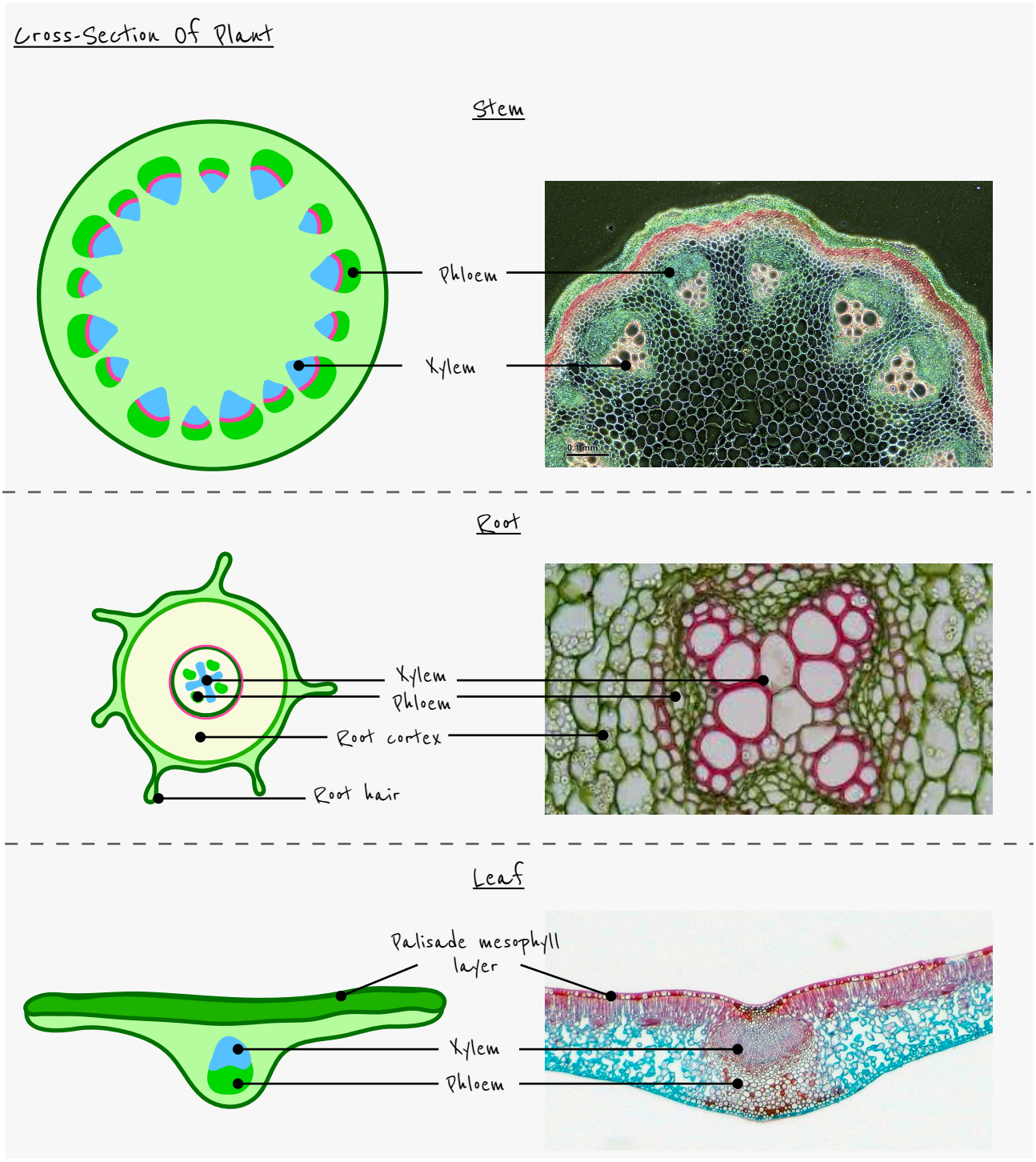
8. TRANSPORT IN PLANTS

8.1 Xylem and phloem

Describe the function of the xylem
- Transports water and mineral ions **up** the plant
  - From roots to leaves
- Turgor (water) pressure supports plant

Describe the function of the phloem
- Transports sugar (sucrose) and amino acids
  - From the leaves **up and down** rest of plant



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Describe the structure of the xylem
- *Thick walls of lignin*
  - *Strengthens and supports plant*
- *Made from dead cells*
  - *No cell contents (e.g. cytoplasm) → more space for water to be transported*
- *Continuous column*
  - *No cross walls → easier to transport water up long continuous tube*

8.2 Water uptake

How is a root hair cell adapted for its function?
- Large surface area
  - Increases rate of water absorption by osmosis
  - Increases mineral ion uptake by active transport

How do mineral ions enter the plant?
- Active transport
- From an area of low concentration (soil) to an area of high concentration (in the root hair)
- Requires energy

How is water absorbed by root hair cells?
- Osmosis
- From an area of high water potential (the soil)
- To an area of low water potential (root hair cell)
- Through cell walls across a partially permeable membrane

Describe the pathway of water in a plant
- Root hair cell → Root cortex cells → Xylem → Mesophyll cells (leaf)

How could you investigate the path of water through a plant?
- Cut a piece of celery
- Put in water
- Add stain (methylene blue or eosin)
- Wait a few hours and cut surface - dye appears in xylem

8.3 Transpiration

Define transpiration
- Loss of water vapour from leaves

Outline the process of transpiration
- Water evaporates from surface of mesophyll cells
  - *Interconnecting air spaces between mesophyll cells creates a large surface area for evaporation*
- Water vapour enters air spaces
- Water vapour diffuses out of leaf through stomata
  - Down concentration gradient
  - *Diffusion occurs rapidly when stomata are open*
  - *Many stomata = greater rate of diffusion of water vapour*

Explain the mechanism by which water moves upwards in the xylem
- *Loss of water vapour causes transpiration pull*
- *Column of water drawn up xylem*
- *Water molecules held together by cohesive forces of attraction (hydrogen bonds)*

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What is the transpiration stream?
- *Continuous column of water*
- *Moving up xylem from roots to leaves*

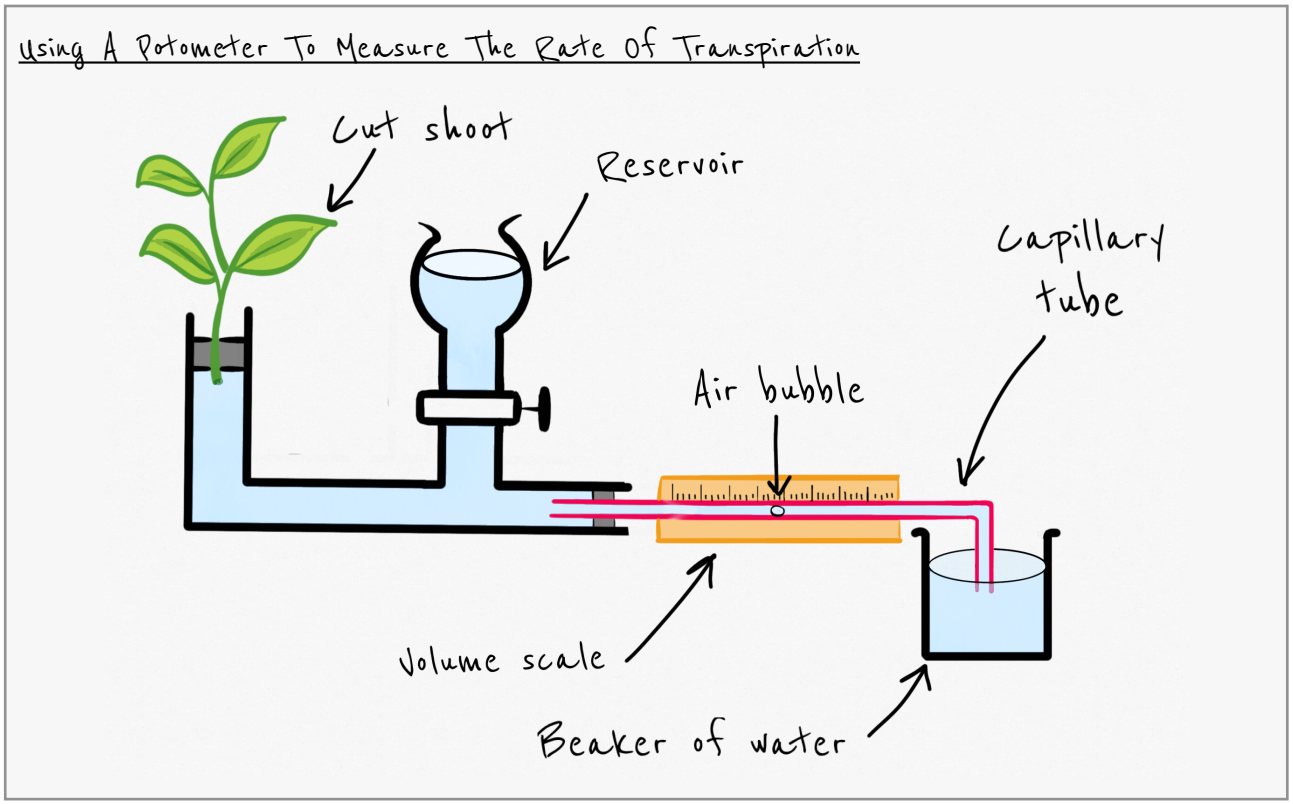
Describe the transport of water in a plant
- *Enters root hair cell by osmosis*
- *Water molecules are attracted to each other*
- *Transpiration stream in xylem*
- *Evaporation from mesophyll cells*
- *Diffusion of water vapour out of the stomata*

What is the role of the transpiration stream?
- *Transports mineral ions*
- *Keeps plant cells turgid*
- *Cools the plant*
- *Supplies water for the leaves for photosynthesis*

Describe and explain how rates of transpiration may be increased
- *Hot - water evaporates faster*
- *Dry - increases the concentration gradient between the leaf and the surrounding air*
- *Windy - water vapour is blown off the leaf increasing concentration gradient*

Describe and explain how rates of transpiration may be decreased
- *Cold - water evaporates slower*
- *Humid - small concentration gradient between the leaf and the surrounding air*
- *Still air - water vapour is not removed from the surface of the leaf*

What instrument is used to measure water uptake by a plant?
- Potometer



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Describe how to use a potometer to measure the rate of water uptake at different light intensities
- Cut plant shoot underwater
- Set up the apparatus and make sure it is airtight
- Dry leaves of shoot
- Allow single air bubble to form in capillary tube
- Place lamp 10cm from leaf
- Allow plant to adapt to conditions for 5 minutes
- Record starting location of air bubble
- Leave for 30 minutes
- Record the end location of the air bubble
- Change the light intensity
- Calculate rate of transpiration
- Repeat with lamp at different distances

How is the rate of transpiration calculated?
- Divide distance travelled by bubble by the time period
  - The further the bubble travels, the greater the rate of transpiration

Why is the plant cut underwater?
- To prevent air entering xylem

Why is it necessary to dry the leaves of the shoot?
- Wet leaves will reduce rate of transpiration

Why does the plant need to be left for 5 minutes before recording location of bubble?
- Allows plant to equilibrate to new conditions
- Change in transpiration rate is not instantaneous

What is the independent variable in this investigation?
- Distance of light from plant
  - i.e light intensity

What is the dependent variable in this investigation?
- Distance moved by bubble along capillary tube

Give control variables for this investigation
- Temperature
- Air flow around plant
- Supply of water to plant

Why is the rate of water uptake not a full representation of rate of transpiration?
- Water used in photosynthesis
- Water produced by respiration
- Water used for cooling
- Water used for support of plant stem

Define wilting
- *When cells become flaccid*
- *Due to more water evaporating from leaves than is absorbed by roots*
- *Turgor pressure cannot support plant*
- *Plant starts to collapse*

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8.4 Translocation

Define 'source'
- *Part of plants that release sucrose or amino acids*

Define 'sink'
- *Part of plants that use or store sucrose or amino acids*

Describe translocation
- *Movement of sucrose and amino acids*
- *In the phloem*
- *From source (where produced) to regions of storage OR where used in respiration (sink)*

Explain why some parts of a plant may act as a source and a sink at different times
- *Spring*
  - *Growth period for most plants*
  - *Roots and storage organs act as source*
    - *Starch converted into glucose*
  - *Growing areas act as sinks*
    - *Sucrose and amino acid needed for growth*
- *Summer*
  - *Most plants finished growing*
  - *Leaves act as source*
    - *Produce large quantities of sugars through photosynthesis*
  - *Roots/tubers act as sink*
    - *Store sucrose as starch until it is needed*
- *Winter*
  - *Many plants have no leaves*
  - *Storage organs act as source*
  - *Sucrose and amino acids transported from the storage organs (e.g. tubers, roots)*
  - *To other parts of the plant for respiration*

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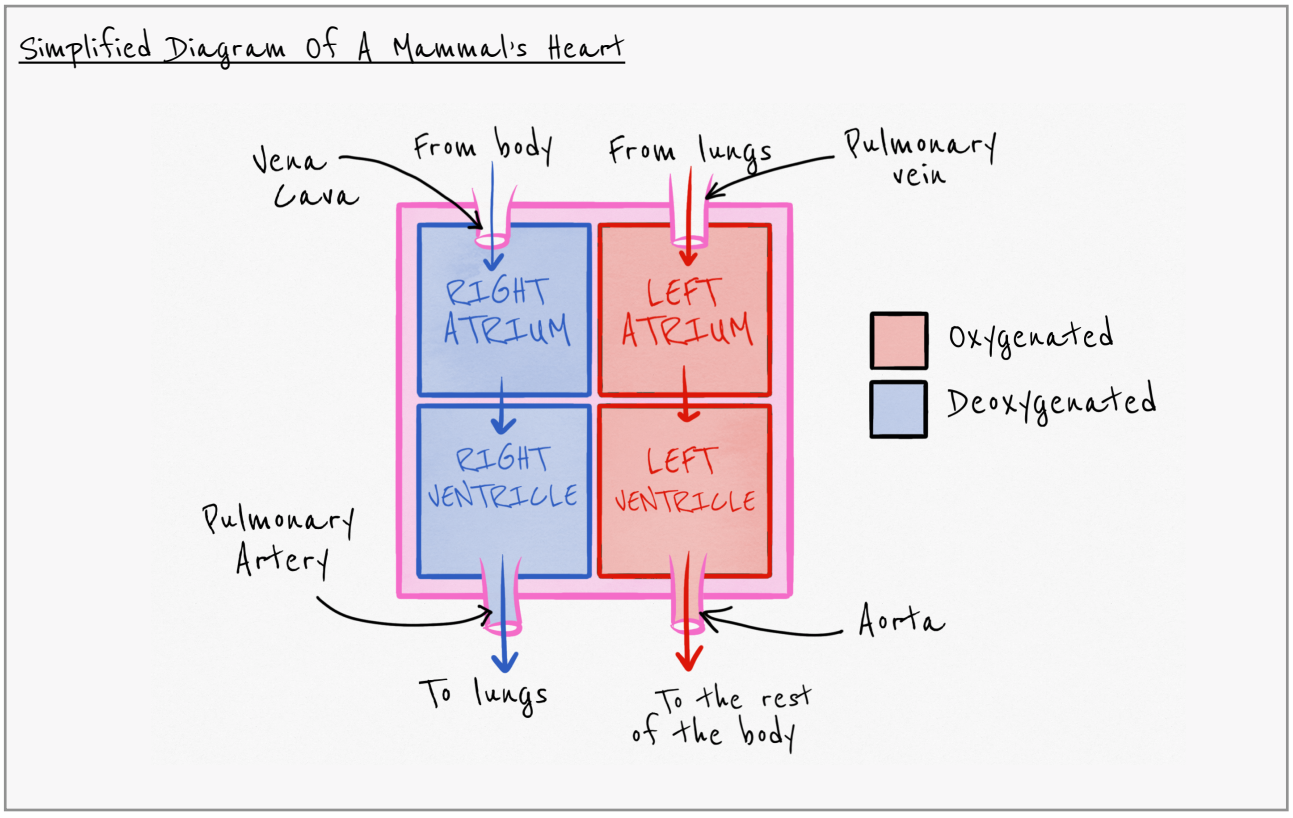
9. TRANSPORT IN ANIMALS

9.1 Circulatory systems

Define 'circulatory system'
- System of blood vessels
- With a pump and valves
- Ensuring one-way flow of blood

Describe single circulation
- *Blood flows through heart once for each circuit of the body*
  - *e.g. in fish*
- *Blood pressure lower than mammals*
  - *Too low for kidney function*

Describe double circulation
- *Blood flows through heart twice for each circuit of the body*
  - *Pulmonary circulation (heart - lungs - heart)*
  - *Systemic circulation (heart - body - heart)*
  - *e.g. in mammals*



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What are the advantages of a double circulation?
- *Blood passes through heart twice per circuit*
  - *Blood loses pressure through capillaries surrounding lungs*
  - *Blood slows down*
- *Pressure increased again passing through heart a second time*
  - *Cells provided with oxygen and glucose faster*

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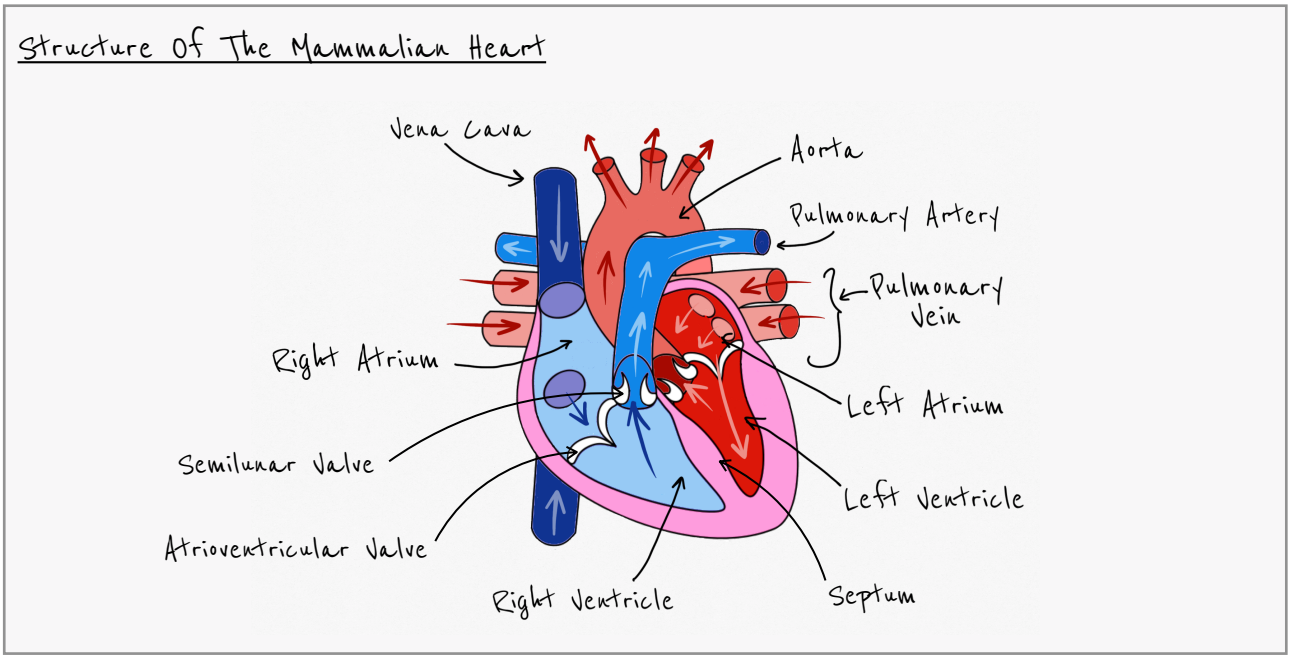
9.2 Heart



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Describe the movement of the blood around the body starting at the right atrium
- Deoxygenated blood enters the right atrium via the vena cava
- Right atrium contracts forcing blood through tricuspid (atrioventricular) valve into right ventricle
- Blood enters the right ventricle and leaves via the pulmonary artery
- Blood flows to the lungs
- Blood become oxygenated
- Blood returns to the heart and enters the left atrium via the pulmonary vein
- Left atrium contracts forcing blood through bicuspid (atrioventricular) valve into the left ventricle
- Left ventricles contracts forcing blood into the aorta
- Oxygenated blood flows around the body and oxygen is used in respiration

Give the role of arteries
- Carry blood away from the heart

Give the role of veins
- Return blood to the heart

Why is the wall of the ventricles thicker than that of the atria?
- *The ventricles have to pump the blood further*

Why is the wall of the left ventricle thicker than that of the right ventricle?
- *Blood from the right ventricle is only pumped to the lungs*
- *Blood from the left ventricle is pumped much further - around the whole body*
  - *Therefore requires more pressure*

What is the function of the septum?
- *Separates oxygenated and deoxygenated blood in the heart*

Explain the consequences of a hole in the septum between the left and right ventricles
- *Blood can flow between right and left ventricles*
- *Both sides of heart will contain mixture of oxygenated and deoxygenated blood*
- *Blood pushed around body only partially oxygenated*
- *Not enough oxygen will reach tissues for respiration*

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What is the role of the atrioventricular valves?
- *Prevent blood flowing back into atria from ventricles*

What is the role of the semilunar valves?
- *Prevent blood flowing back into ventricles from aorta/pulmonary artery*

How can heart activity be monitored?
- By an ECG (electrocardiogram)
- Measuring pulse rate
- Listening to valves closing with stethoscope

Credit: Wikimedia Commons

Describe and explain the effect of physical activity on heart rate
- Heart rate increases
- *Muscles contract more during exercise*
- *Require more energy*
- *Increased rate of respiration*
- *Cardiac output increases to provide more oxygen and glucose to respiring tissues*

What is an oxygen debt?
- Volume of oxygen needed to completely breakdown lactic acid
  - Lactic acid produced by anaerobic respiration

Why does heart rate not return to normal immediately after exercise?
- Anaerobic respiration can occur when insufficient oxygen delivered to muscles
  - e.g. when sprinting
- Glucose → lactic acid (+ little energy) during anaerobic respiration
- Oxygen debt builds up
- Heart rate remains high and breathing remains faster and deeper
  - Ensures all lactic acid is broken down and removed

How would you investigate effect of exercise on pulse rate?
- Take pulse at rest
- Perform exercise for a set time
- Take pulse rate again
- Allow pulse rate to return to normal
- Repeat and take average

What is the coronary artery?
- Blood vessel that supplies the heart with oxygen

Explain how coronary heart disease can cause death
- A lot of cholesterol can block coronary arteries
- Less oxygenated blood to heart muscle cells
- Less aerobic respiration, more anaerobic respiration
- Lactic acid build up causes heart attack
  - Increased lactic acid → decrease in pH → enzymes denature

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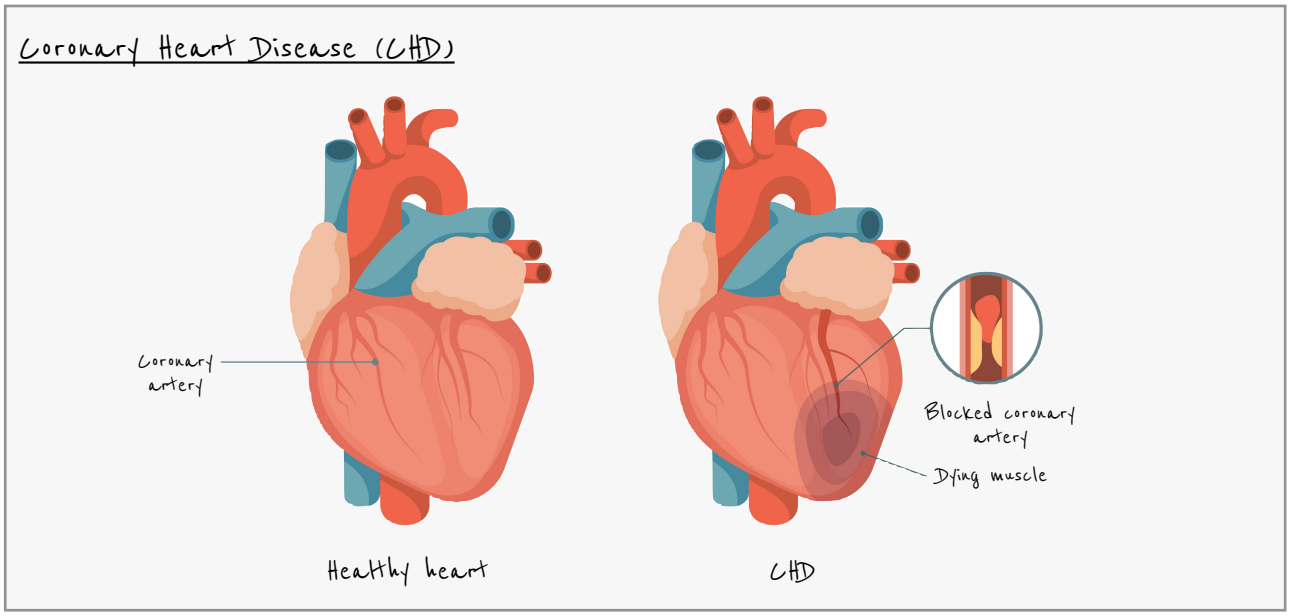

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What are the risk factors of coronary heart disease?
- Genetic predisposition
- High blood pressure
- Diet - high levels of saturated fat and cholesterol
- Smoking
- Stress
- Lack of exercise
- Age
- Sex

How can diet and exercise help prevent coronary heart disease?
- Poor diet and lifestyle are risk factors
- Diet with low levels of cholesterol and low in saturated fatty acids prevents blockage of coronary arteries
- Exercise strengthens heart muscle and reduces stress

9.3 Blood vessels

Describe the structure of arteries, veins and capillaries

Vessel	Description	*How is it adapted for its function?*
Arteries	- Thick muscle and elastic fibre wall - Narrow lumen - Carries blood away from heart at high pressure	- *Thick walls withstand high pressure* - *Elastic walls expand and relax to smooth blood flow*
Veins	- Thin muscle and elastic fibre wall - Wide lumen - Valves - Returns blood to heart at low pressure	- *Blood flowing at low pressure* - *Valves prevent back flow of blood* - *Wide lumen creates low resistance for blood to flow*
Capillaries	- Walls one cell thick - Narrow lumen - Branched structures	- *Short diffusion distance* - *Large surface area maximises exchange of substances*

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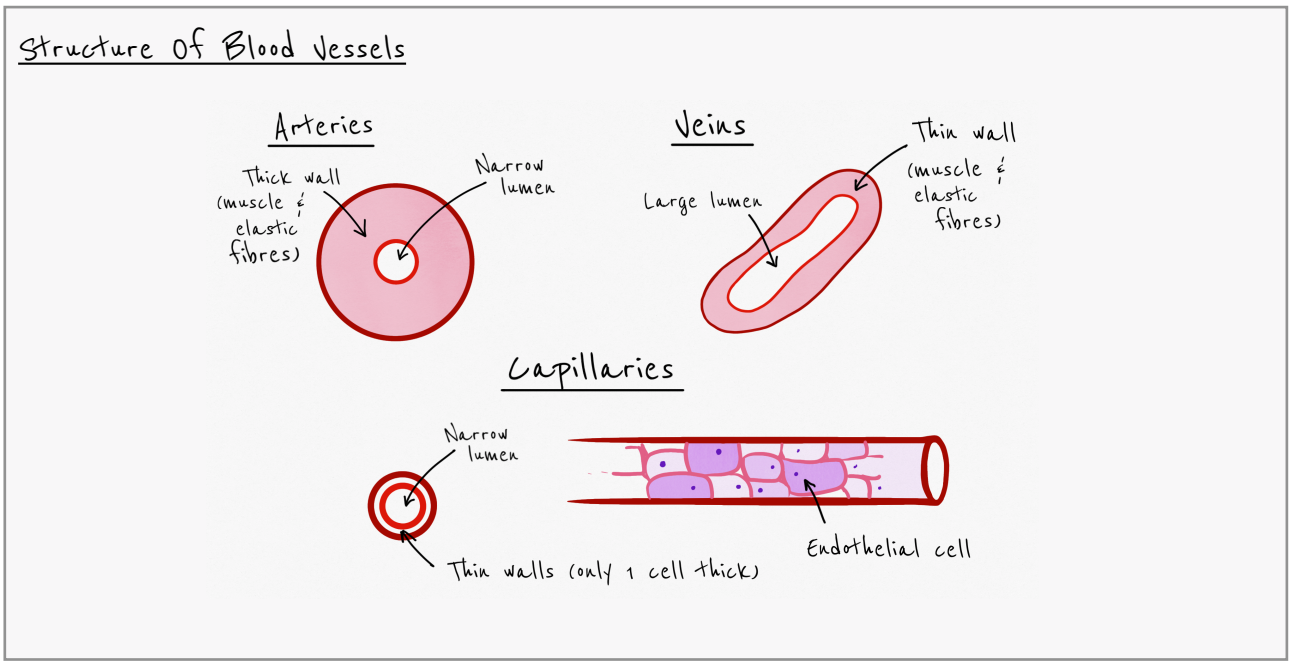

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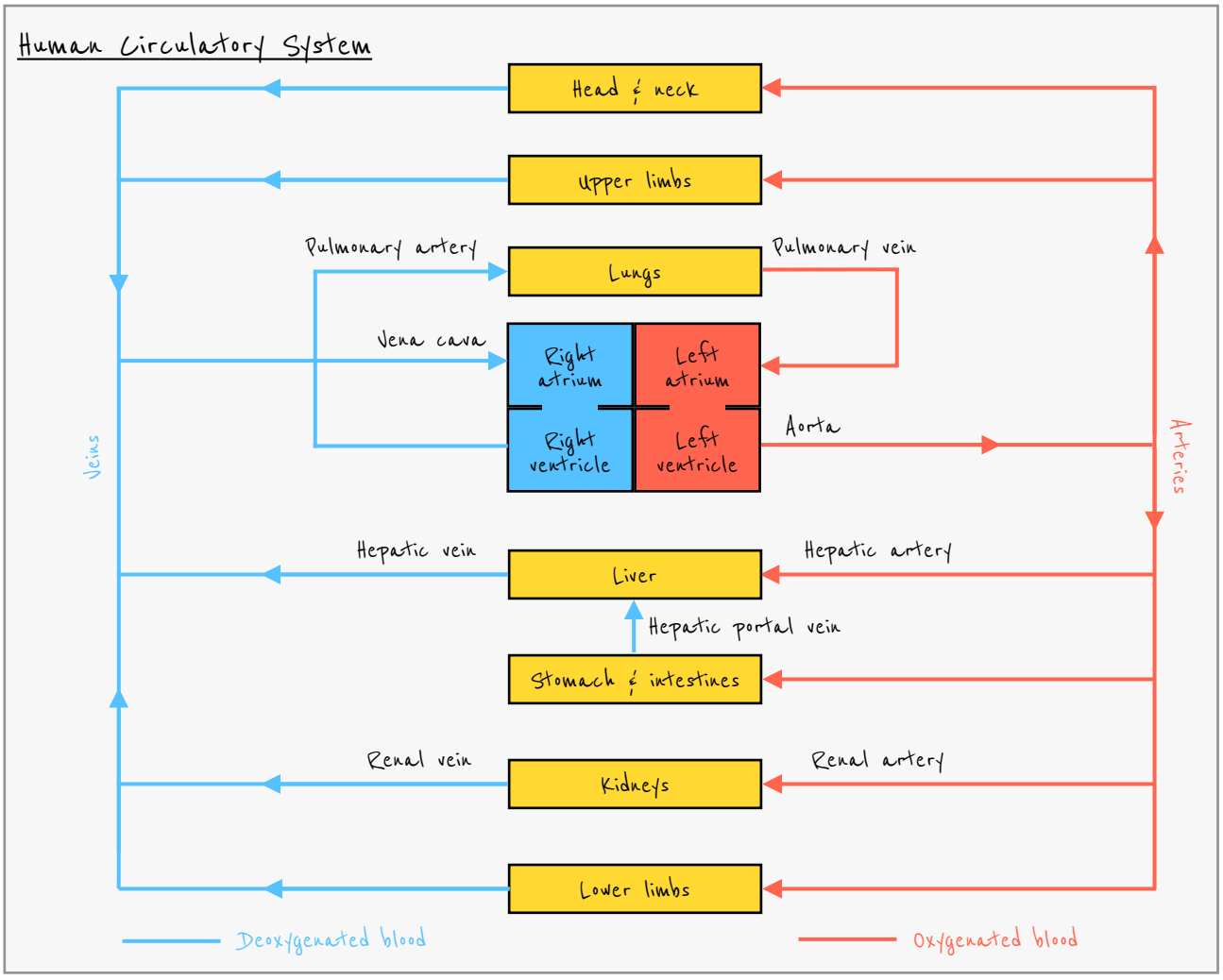

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Name the main blood vessels going to and from the heart

- Vena cava (deoxygenated blood from body to heart)
- Pulmonary artery (deoxygenated blood from heart to lungs)
- Pulmonary vein (oxygenated blood from lungs to heart)
- Aorta (oxygenated blood from heart to body)

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Name the blood vessel that takes oxygenated blood to the kidney
- Renal artery

Name the blood vessel that takes deoxygenated blood from the kidney
- Renal vein

Name the blood vessel that takes oxygenated blood to the liver
- *Hepatic artery*

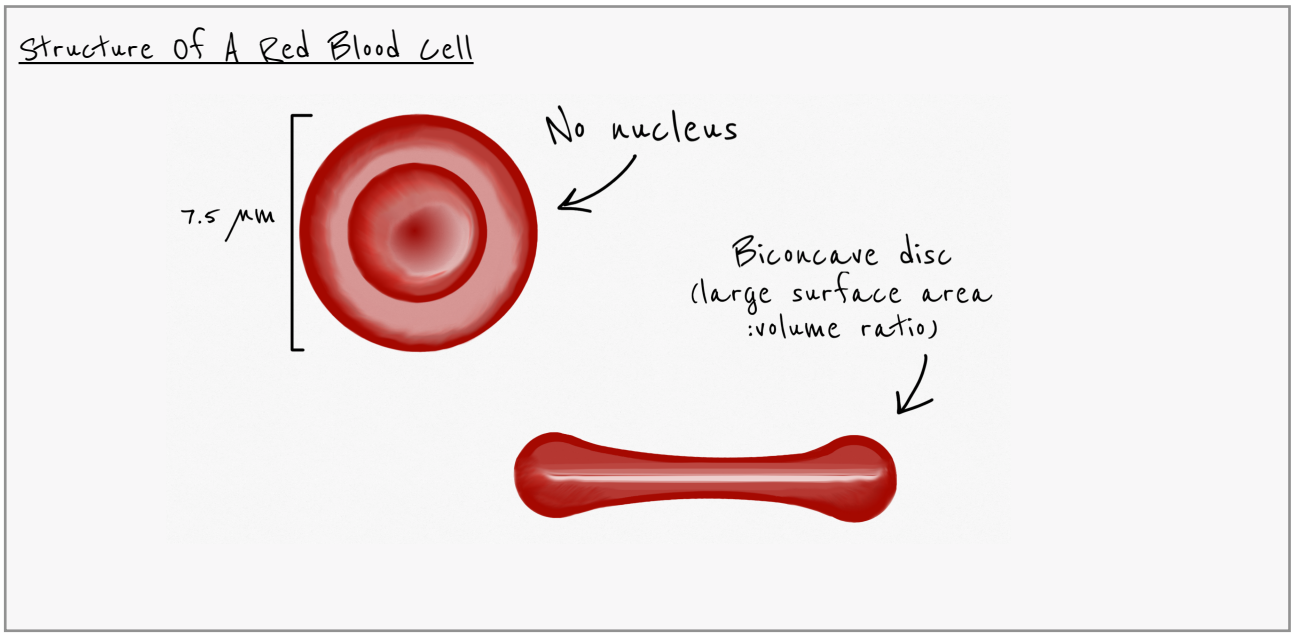
Name the blood vessel that takes deoxygenated blood from the liver
- *Hepatic vein*

Name the blood vessel that takes blood full of digested products to the liver
- *Hepatic portal vein*

9.4 Blood

List the components of the blood and their functions

Blood component	Function
Red blood cells	Transport oxygen bound to haemoglobin
White blood cells	Phagocytosis and antibody production
Platelets	Blood clotting at site of wound
Plasma	Transports all blood cells, ions, nutrients, urea, hormones and carbon dioxide



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How are red blood cells adapted for their function?
- Biconcave disc shape - large surface area for transport of oxygen
- Haemoglobin binds to oxygen forming oxyhaemoglobin
- No nucleus - more space for haemoglobin

How do white blood cells attack invading pathogens?
- *Phagocytes engulf pathogens by phagocytosis*
- *Lymphocytes recognise antigens and produce antibodies which destroy pathogens*

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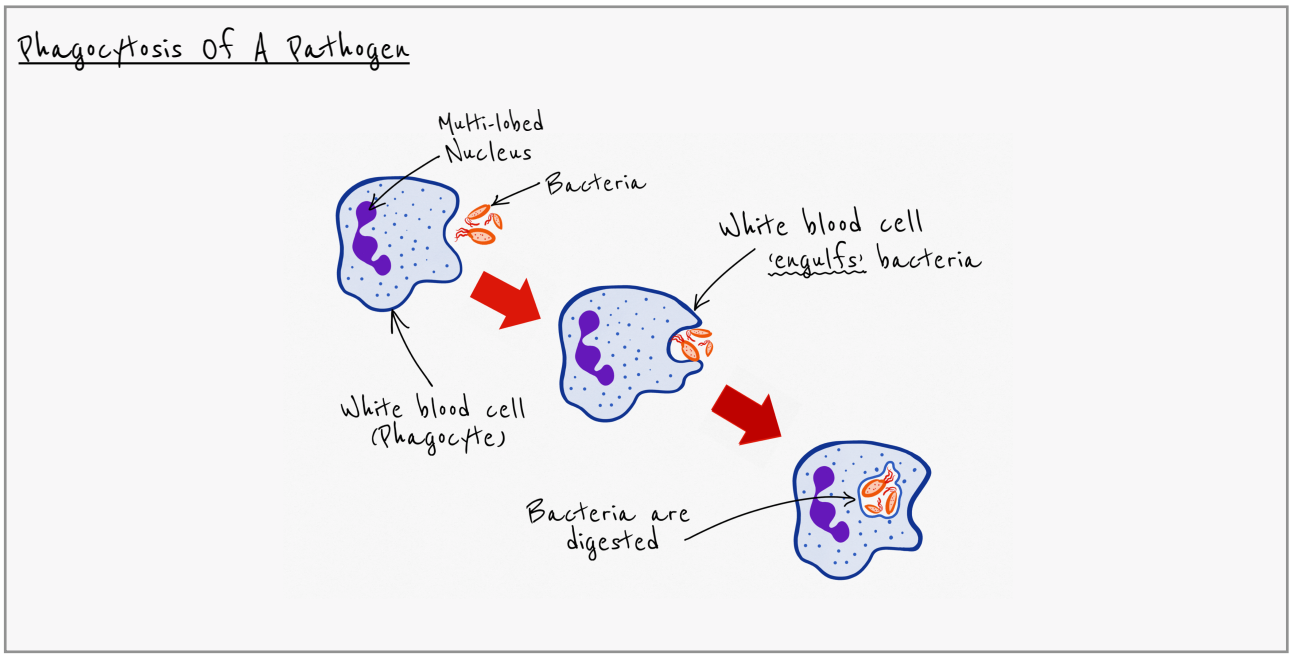
Describe the structure and function of a lymphocyte
- *Little cytoplasm*
- *Large nucleus*
- *Recognise antigens (or vaccines)*
  - *Produces antibodies*
  - *Memory cells also produced*

Describe the structure and function of a phagocyte
- *Lobed (irregular-shaped) nucleus*
- *Engulfs and breaks down pathogens (phagocytosis)*



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What is the role of platelets?
- Clots blood at site of wound
  - Reduces blood loss
  - Prevents entry of pathogens

Describe the process of clotting
- *Platelets collect at site of wound*
- *Soluble fibrinogen converted to insoluble fibrin*
- *Forms a mesh at site of wound*

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10. DISEASES AND IMMUNITY

10.1 Diseases and immunity

Define 'pathogen'
- Disease-causing microorganism

Define 'transmissible disease'
- Disease in which the pathogen can be passed from one host to another

How can pathogens be transmitted?
- Direct contact
  - e.g. blood or body fluids
- Indirectly
  - e.g. contaminated surfaces, food, in the air, animals

Explain the importance of the following actions in controlling the spread of disease

Method to reduce disease	Importance
Clean water supply	Contaminated water can contain pathogens or toxins, e.g. cholera
Hygienic food preparation	Contaminated food can contain pathogens or toxins that cause food poisoning (e.g. *Salmonella*)
Good personal hygiene	Reduce chances of contracting or transmitting disease
Waste disposal	Waste and rubbish is source of infection
Sewage treatment	Reduce risk from contaminated human waste

Describe the body's defences to pathogens
- Skin acts as a barrier
- Hairs in nose trap pathogens and prevent entry
- Mucus traps pathogens in trachea
  - Produced by goblet cells
  - Ciliated epithelial cells move mucus to mouth
- Hydrochloric acid (HCl) in stomach destroys pathogens
- Phagocytes engulf pathogens by phagocytosis
- Lymphocytes produce antibodies

Define 'antigen'
- *Proteins (or other molecules)*
- *Found on surfaces of cells and other pathogens*
- *Recognised by immune system as being 'non-self'*
- *Each pathogen has own antigens with specific shapes*

Define 'antibody'
- *Proteins that bind to antigens*
  - *Specific antibodies have complementary shapes to specific antigens*
- *Causes direct destruction of pathogens*
  - *Or marks pathogens for destruction by phagocytes*
  - *Transported around body in blood*

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Define 'active immunity'
- *Defence against a pathogen*
- *By producing antibodies specific to an antigen*
- *Gained after infection or vaccination*

How do lymphocytes destroy pathogens?
- *Recognise antigens*
- *Make antibodies which destroy pathogens by:*
  - *Causing bacteria to stick together*
  - *Label pathogen so it's easily recognisable by phagocytes*
  - *Produce antitoxins*
  - *Cause bacteria to burst*

How do vaccines work?
- *Weakened pathogen (or their antigens) injected into body*
- *Antigens trigger immune response*
- *Lymphocytes produce antibodies*
- *Memory cells produced for long term immunity*

Why is the immune response faster the second time a pathogen enters the body?
- *Memory cells made after initial infection or vaccination*
- *Produce antibodies much faster next time*

Explain the role of vaccination in controlling the spread of disease
- *Mass vaccination can prevent spread of pathogen into wider population*
- *When a significant number of people have been vaccinated, it gives protection to those who do not have immunity (herd immunity)*

Describe passive immunity
- *Short term defence against pathogens*
- *Antibodies acquired from another individual*
- *Memory cells are NOT produced*
  - *e.g. antibodies cross placenta from mother to fetus*
  - *e.g. antibodies transferred to infant in breast milk*

Explain the importance of breast-feeding for the development of passive immunity in infants
- *Antibodies passed to infant in mother's milk*
- *Required as infants have undeveloped immune systems*

What is diarrhoea?
- *Loss of watery faeces*

How is diarrhoea treated?
- *Oral rehydration therapy - mixture of water and mineral salts*
- *Prevents dehydration*

What is cholera?
- *Bacterial disease*
- *Bacteria produces toxin*
- *Toxin increases secretion of chloride ions into small intestine*
  - *Leads to movement of water into gut by osmosis*
- *Causes diarrhoea, dehydration, loss of ions from blood*

How is cholera transmitted?
- *In contaminated water*

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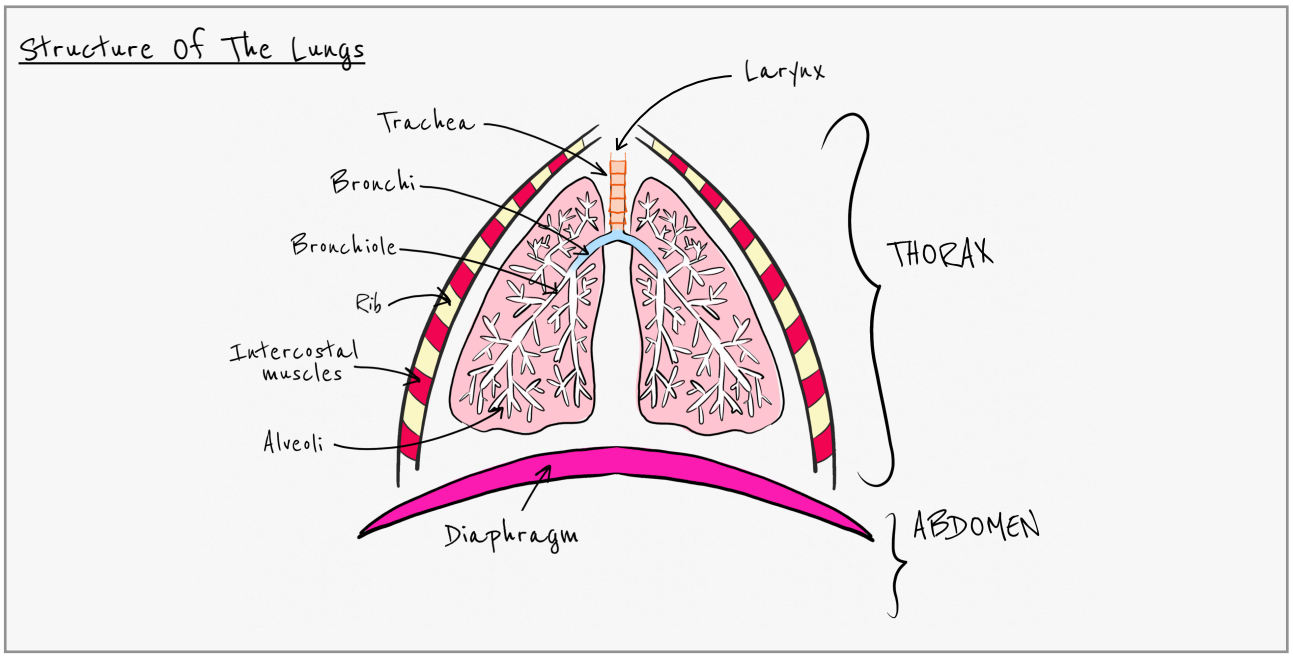
11. GAS EXCHANGE IN HUMANS

11.1 Gas exchange in humans

What are the features of gas exchange surfaces in humans?
- Large surface area
- Thin surface (short diffusion pathway)
- Good blood supply (maintains steep concentration gradient)
- Good ventilation with air (maintains steep concentration gradient)
- Moist (gases can dissolve and diffuse faster)

What is ventilation?
- Movement of air into and out of the lungs



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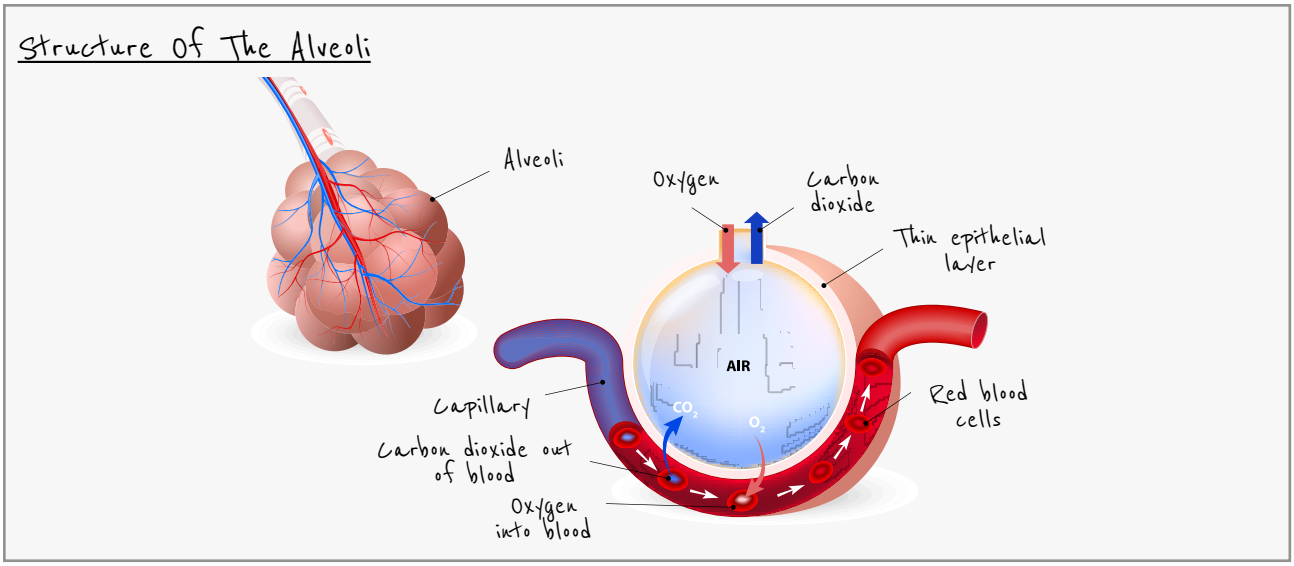
How are the alveoli adapted for gas exchange?
- Very large surface area
- Thin walls (single cell thick) - short diffusion distance
- Moist - allows gases to dissolve
- Good blood supply from capillaries - maintains steep concentration gradient
- Good ventilation - breathing maintains steep diffusion gradient



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What is the function of tracheal cartilage?
- *Provides stiffness*
- *Prevents collapse of trachea during inhalation*

Describe the process of breathing in (inhalation)
- *External intercostal muscles contract*
- *Ribs move up and out*
- *Diaphragm contracts and flattens*
- *Volume inside thorax increases*
- *Pressure decreases*
- *Air is sucked into the lungs*

Describe the process of breathing out (exhalation)
- *Internal intercostal muscles contract*
- *Ribs move down and in*
- *Diaphragm relaxes and become dome shaped*
- *Volume inside thorax decreases*
- *Pressure increases*
- *Air is forced out of the lungs*

Explain the differences in composition between inspired and expired air

Component	**Inspired air**	**Expired air**	***Explanation***
Oxygen	21%	18%	*Oxygen moves from lungs into blood*
Carbon dioxide	0.04%	3%	*CO_2 moves from blood into lungs*
Water vapour	Variable	Saturated	*Water evaporates from inside alveoli*
Nitrogen	*78%*	*78%*	*Not used by body*
Temperature	*Variable*	*37°C*	*Body heat transferred to air*

How do you test for carbon dioxide?
- Bubble gas through limewater indicator
- Limewater turns milky/cloudy in presence of carbon dioxide

In what ways does breathing change during exercise?
- Increased rate – more breaths per min
- Increased tidal volume – more air per breath

How does exercise affect breathing rate and depth?
- *More exercise → increased rate of respiration → more carbon dioxide produced in muscles*
- *Carbon dioxide in blood increases*
- *Detected by receptors in the medulla (brain)*
- *Causes increased breathing rate and depth*

How is the breathing system protected from pathogens and particles?
- Mucus produced by goblet cells
  - Traps particles and pathogens
- Cilia on surface beat to move mucus
  - Mucus moved up and out of lung
- Mucus swallowed and pathogens killed by stomach acid

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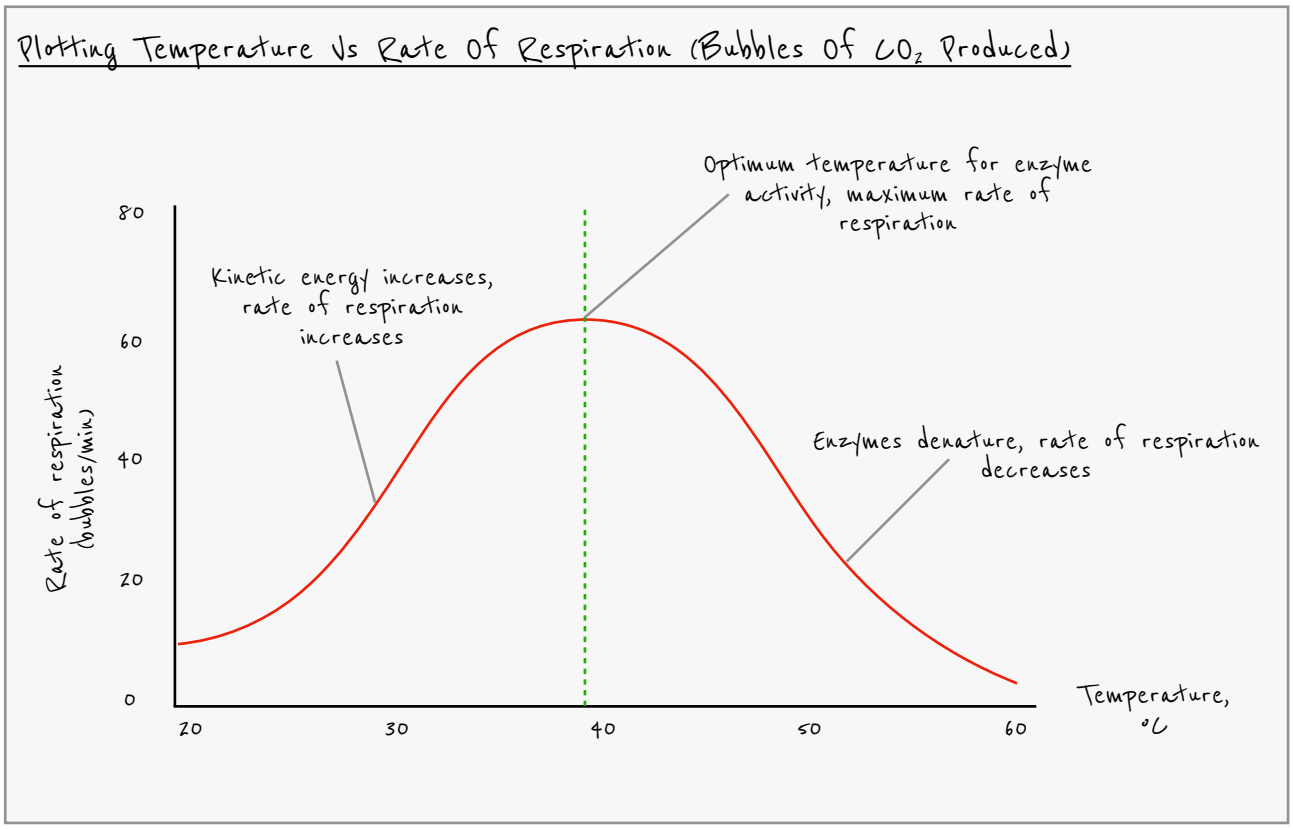
12. RESPIRATION

12.1 Respiration

How is energy used in living organisms?
- Muscle contraction
- Protein synthesis
- Cell division
- Active transport
- Growth
- Nerve impulses
- Keeping body temperature constant

Describe how to investigate the effect of temperature on respiration in yeast
- Add yeast to solution of glucose and water in a test tube (required for respiration)
- Leave at room temperature for 1 hour
- Place in water bath at 20°C
- Seal test tube with bung and connect delivery tube
  - Place other end of deliver tube in beaker filled with water (used to count bubbles of CO_2)
- Leave for 2 minutes for yeast to equilibrate
- Record number of bubbles of CO_2 for 1 minute
- Repeat 3 times and calculate mean number of bubbles per minute
- Repeat with water baths at 30°C - 60°C
- Plot a graph of results



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Describe and explain the results of this investigation
- As temperature increases up to 40°C, rate of respiration increases
  - Enzymes and substrate increase in kinetic energy → more collisions
- Above 40°C, rate of respiration decreases
  - Enzymes denature

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12.2 Aerobic respiration

Define aerobic respiration
- Chemical reaction in cells
- Oxygen used to break down glucose to release energy

In which organelle does aerobic respiration occur?
- Mitochondria

Give the word equation for aerobic respiration
- Glucose + Oxygen → Carbon dioxide + Water (+ energy)

Give the symbol equation for aerobic respiration
- $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_20$

12.3 Anaerobic respiration

Define 'anaerobic respiration'
- Chemical reaction in cells
- Glucose broken down to release energy
- Without using oxygen
- Releases less energy per molecule of glucose

Give the advantage of using aerobic rather than anaerobic respiration
- Aerobic respiration releases more energy per molecule of glucose

Give the word equation for anaerobic respiration in yeast
- Glucose → Ethanol + Carbon dioxide

Give the symbol for anaerobic respiration in yeast
- $C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$

Give the word equation for anaerobic respiration in muscles
- Glucose → Lactic Acid

What is an oxygen debt?
- *Build up of lactic acid in muscles and blood during exercise*

How is the oxygen debt removed?
- *Lactic acid removed by aerobic respiration in liver*
- *Fast heart rate continues after exercise to take lactic acid from muscles to liver*
- *Fast and deep breathing continues after exercise to supply oxygen for aerobic respiration in liver*

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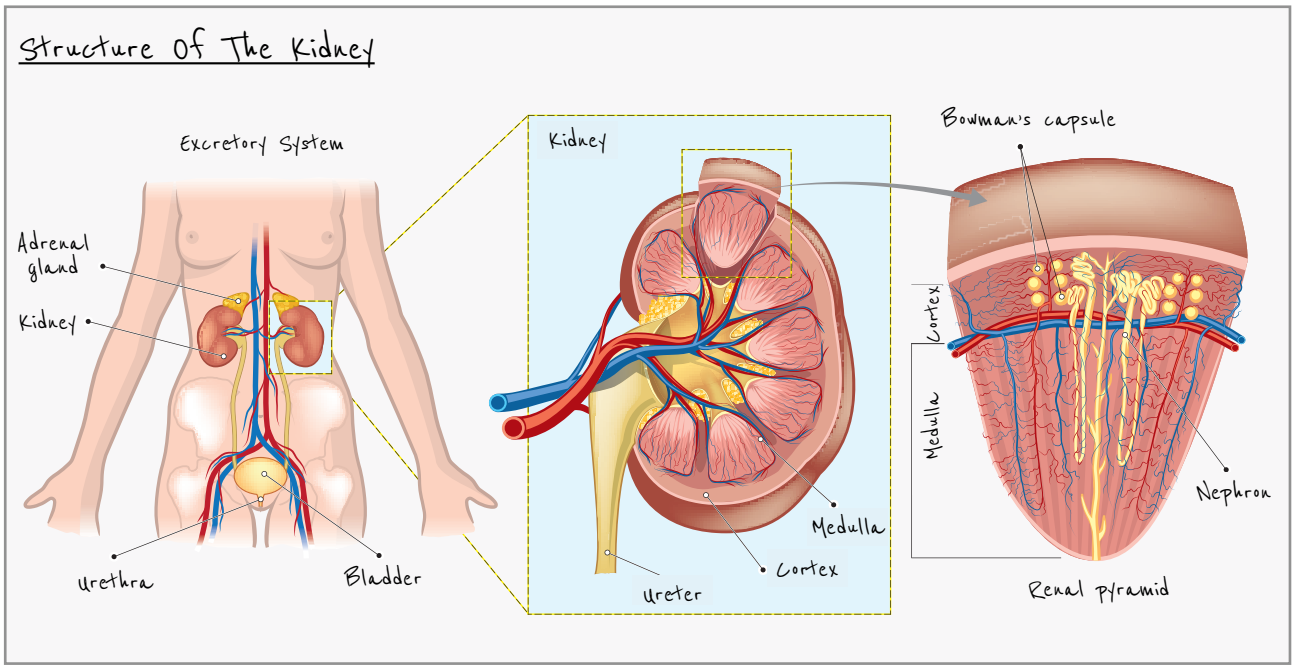
13. EXCRETION IN HUMANS

13.1 Excretion in humans

How is carbon dioxide excreted?
- Through the lungs

What does the kidney excrete?
- Urea
- Excess water
- Ions
- Note: faeces is NOT excreted, it is egested



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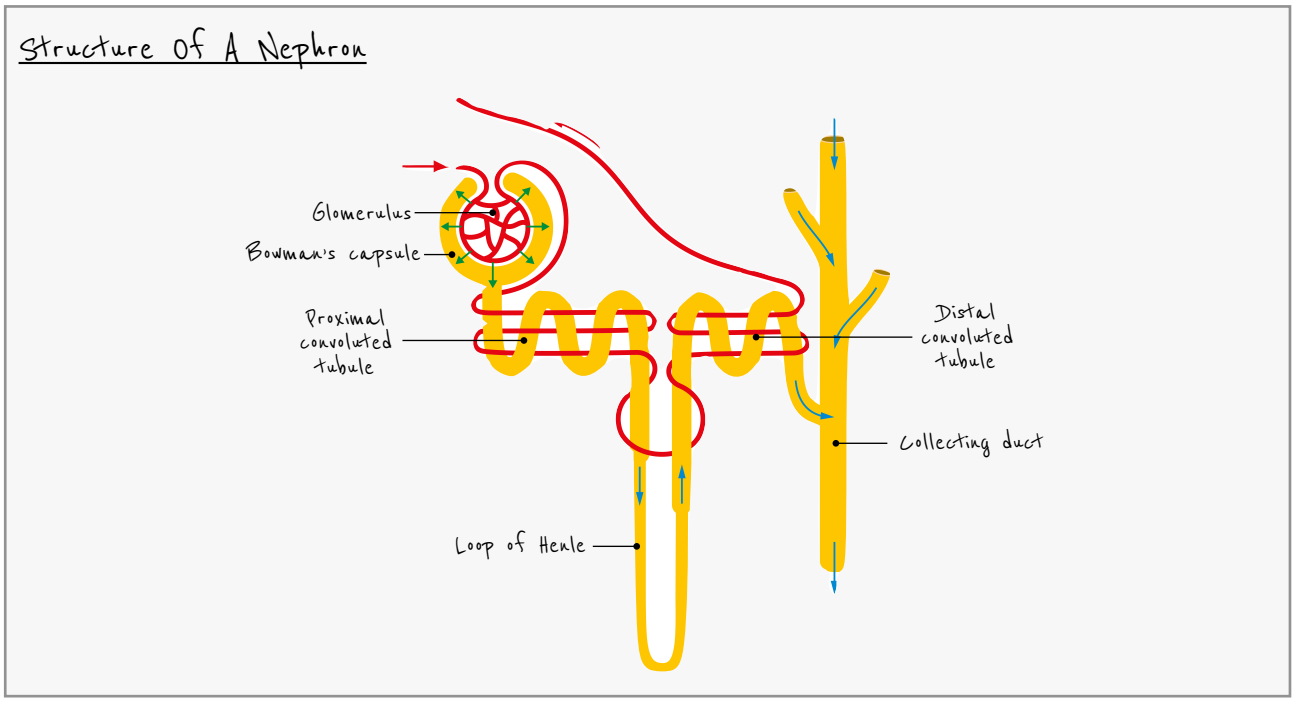

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Outline the role of the glomerulus
- *Filters small molecules from blood into the Bowman's capsule (ultrafiltration)*
- *Glucose, ions, and urea (the glomerular filtrate) enter Bowman's capsule*
- *Proteins stay in blood - too large to pass through basement membrane*

Explain how the structure of the blood vessels entering and leaving the glomerulus help to move glucose into the Bowman's capsule
- *Vessel entering is wider than vessel leaving*
- *Increased pressure*
- *Causes ultrafiltration*

Outline the role of the nephron
- *Reabsorbs all the glucose, most of water and some salts back into blood*
- *Leads to concentrated urea in urine*
- *Excess water and ions remain in nephron*

Describe how glucose is reabsorbed back into the blood
- *Active transport (requires energy)*
- *From low concentration in the nephron to a high concentration in the blood*

What is the composition of urine?
- *Ureas*
- *Excess ions*
- *Excess water*

What affects the volume and concentration of urine?
- *Water intake*
- *Temperature*
- *Exercise*

What role does the liver play in excretion?
- *Forms urea from excess amino acids*
- *Assimilation - converts amino acids into proteins*

Define 'deamination'
- *Removal of nitrogen containing part of amino acids*
- *Forms urea*

Why is excretion needed?
- *Urea is toxic when allowed to build up in blood*

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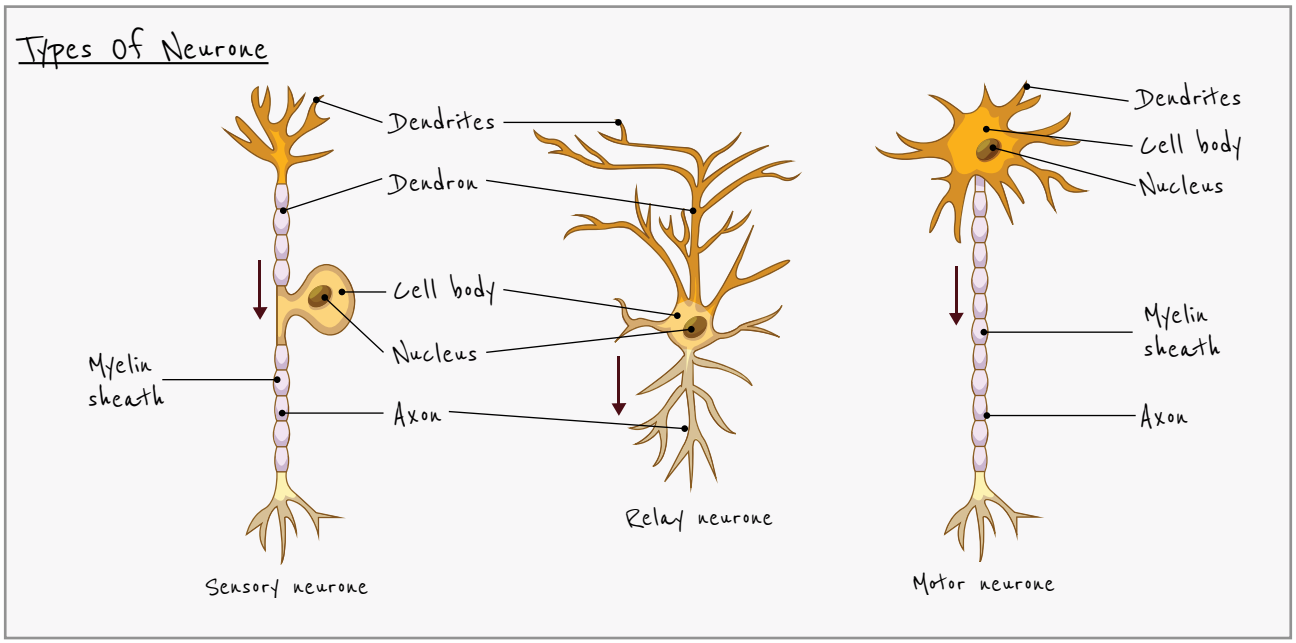
14. COORDINATION AND RESPONSE

14.1 Coordination and response

Describe a nerve impulse
- Electrical impulse that passes along neurones

What makes up the human nervous system?
- Central nervous system (CNS)
  - Brain
  - Spinal cord
- Peripheral nervous system (PNS)
  - Nerves outside of brain and spinal cord

Describe the role of the nervous system
- Coordination and regulation of body functions
- Voluntary actions involve the brain, involuntary do not



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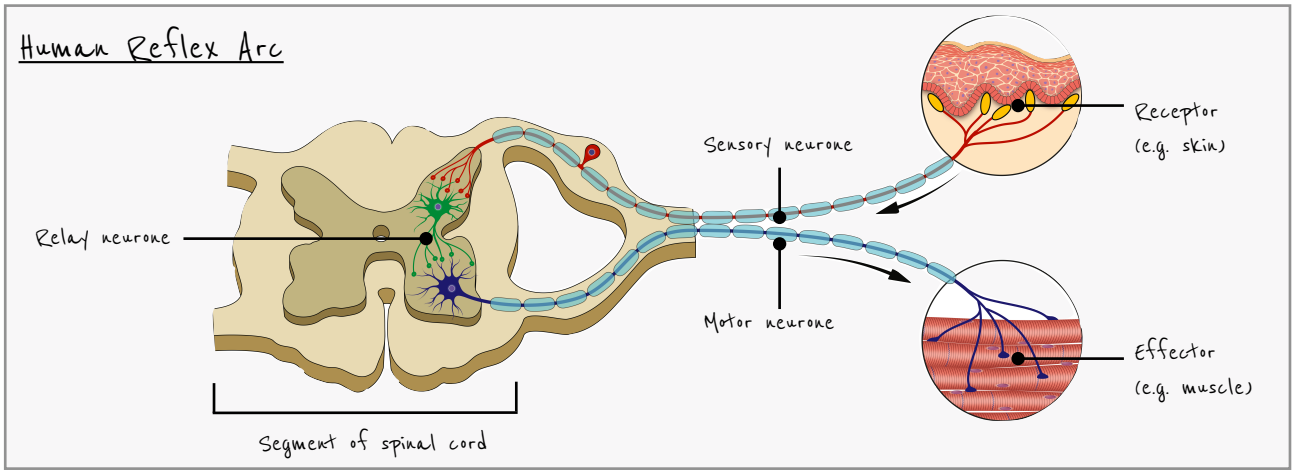
Describe the pathway of a reflex arc
- Stimulus - receptor - sensory neurone - relay neurone - motor neurone - effector - response
- Involves electrical impulses and synapses
  - e.g. withdrawal of finger from hot object



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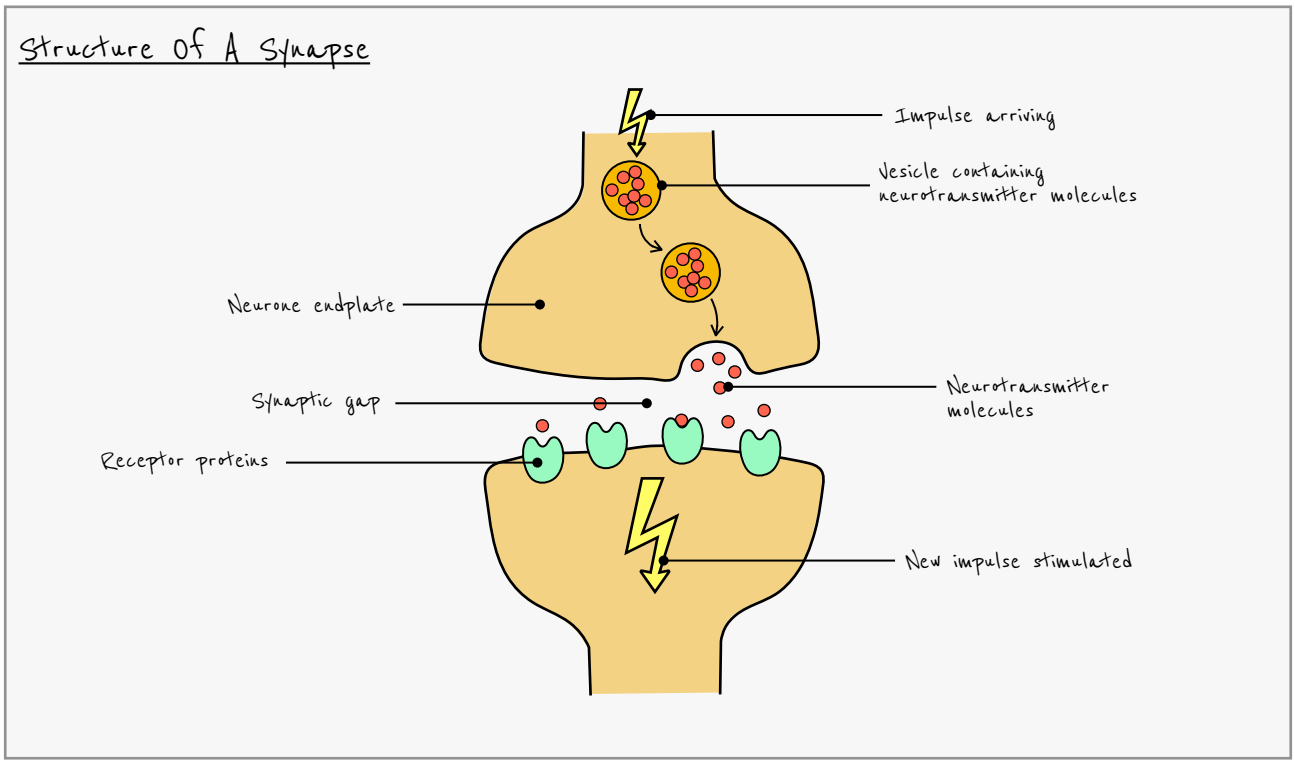
Define ‘reflex action’
- An automatic and rapid response
- Integrates and coordinates stimuli with the response effectors

What is an effector?
- Muscle (contracts) or a gland (secretes a hormone)

What is a synapse?
- Junction between two neurones
- Neurotransmitter diffuses and binds to post-synaptic membrane



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Describe the structure of a synapse
- *Pre-synaptic neurone endplate contains vesicles containing neurotransmitter molecules*
- *Synaptic gap is space between two neurones*
- *Post-synaptic membrane contains protein receptors specific for neurotransmitter*

How does an impulse cross a synapse?
- *Electrical impulse arrives at endplate*
- *Impulse stimulates release of neurotransmitter molecules from vesicles into synaptic gap*
- *Neurotransmitter molecules diffuses across gap*
- *Neurotransmitter molecules bind with receptor proteins on next neurone*
- *Impulse stimulated in next neurone*

What is the role of a synapse?
- *Ensures impulses travel in one direction only*

14.2 Sense organs

What is a sense organ?
- Group of receptor cells that respond to specific stimuli
- Stimuli include: light, sound, touch, temperature, chemicals

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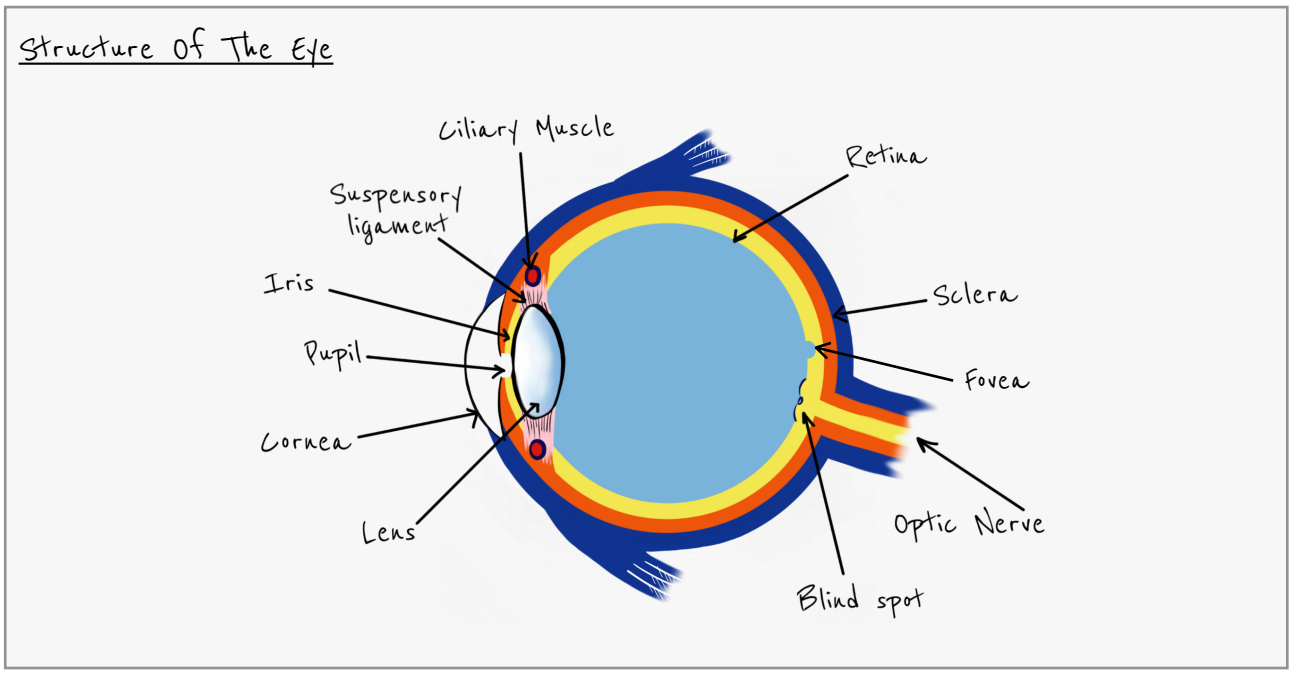

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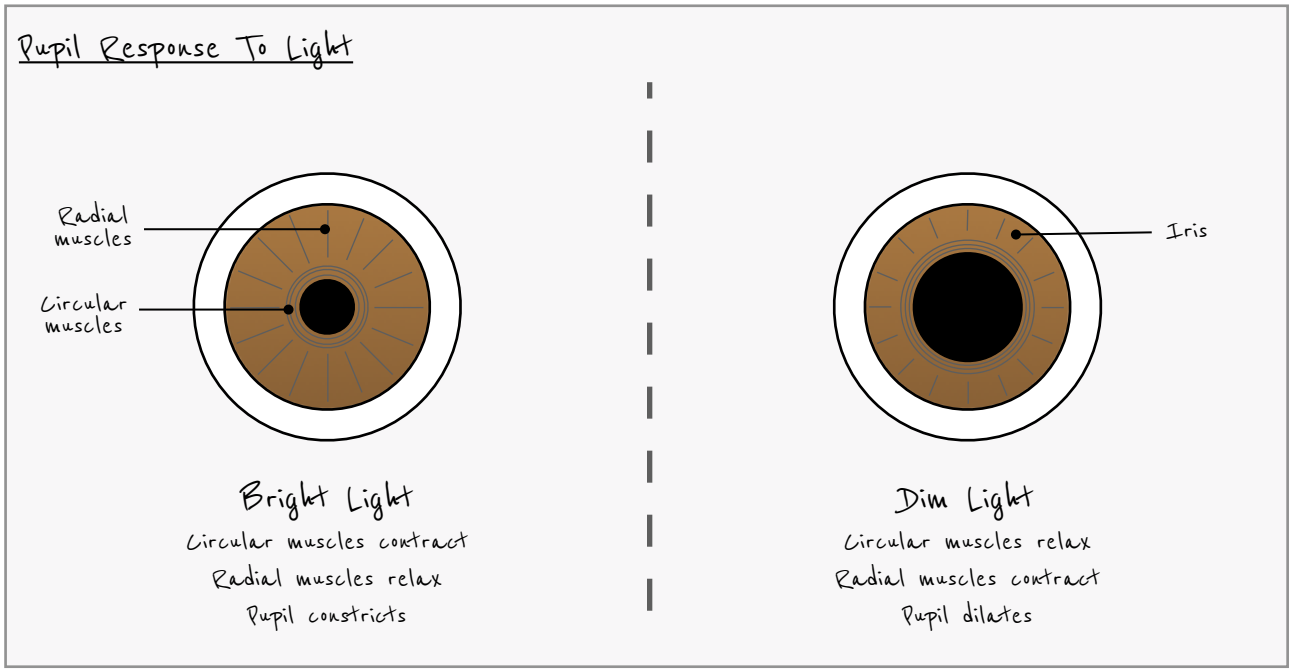
What is the role of:
- Cornea - refracts light
- Iris - contains radial and circular muscles which control how much light enters pupil
- Lens - refracts light to focus it on retina
- Retina - contains photoreceptors (rods (dim light) and cones (detect colour)) which are sensitive to light
- Pupil - allows light to enter the eye
- Optic nerve - carries electrical impulses from the eye to the brain
- Blind spot - where the the optic nerve enters the eye

How does the diameter of the pupil change in bright and dim light?
- Bright light - pupil diameter decreases to protect retina
- Dim light - pupil diameter increases to let in more light



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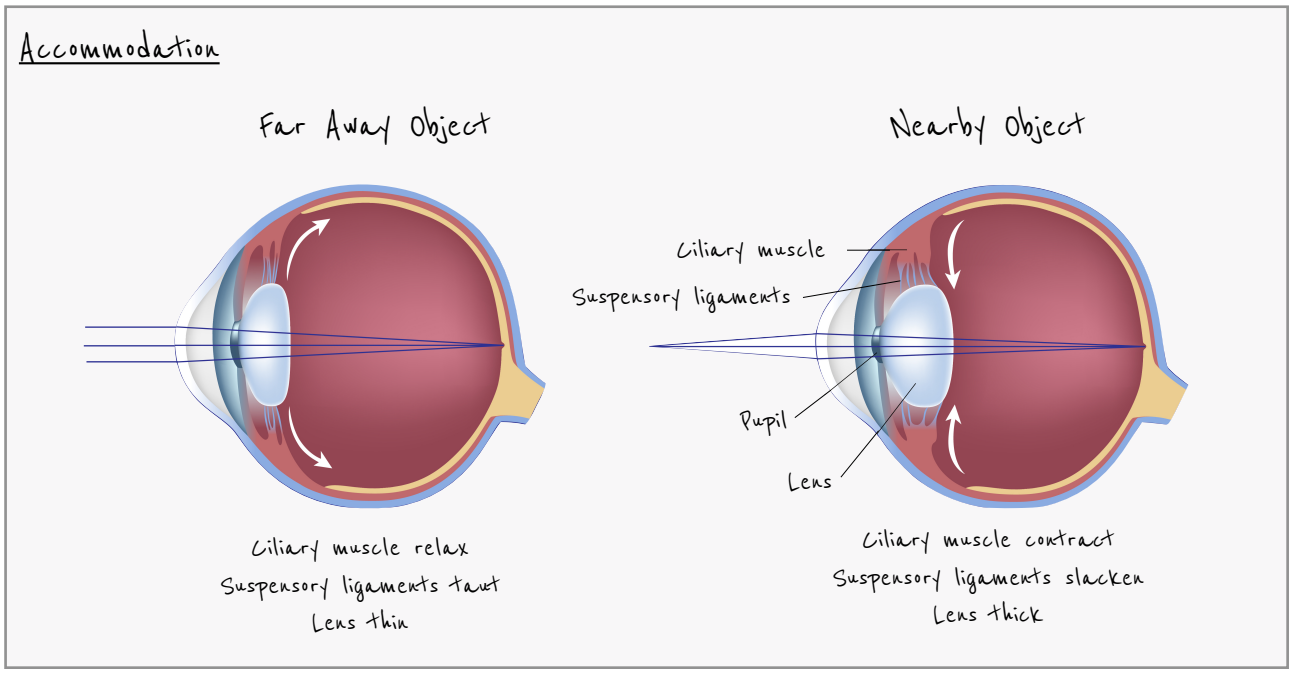
How does the pupil constrict in bright light and why is this necessary?
- *Circular muscles contract*
- *Radial muscles relax*
- *Pupil constricts*
- *Protects the retina from the bright light*

How does the pupil dilate in dim light and why is this necessary?
- *Circular muscles relax*
- *Radial muscles contract*
- *Pupil dilates*
- *Allows more light to enter the eye*

What is accommodation?
- *Changes that take place within the eye*
- *Enable us to focus on objects at different distances*

How does the eye focus on a nearby object?
- *Ciliary muscle contracts*
- *Suspensory ligaments slacken*
- *Lens fat*
- *Light refracted strongly*

How does the eye focus on a faraway object?
- *Ciliary muscle relax*
- *Suspensory ligaments taut*
- *Lens thin*
- *Light refracted less strongly*



Credit: Adobe Stock

How are rods and cones distributed in the retina?
- *Rods around the edge and cones in centre of retina*

What is the function of rods?
- *See in black and white*
- *Very sensitive to light*
- *Allow vision in low light levels*

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What is the function of cones?
- *See in colour*
- *Three different types (absorb red, blue and green light)*
- *Give colour vision and detail in bright conditions*

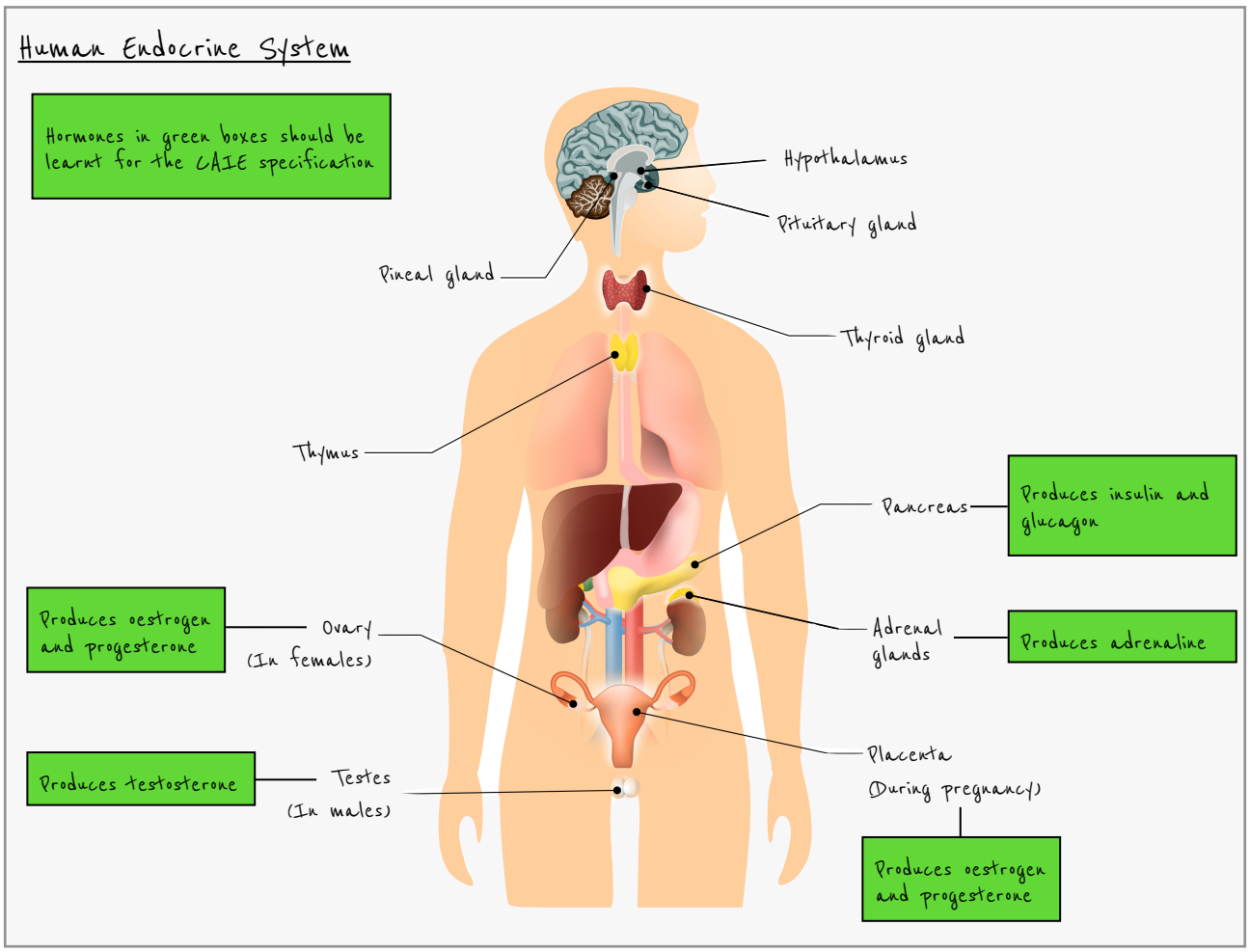
Where is the fovea?
- *Centre of the retina*

What is the function of the fovea?
- *Contains large concentration of cones*
- *Provides greatest visual acuity*

14.3 Hormones

What is a hormone?
- A chemical substance produced by a gland
- Travels in blood
- Alters activity of specific target organ(s)

Define endocrine gland
- Group of specialised cells
- Secrete hormones into bloodstream



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Describe the effects of adrenaline on the body
- *Prepares the body for 'flight or fight' situations*
- *Increases breathing and heart rate*
- *Increases pupil diameter*

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Explain the effects of adrenaline in the body
- *Pupils dilate - allows more light to enter the eye*
- *Breathing rate increases - to allow more oxygen into the body*
- *Heart rate increases - to deliver more oxygen around the body*
- *Increased conversion of glycogen to glucose - blood glucose concentration increases*
  - *Oxygen and glucose required for respiration*

What is the difference between hormonal and nervous responses?
- Nervous involves electrical impulses, hormonal involves chemicals carried in the blood
- Nervous response faster, hormonal slower
- Nervous response short-lived, hormonal long-lived
- Nervous response very localised, hormonal wide-spread

14.4 Homeostasis

Define homeostasis
- Maintenance of a constant internal environment

Explain how homeostatic control is achieved
- *Negative feedback mechanisms*
- *Keep internal environment within narrow limits around a set point*

What is negative feedback?
- *Body's response when internal conditions deviate from the ideal set point*
- *Body returns conditions to this set point*

Describe the role of insulin
- Decreases blood glucose concentration
- Causes glucose to be converted to glycogen
- Released after eating carbohydrate-rich food

How is blood glucose level decreased?
- Pancreas secretes insulin
- Insulin causes conversion of soluble glucose into insoluble glycogen
- Glycogen stored in liver

Describe the role of glucagon
- *Increases blood glucose concentration*
- *Causes glycogen to be converted to glucose*

How is glucose level in the blood controlled?
- *Low glucose in blood detected → pancreas secretes glucagon → glycogen in liver converted glucose and released into blood → blood glucose concentration increases*
- *High glucose in blood detected → pancreas secretes insulin → liver and tissues take up glucose → glucose converted to glycogen → blood glucose concentration falls*

What causes type-1 diabetes?
- *Immune system targeting and destroying own body cells*
- *Body no longer responds to insulin*

What are the symptoms and treatment of type-1 diabetes?
- *Symptoms:*
  - *Excessive thirst, urine production and hunger*
  - *Glucose in urine*
- *Treated by regular injections of insulin, monitoring of blood glucose concentration*

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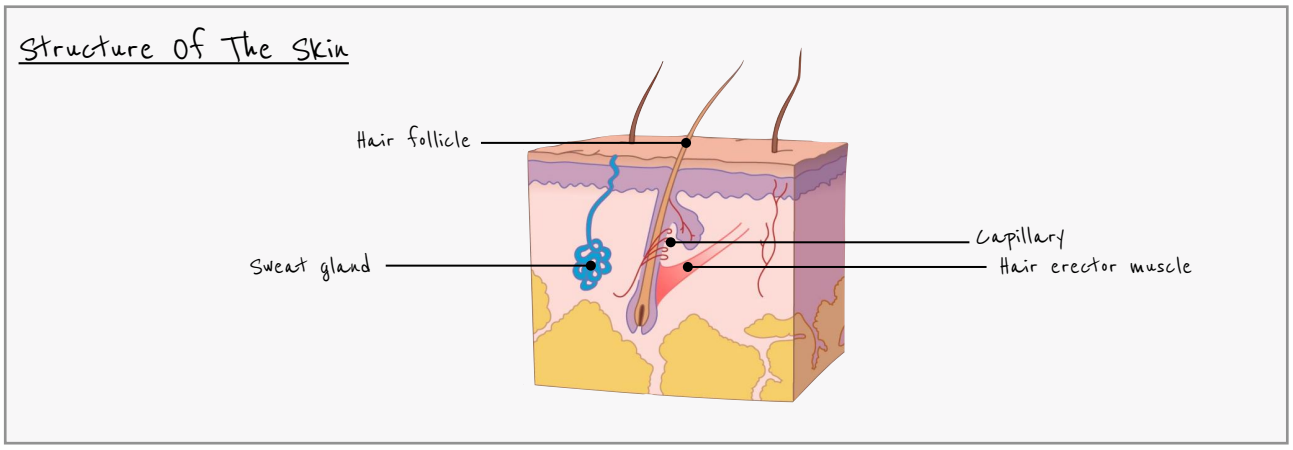
What is the role of the skin?
- *Sense organ for pain, touch and pressure*
- *Tough outer layer*
- *Controls heat loss*
- *Barrier - prevents entry of pathogens*
- *Prevents water loss*

Explain what happens when your body temperature is too high
- *Blood temperature receptors in brain detect increase in blood temperature*
- *Hair erector muscles relax*
  - *Hairs lay flat*
  - *Less insulating air trapped close to the body*
- *Vasodilation (arterioles dilate)*
  - *Blood flows closer to skin surface*
  - *More heat radiated*
- *Sweat evaporates and cools the body*

Explain what happens when your body temperature is too low
- *Blood temperature receptors in brain detect decrease in blood temperature*
- *Hair erector muscles contract*
  - *Hairs stand up*
  - *More insulating air trapped close to the body*
- *Vasoconstriction (arterioles constrict)*
  - *Less blood flows to surface of skin*
  - *Less heat radiated*
- *Shiver - contraction of muscle releases heat*



Credit: healthline.com

14.5 Tropic responses

What are auxins?
- Plant hormones

What is a tropism?
- The response of a plant to a directional stimulus

Define gravitropism
- Response of plant to grow with/against gravity

Define phototropism
- Response of a plant towards/away from light

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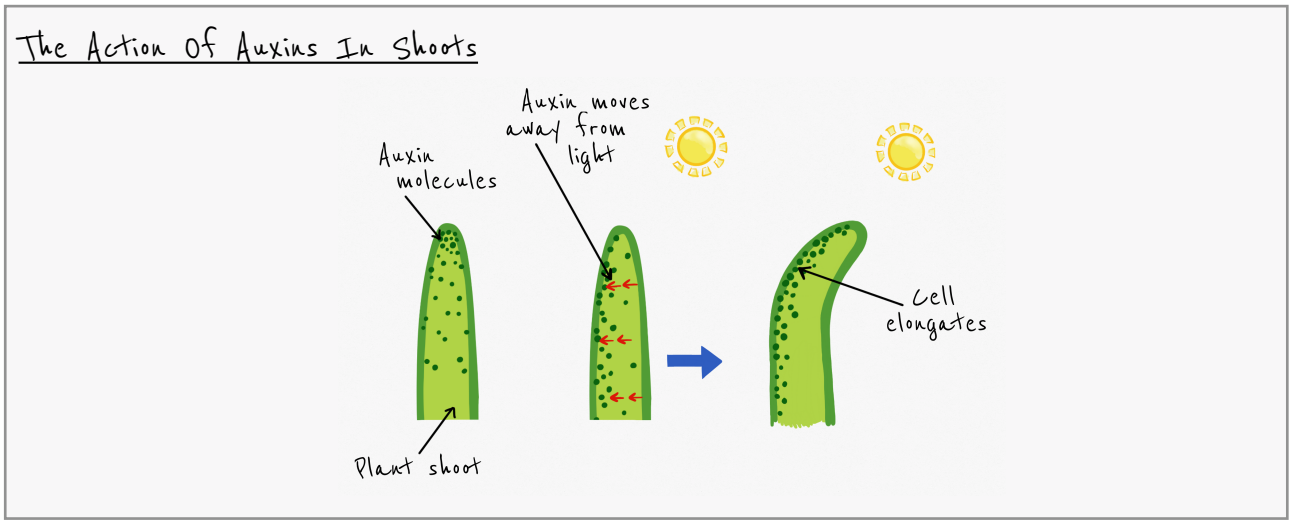
Describe the roots and shoots response to light
- Roots - negative phototropism
- Shoots - positive phototropism

Describe the roots and shoots response to gravity
- Roots - positive geotropism
- Shoots - negative geotropism

What is a coleoptile?
- Simple plants used to investigate tropism
- Cereal seedling

What is a clinostat?
- Apparatus used to remove the effect of gravity/light/water

Describe how a shoot may bend towards the light
- Auxins diffuse down from tip of shoot
- Auxins concentrate on the side furthest from the light
- Causes cell elongation
- Stem bends towards light



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Describe how a shoot may bend up against the force of gravity
- *If a shoot horizontal, auxin concentrates at bottom of shoot*
- *Auxin causes cell elongation*
- *Shoot grows upwards against force of gravity*

Explain why phototropism and gravitropism are under chemical control
- *Auxins are chemicals made in shoot tip*
- *Auxin diffuses through plant from shoot tip*
- *Auxin gets unequally distributed due to light and gravity*
- *Auxin causes cell elongation*

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15. DRUGS

15.1. Drugs

What is a drug?
- A substance taken into the body
- Modifies or affects chemical reactions

What is an antibiotic?
- Drug used to treat bacterial infection
- Does not affect viruses
- Some bacteria are resistant to antibiotics which reduces drug's effectiveness

Why do antibiotics not affect viruses?
- Antibiotics work by stopping bacterial replication and metabolism
- Viruses don't replicate the same way as bacteria
- Viruses live inside cells of the host

How may bacteria become resistant to antibiotics?
- *Some bacteria have mutations which make them more likely to survive*
- *The bacteria reproduce and pass on these favourable alleles to future bacteria*
- *Soon the whole population of bacteria is resistant to the antibiotic*

Why is antibiotic resistant bacteria (e.g. MRSA) becoming more common?
- *Overuse of antibiotics*
- *Failing to complete fully prescribed course*
- *Use of antibiotics in farming*
  - *Could lead to spread of antibiotic resistance from animals into human hosts*

How can antibiotic resistance be minimised?
- *Using antibiotics only when essential*
  - *If patient has viral infection - antibiotics ineffective and unnecessary*
- *Ensuring treatment course is completed*
  - *Ensures all bacteria are killed*
  - *So none survive which could mutate and produce resistant strains*
- *Treat specific bacteria with specific antibiotics*
  - *Increases likelihood that specific bacteria are killed*
  - *Less likely to mutate and produce resistant strains to wide range of antibiotics*
- *High hospital hygiene levels*
  - *Reduces likelihood of resistant strains spreading between patients*

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16. REPRODUCTION

16.1 Asexual reproduction

Define 'asexual reproduction'
- One parent only
- No gametes
- No fertilisation
- Cells from parent divide by mitosis and then break away
- Forms new organism which is identical to parent (clone)
  - e.g. bacteria, propagated plants

Outline the advantages and disadvantages of asexual reproduction

Asexual reproduction	***Advantage***	***Disadvantage***
Population of a species in the wild	- *Population can increase rapidly* - *Can exploit a suitable habitat quickly*	- *No variation in a population* - *Species cannot adapt quickly to change in environment* - *Disease may affect all individuals*
Crop production	- *Only one parent needed* - *Rapid colonisation of favourable environments → large yields possible* - *Entire crop will show same characteristics*	- *Any change in environmental conditions will affect all individuals* - *e.g. disease, drought*

Give examples of natural asexual reproduction in plants
- Strawberry runners
- Tubers

Describe how strawberry runners reproduce asexually
- Runners = horizontal stems that grow sideways from parent plant
- When runners touch the soil, plantlets grow roots
- New plantlets grow and become independent from parent plant

Give an example of an artificial method of asexual reproduction in plants
- Taking a cutting

Describe the process of taking a cutting
- A piece of a plant's stem is cut off
- Dipped in rooting powder
  - Contains plant growth hormones
- Transferred to soil
- Grow into genetically identical plants

Describe the advantages of using cuttings rather than seeds to reproduce crop plants
- Cutting is form of asexual reproduction
- Minimises genetic variation - gives a uniform crop
- Produces plants that all have the same features
- Ensures consistency of product
- Faster process than growing from seed

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16.2 Sexual reproduction

Define ‘sexual reproduction'
- Two parents needed to make gametes (sex cells - e.g. sperm and eggs)
- Gametes fuse at fertilisation
- Zygote formed
- Divides by mitosis to form embryo
- Produces genetically varied offspring

What is fertilisation?
- Fusion of male (sperm) and female (egg) gamete
- Zygote formed
  - Chromosomes duplicate
  - Chromosomes separate
  - Undergoes mitosis repeatedly
  - Forms cluster of cells
- Embryo formed

Define ‘gamete’
- Sex cell
  - e.g. egg cell, sperm cell
- *Haploid nucleus*
  - *Contains one complete set of chromosomes*

What is a zygote?
- Single cell formed after fertilisation occurs
- *Diploid nucleus*
  - *Contains two complete sets of chromosomes*

Outline the advantages and disadvantages of sexual reproduction

Sexual reproduction	***Advantage***	***Disadvantage***
Population of a species in the wild	- *Increases genetic variation* - *Species can adapt to changing conditions/environments quicker* - *Disease less likely to affect population*	- *Energy and time required to find mate* - *Isolated organisms cannot do it* - *Produces fewer offspring than asexual reproduction - takes longer to colonise new habitats*
Crop production	- *Variation means disease less likely to affect entire population* - *Selective breeding can be used to produce crops with desired characteristics*	- *Variation may produce offspring without desired features* - *Could lead to reduced or unpredictable harvests*

How does sexual reproduction make it more likely that a species can adapt to a changing environment?
- Produces genetically varied offspring by:
  - Random fertilisation of gametes
  - Mixing of alleles from both parents
  - Meiosis

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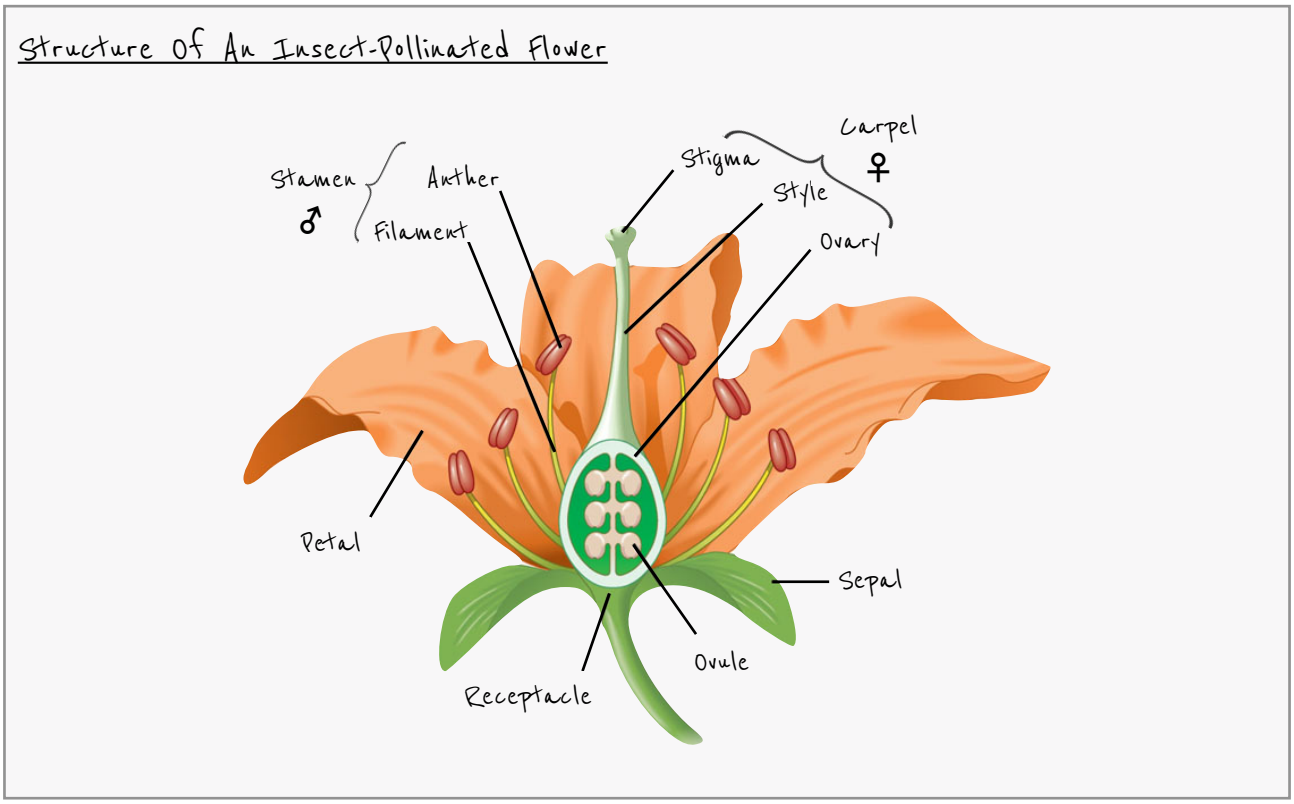
Compare sexual and asexual reproduction

	Sexual Reproduction	Asexual Reproduction
Sex cells produced	Yes	No
Fertilisation takes place	Yes	No
Variation in offspring	Yes	No
Helps survival in:	Changing environment	Stable environment

16.3 Sexual reproduction in plants



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State the functions of the different structures of an insect-pollinated flower

Structure	Function
Sepal	Protect flower bud
Petal	Brightly coloured to attract insects May produce nectar
Anther	Male reproductive part Pollen grains contain male nucleus (gamete)
Stigma	Platform for pollen grains to land
Ovaries	Female reproductive part Contains female nucleus in an ovum

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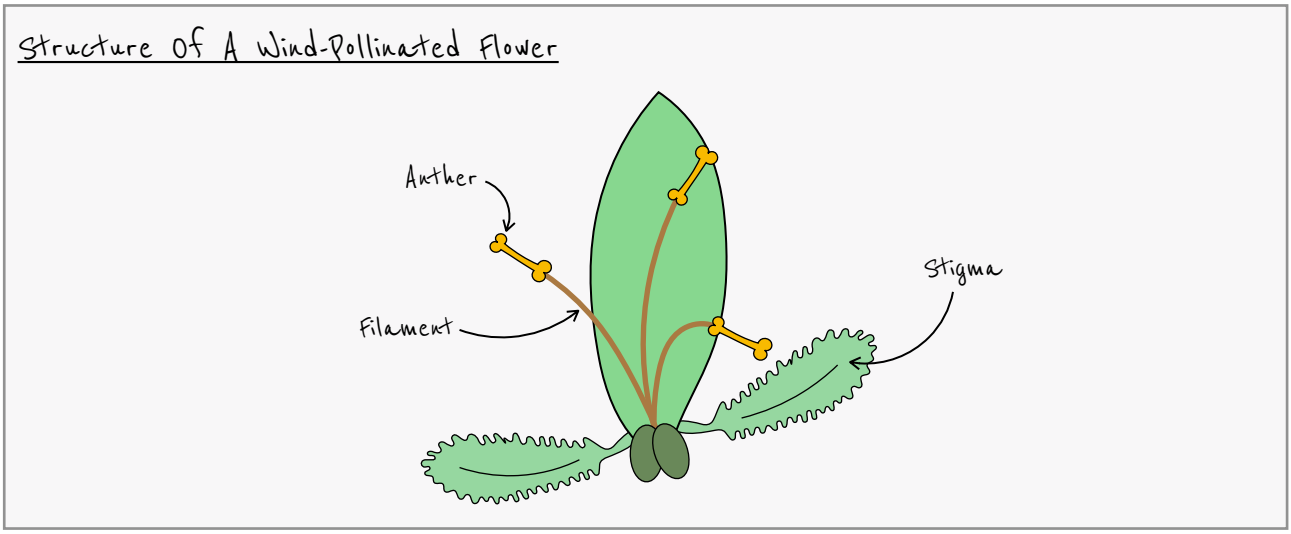
Describe the features of an insect pollinated flower that help it attract insects
- Large petals - attract insects
- Coloured petals - attract insects
- Scent - makes insects push past stamen
- Nectar - makes insects push past stamen
- Sticky pollen grains - attach to insect

Describe the features of a wind pollinated flower
- Exposed stamens - allow pollen grains to be easily released
- Feathery stigma - catches drifting pollen grains
- Small petals - allows stamens and stigmas to be exposed
- Small pollen grains - easily carried by the wind



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Describe the differences between wind and insect pollinated flowers

	Wind pollinated	**Insect pollinated**
Stigma	Long, feathery, sticks out	Flat or lobed
Petals	Small, dull, no nectar	Large, bright, nectar
Anther	Hang loosely, thin filaments	Stiff, firmly attached
Pollen	Large quantities, light, smooth	Small numbers, large, sticky

What is pollination
- Transfer of pollen grains from anther to stigma

What is self-pollination?
- *Transfer of pollen grains from anther to stigma*
- *On flower of same plant*

Outline the advantages and disadvantages of self-pollination
- *Advantages*
  - *More efficient*
  - *Does not rely on pollinators*
- *Disadvantages*
  - *Less variation*
  - *Less able to respond to changes in environment*

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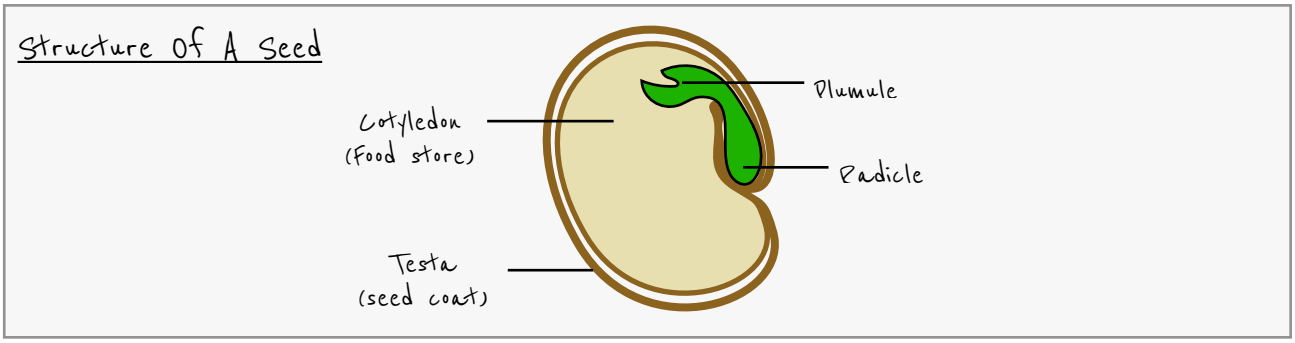
What is cross-pollination?
- *Pollen transfer to different plant of same species*

Outline the advantages and disadvantages of cross-pollination
- *Advantages*
  - *More variation*
  - *Can adapt to environmental changes*
- *Disadvantages*
  - *Relies on proximity/chance of pollination by pollinators*

Describe the process of fertilisation in plants
- When pollen nucleus fuses with ovule nucleus
- *Pollen grain landing on stigma releases chemical signals*
- *Pollen tube grows down through style*
- *Acts as channel to deliver male gamete to ovule*
- *Tip of pollen tube locates micropyle on ovule*
- *Male gamete enters ovule through micropyle*



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Outline the process of germination
- Food store in seed is used up
- Radicle grows down
- Plumule grows up towards light and starts photosynthesis

What conditions are needed for germination?
- Water
  - Required to activate enzymes
- Oxygen
  - For respiration
- Warm temperature
  - Optimum temperature for enzyme-controlled reactions

Describe an investigation into the factors needed for germination
- Set up 4 test tubes, with each containing 15 cress seeds on cotton wool
  - In one test tube (A) leave cotton wool dry
  - In one test tube (B) add water to cotton wool to make it moist
  - In one test tube (C) add water to cotton wool, then add layer of oil on top
  - In one test tube (D) add water to cotton wool to make it moist, then place in fridge
- Leave tubes A, B and C at room temperature
- Leave all tubes for set period of time (e.g. 5 days)
- Compare results and see which tube has the greatest number of germinated seeds

What is the purpose of the layer of oil in test tube C?
- Prevent oxygen reaching seeds

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Which test tube would you expect to see the greatest number of seeds germinating?
- B
  - Only tube to provide water, oxygen and warmth
  - All others missing at least one factor

Give the independent variable for this investigation
- Abiotic conditions in which seeds are germinating (water, oxygen, temperature)

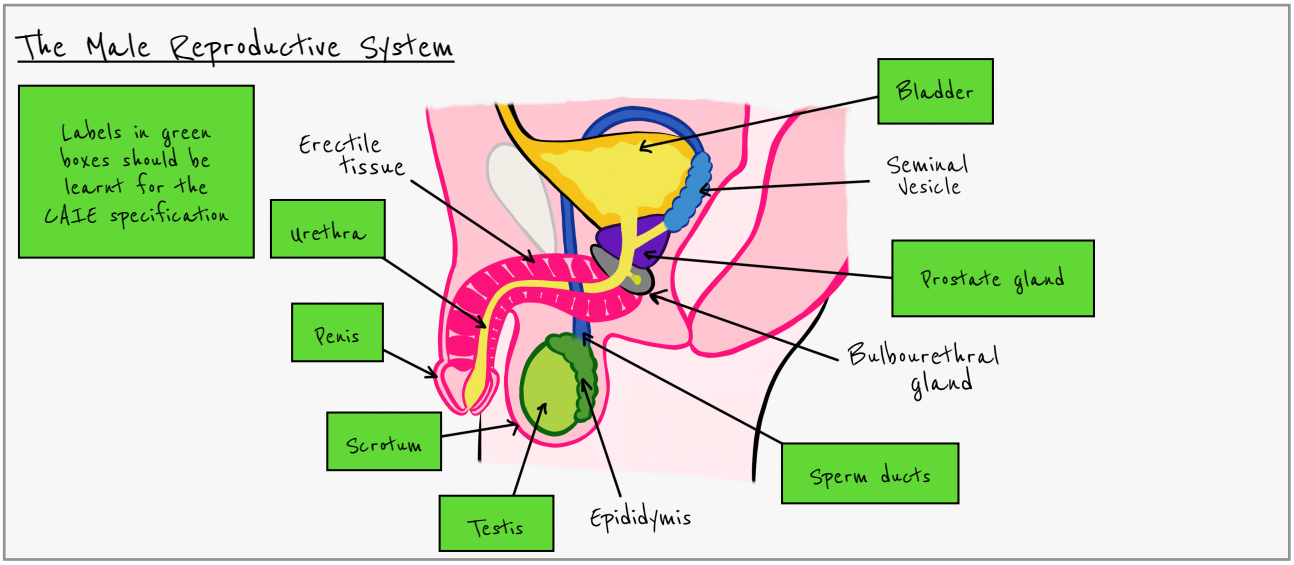
Give the dependent variable for this investigation
- Number of seeds germinating after 5 days

Give control variables for this investigation
- Temperature of tubes A, B and C
- Species of cress seeds used
- Parent plant of cress seeds
- Type of water used (boil first then cool)
- Light intensity

16.4 Sexual reproduction in humans

Describe the structure and function of the male reproductive system

Structure	Function
Penis	- Passes urine out of the body from the bladder - Allows semen to enter into the vagina of a woman during sexual intercourse
Testis	- Contained in the scrotum - Produces sperm and testosterone
Scrotum	- Support testes outside of body - Ensures sperm kept at lower temperature than body temperature
Sperm Ducts	- Sperm passes through the sperm duct where it mixes with fluids produced by the sex gland
Prostate Gland	- Produces semen (provides sperm cells with nutrients)
Urethra	- Exports urine or semen from the body - Ring of muscle in the urethra prevents mixing of urine and semen



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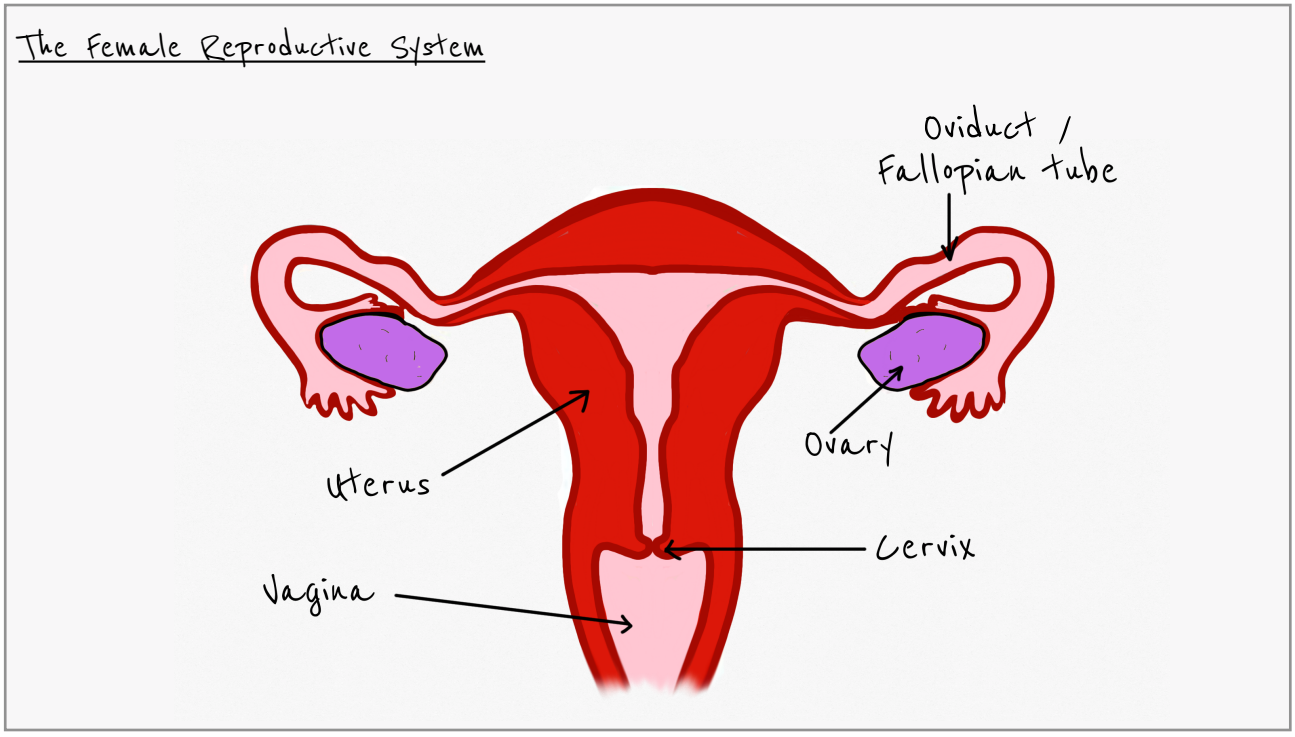
Describe the structure and function of the female reproductive system

Structure	Function
Oviduct (Fallopian Tube)	- Connects the ovary to the uterus - Lined with ciliated cells to push the ovum towards uterus for fertilisation
Ovary	- Contains female gametes (ova) which mature and develop when FSH is released
Uterus	- Muscular structure with a soft lining - Fertilised egg cell implanted there to develop into a fetus - Protects fetus from physical damage
Cervix	- Ring of muscle at lower end of uterus - Keeps fetus in place during pregnancy
Urethra	- Tube that passes urine out of the body
Vagina	- Muscular tube that the male's penis enters during sexual intercourse



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What is fertilisation (in a human)?
- Fusion of nuclei from a male gamete (sperm)
- With a female gamete (ovum/egg cell)

What are the adaptive features of sperm?
- Flagellum for movement
- Mitochondria to supply energy for beating of flagellum
- Acrosome enzymes to penetrate egg cell membrane

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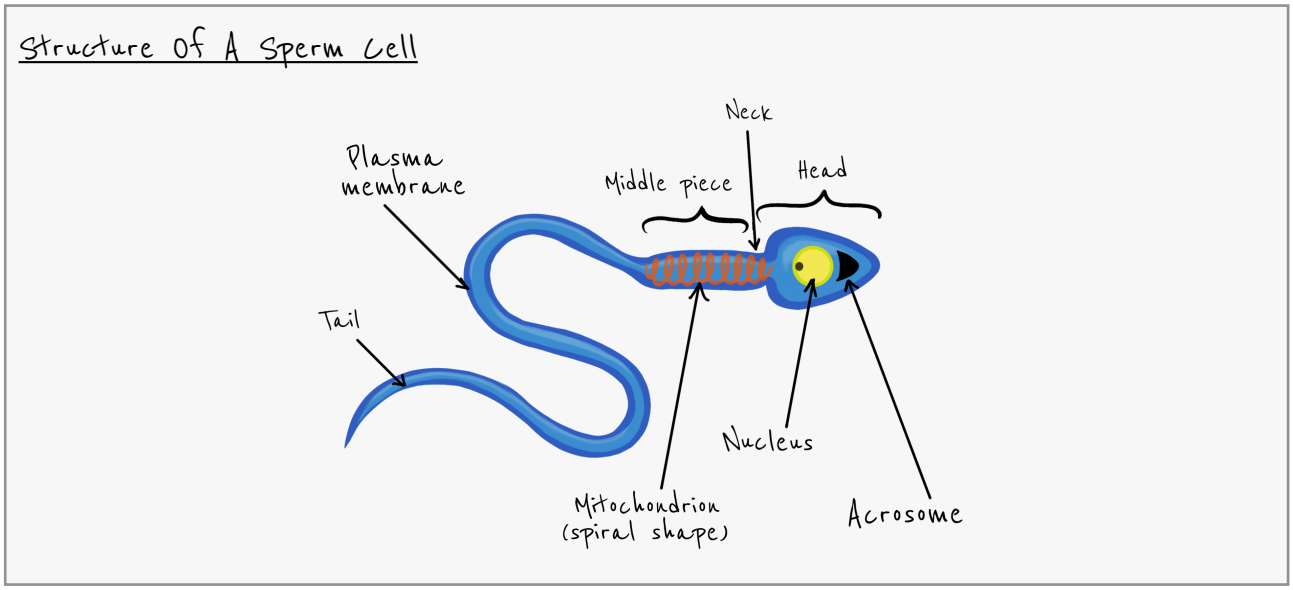

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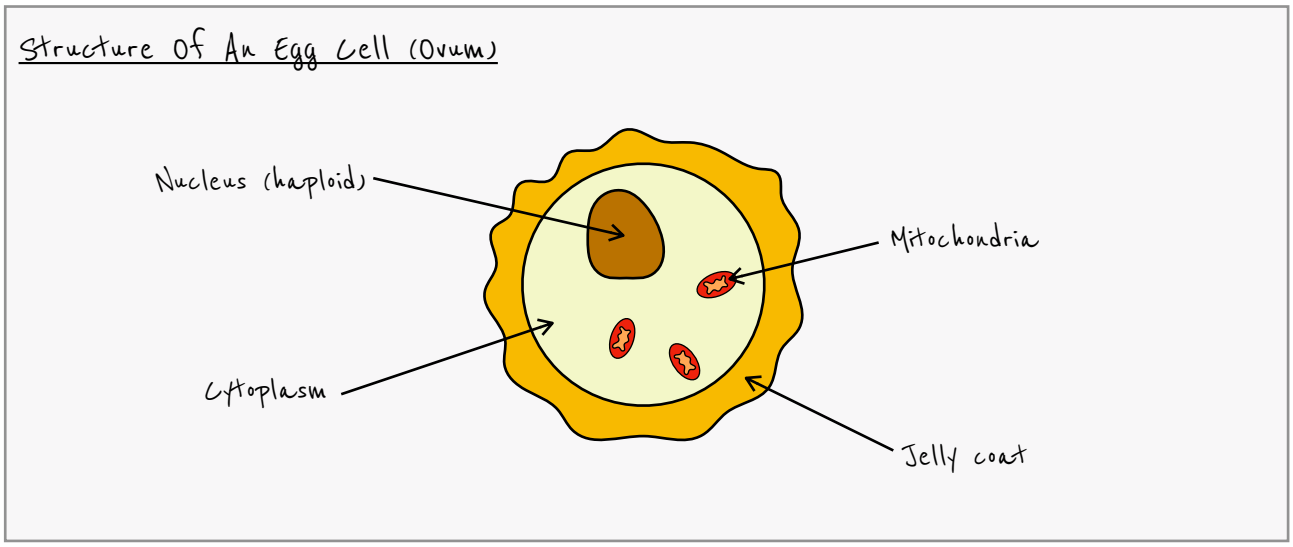
What are the adaptive features of egg cells (ova)?

- Energy stores (protein and fat) to supply energy for early development
  - Required for making new cells after fertilisation, making membranes, enzymes, mitosis
- Jelly coat changes and hardens at fertilisation to allow entry of only one male nucleus



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Compare the male and female gametes

	Sperm	Egg
Size	Very small (approx. 60µm)	Large (0.15-0.2mm)
Motility	Motile - flagella used for 'swimming'	Immobile - passively moves through oviduct in fluid
Numbers	Millions released in each ejaculate	One released by ovaries each month from puberty to menopause

What happens after fertilisation?

- Zygote forms embryo
- Embryo is ball of cells that implants into uterus wall

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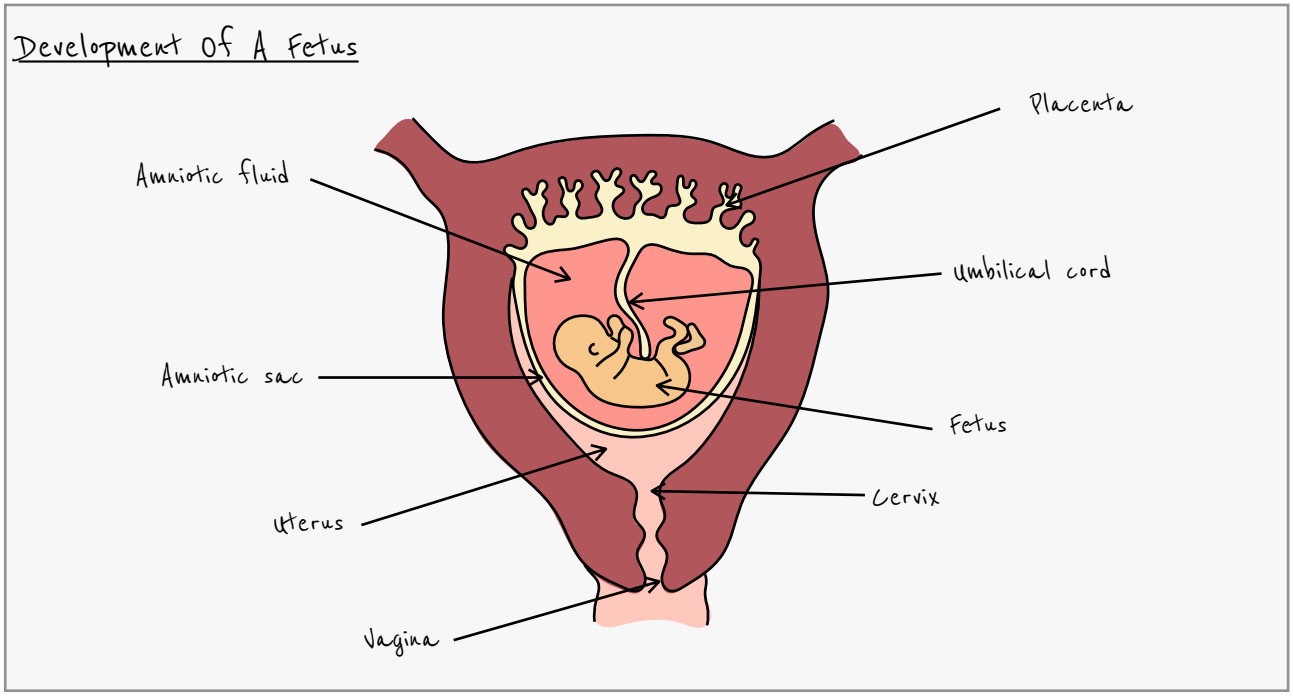

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State the function of the umbilical cord, placenta, amniotic sac and amniotic fluid

Structure	Function
Umbilical cord	- Connects fetus to placenta - Transports blood to and from fetus and placenta
Placenta	- Oxygen and nutrients transferred from mother to fetus - Antibodies transferred from mother to fetus - Excretory products (carbon dioxide and urea) transferred from fetus to mother - Prevents mixing of blood from mother and fetus - Protects fetus from blood pressure changes, pathogens and antigens (e.g. different blood groups) - Secretes hormones during pregnancy
Amniotic sac	- Encloses amniotic fluid - Prevents entry of pathogens
Amniotic fluid	- Fluid surrounding fetus - Protects fetus from mechanical shock
Uterus	- Protects fetus from physical damage

Explain how a fetus can be poisoned by toxins in the mother's blood
- *Some toxins can cross placenta*
  - *e.g. nicotine can cross placenta and affect fetus*

16.5 Sexual hormones in humans

Where is testosterone made?
- Testes

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What is the role of testosterone?
- Stimulates testes to produce sperm
- Secondary sexual characteristics:
  - Penis and scrotum get larger
  - Behaviour changes, aggression, territorial, attracted to girls
  - Facial and chest hair start to grow
  - Broader chest, larger muscles, deeper voice

How long does the human menstrual cycle last?
- Approximately 28 days

On which day is the egg usually released (ovulation)?
- 14

What is menstruation?
- Breakdown of thickened uterus lining
- Occurs when egg has not been fertilised

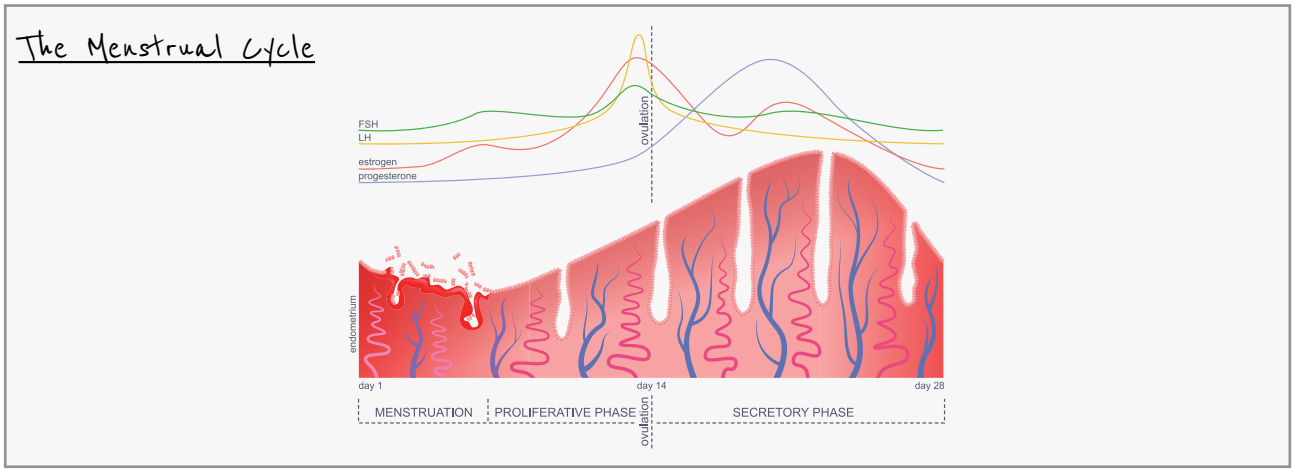
How long does menstruation last?
- 5 - 7 days

Where is oestrogen made and what is its function?
- Ovaries
- Stimulates secondary sexual characteristics e.g. hips widening, breast growth, pubic hair
- Causes thickening of uterus lining
- Inhibits FSH production, stimulates LH production

Where is progesterone made and what is its function?
- *Initially corpus luteum, later in pregnancy the placenta*
- *Maintains uterus lining*
- *Inhibits release of LH and FSH*

Where is FSH (Follicle Stimulating Hormone) made and what is its function?
- *Pituitary gland*
- *Matures eggs in ovaries*
- *Stimulates ovaries to produce oestrogen*
- *Stimulates sperm production in males*

Where is LH (Luteinising Hormone) made and what is its function?
- *Pituitary gland*
- *Causes ovulation (egg release from ovary)*
- *Stimulates sperm production in males*



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Explain the hormonal control of menstruation
- *Pituitary gland produces FSH → stimulates development of a follicle in the ovary*
  - *Egg develops inside follicle*
- *Follicle produces oestrogen*
  - *Oestrogen causes growth and repair of uterus lining*
  - *Inhibits production of FSH*
- *When oestrogen reaches high enough level → stimulates release of LH from pituitary gland*
  - *LH causes ovulation (approximately day 14 of cycle)*
- *Follicle becomes corpus luteum → starts producing progesterone*
  - *Progesterone maintains uterus lining*
- *If the ovum not fertilised → corpus luteum breaks down, progesterone levels drop*
  - *Causes menstruation*
  - *Uterus lining breaks down and is removed through the vagina*
- *If fertilisation occurs → corpus luteum continues to produce progesterone*
  - *Prevents uterus lining from breaking down and aborting pregnancy*
  - *After placenta develops, it secretes progesterone throughout pregnancy*

Describe the changes that take place in the uterus during the menstrual cycle
- Uterus lining thickens
- Progesterone maintains lining
- If fertilisation has not occurred, lining breaks down and is shed
- If egg is fertilised, lining not broken down

Describe the passage of sperm in the female human
- Semen (contains sperm and fluid from seminal vesicles) is ejaculated into the vagina
- Sperm swim through uterus to oviduct

Where does fertilisation take place?
- Oviduct

16.6 Sexually transmitted infections

What is a sexually transmitted infection (STI)?
- Infection transmitted through sexual contact

What is human immunodeficiency virus (HIV)?
- A pathogen that causes an STI

How does HIV affect the body?
- Can lead to AIDS
- Affects immune system - reduces lymphocyte numbers
- Reduced ability to produce antibodies

How is HIV transmitted?
- Unprotected sex with an infected person
- Contact with infected blood (e.g. blood transfusion)
- Mother to child
- Sharing syringes

How is the spread of STIs controlled?
- Individuals should use condoms, know partners' sexual history and have medical checks
- Communities can offer testing
- Tracing sexual contacts to identify source
- Worldwide education programmes
- Providing antibiotics, vaccines and antiviral drugs

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17. INHERITANCE

17.1 Chromosomes, genes and proteins

What is a chromosome?
- Thread like structure of DNA
- Carries genetic information in the form of genes

What is a gene?
- Length of DNA that codes for a protein

What is an allele?
- Alternative forms of the same gene which gives rise to different characteristics

How is sex inherited in humans?
- One sex chromosome inherited from each parent
  - Females are XX
  - Males are XY
- Inherit an X from the mother, and either X or Y from father
- 50:50 chance of offspring being male or female

Sex Inheritance

Draw a Punnett square to show how sex is inherited in humans. Females are XX, males are XY

	Mother	**Father**
Phenotype	Female	Male
Genotype	XX	XY
Gametes	X or X	X or Y

		Father	
		X	**Y**
Mother	X	XX (Female)	XY (Male)
	X	XX (Female)	XY (Male)

Result: 50% female, 50% male

What is the role of genes?
- *Control the activities of the cell*
- *Determines the sequence of amino acids used to make a specific protein*

What are the four DNA bases?
- *Adenine (A)*
- *Thymine (T)*
- *Cytosine (C)*
- *Guanine (G)*

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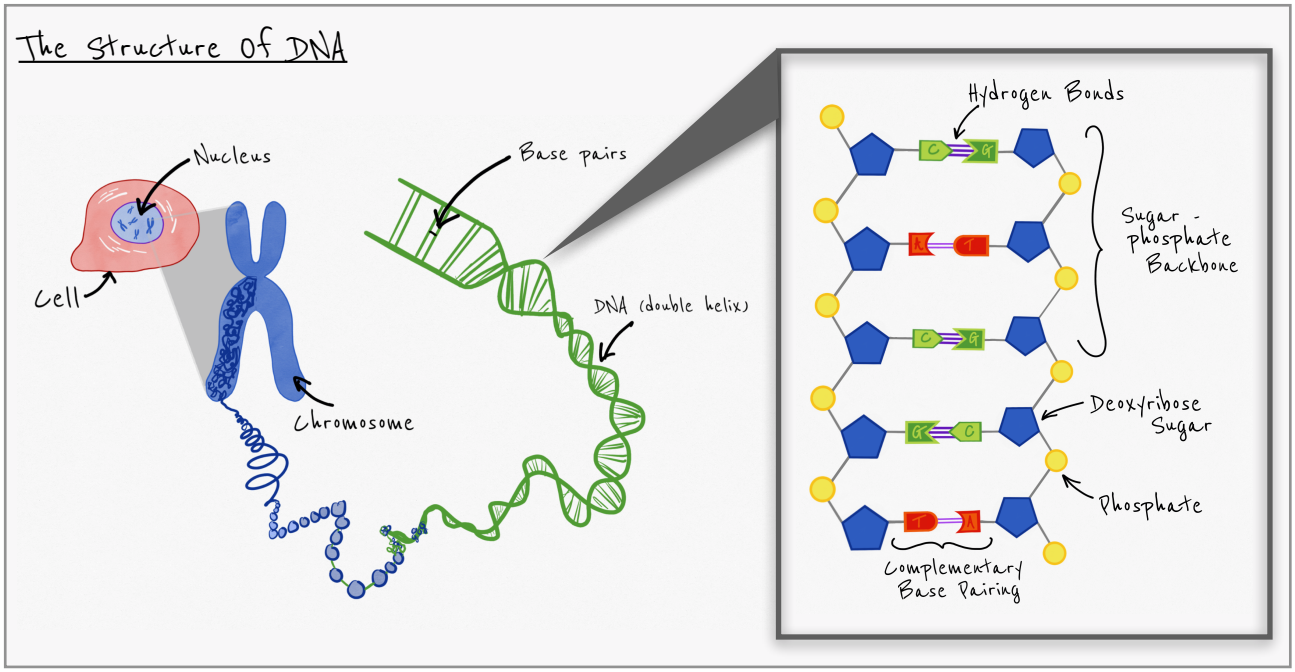
Describe base pairing in DNA
- *Adenine (A) - Thymine (T)*
- *Cytosine (C) - Guanine (G)*

Describe the structure of DNA
- *2 strands*
- *Coiled to form double helix*
- *Strands linked by paired bases*
  - *Adenine to thymine, guanine to cytosine*



Credit: Virginia Caddick for SwH Learning

How does DNA control cell functions?
- *Controls production of proteins*
  - *e.g. enzymes, membrane carriers and receptors for neurotransmitters*

What is mRNA?
- *A copy of a gene*
- *moves a copy of the gene from the nucleus to the cytoplasm*

Describe the structure of RNA
- *Single stranded*
- *Contains uracil base (U) instead of thymine (T)*

Describe base pairing in RNA
- *Adenine (A) - Uracil (U)*
- *Cytosine (C) - Guanine (G)*

How does DNA differ from RNA?

	DNA	***RNA***
Sugar	*Deoxyribose*	*Ribose*
Bases	*A, T, C, G*	*A, U, C, G*
Double or single stranded	*Double stranded*	*Single stranded*
Length	*Long*	*Short*

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How is a protein made?
- *Gene in DNA coding for protein stays in nucleus*
- *mRNA forms a copy of the gene*
  - *mRNA made in nucleus and moves to the cytoplasm*
- *mRNA passes through ribosomes*
- *Ribosome assembles amino acids into proteins*
- *Specific order of amino acids determined by sequence of bases in mRNA*

Are all proteins made in all cells?
- *No*
- *Most cells contain all genes but many genes not expressed*
- *Each cell only makes the specific proteins it needs*

What is a haploid nucleus?
- *Nucleus containing single set of unpaired chromosomes*
  - *i.e. gametes*

What is a diploid nucleus?
- *Nucleus containing two sets of chromosomes*
  - *i.e. all body cells except gametes*
- *One pair of each type of chromosome*
  - *23 pairs in a human*

17.2 Mitosis

What is mitosis?
- *Nuclear division producing genetically identical cells*
- *Needed in growth, repair and replacement of cells*
- *Cell division process used for asexual replication*

How does mitosis happen?
- *Chromosomes replicate before mitosis occurs*
- *Copies of chromosomes separate*
- *Chromosome number is maintained in each daughter cell*

What is the product of one round of mitosis?
- *Two genetically identical cells*
- *Cells are diploid*

What is a stem cell?
- *Unspecialised cell*
  - *Has potential to divide many times whilst remaining undifferentiated*
- *Divides by mitosis to produce daughter cells*
- *Daughter cells can become specialised for specific functions*

17.3 Meiosis

What is meiosis?
  - *Nuclear division involved in producing gametes*

Where does meiosis occur?
- *Sex organs*
  - *Meiosis produces gametes*

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Why is meiosis known as a 'reductive division'?
- *Chromosome number is halved (from diploid to haploid)*
- *Results in genetically varied daughter cells*
  - *New combinations of maternal and paternal genes made*

What is the product of one round of meiosis?
- *4 genetically varied cells*
- *Haploid*

Compare the features of mitosis and meiosis

Feature	***Mitosis***	***Meiosis***
Number of cell divisions	*1*	*2*
Number of daughter cells formed	*2*	*4*
Number of chromosomes in cells formed	*Diploid*	*Haploid*
Type of cells formed	*Body cells*	*Sex cells (gametes)*
Genetic variation in cells formed	*None*	*Variation*

17.4 Monohybrid inheritance

Define 'inheritance'
- Transmission of genetic information from generation to generation

Define 'genotype'
- Genetic make-up of an organism
  - i.e. which alleles are present in the organism's genome

Define 'phenotype'
- Observable features of the organism

Define 'homozygous'
- Having two identical alleles of a gene

Define 'pure-breeding'
- When two identical homozygous individuals breed together

Define 'heterozygous'
- Having two different alleles of a particular gene
  - A heterozygous individual cannot produce pure-bred offspring

Define 'dominant'
- An allele that is expressed where it is present
  - Only one dominant allele require for phenotype to be expressed

Define 'recessive'
- Allele only expressed when there is no dominant allele present
  - Phenotype only expressed if both alleles are recessive

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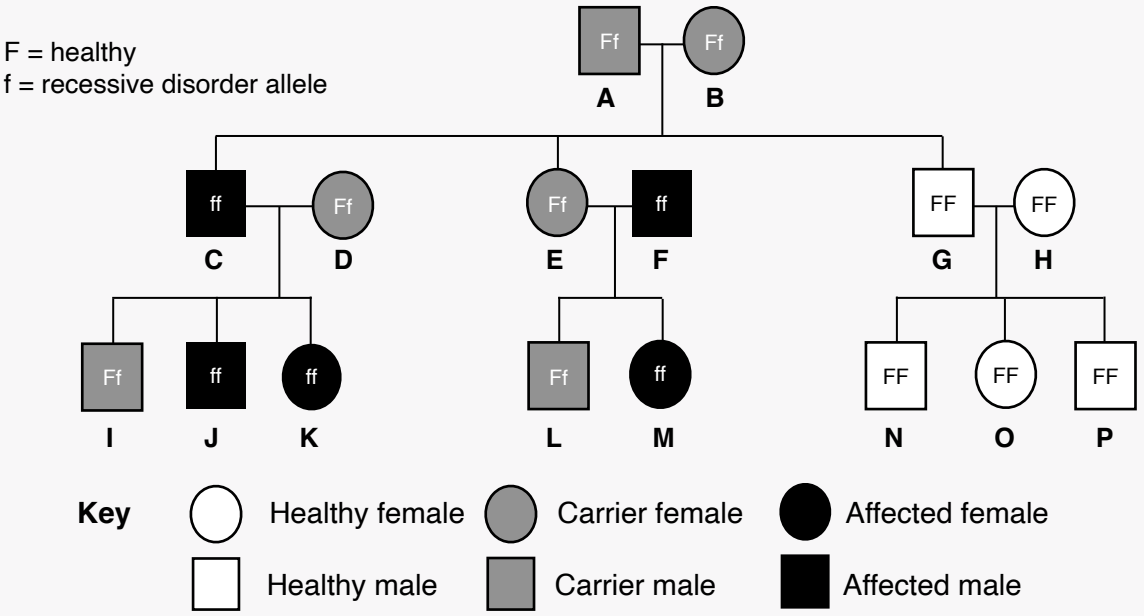
What is a pedigree diagram?
- Shows how a genetic condition is passed from generation to generation
- Possible to work out which is the dominant allele
- Can then work out genotype of each person/animal in the pedigree

Example of A Pedigree Chart For A Recessive Genetic Disorder Allele (Non Sex-Linked)



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How to read a pedigree chart:

- Determine whether trait is dominant or recessive
  - If trait is dominant, one of the parents **must** have the trait
  - Dominant traits will not skip a generation
  - If trait is recessive, it is possible neither parent displays the phenotype as they can both be heterozygous (carriers)

- Determine if chart shows a sex-linked trait or not
  - If trait is X-linked recessive, males are much more commonly affected than females
  - If trait is not sex-linked, both males and females are equally likely to be affected

What is a carrier?
- Someone who has a gene for a disease but does not suffer from any symptoms
  - Occurs when disease caused by recessive allele
  - Carrier must be heterozygous

Define monohybrid inheritance
- Single gene responsible for phenotype

Define polygenic inheritance
- Many genes combine to give phenotype
- Most phenotypic features are a result of polygenic inheritance

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Genetic Crosses - Punnett Squares (ALWAYS SET OUT YOUR ANSWER LIKE THIS)

Example 1: Monohybrid Cross With 1:1 Ratio

A mother is recessive and has blonde hair (bb), and a father is heterozygous and brown haired (Bb). Calculate the probability of their children having blonde hair.

First, create a table with the information provided

	Mother	Father
Phenotype	Blonde	Brown
Genotype	bb	Bb
Gametes	b or b	B or b

Then carry out your Punnett square

		Father	
		B	**b**
Mother	**b**	Bb (Brown hair)	bb (Blonde hair)
	b	Bb (Brown hair)	bb (Blonde hair)

Result: 50% blonde hair, 50% brown hair

Example 2: Monohybrid Cross With 3:1 Ratio

Cystic fibrosis is a recessive genetic disorder. A mother and father are both carriers for the recessive cystic fibrosis gene (c). Calculate the probability that their child has cystic fibrosis.

	Mother	Father
Phenotype	Carrier	Carrier
Genotype	Cc	Cc
Gametes	C or c	C or c

		Father	
		C	**c**
Mother	C	CC Healthy	Cc Carrier
	c	Cc Carrier	cc Cystic Fibrosis

Probability of having cystic fibrosis: 25%

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What is a test-cross used for?
- *To identify the genotype of an organism showing the dominant phenotype*

How is a test-cross carried out?
- *Cross the unknown individual with individual showing recessive phenotype*
- *Offspring either 50% dominant and 50% recessive OR all dominant*
- *If any offspring have recessive phenotype → unknown individual was heterozygous*
- *If no offspring have recessive phenotype → unknown individual was homozygous*

Example 3: Carrying Out A Test Cross

In a species of pea plant, height is controlled by one gene. The allele for tall (P^T) is dominant to the allele for short (P^t). A test cross is used to identify the genotype of a tall pea plant. Give the potential genotypes and phenotypes of the offspring if the tall pea plant is a) homozygous and b) heterozygous.

A) Homozygous

		Known Plant (Homozygous Recessive)	
		P^t	**P^t**
Unknown Plant (Homozygous)	P^T	$P^T P^t$ Tall	$P^T P^t$ Tall
	P^T	$P^T P^t$ Tall	$P^T P^t$ Tall

Offspring: All tall

B) Heterozygous

		Known Plant (Homozygous Recessive)	
		P^t	**P^t**
Unknown Plant (Heterozygous)	P^T	$P^T P^t$ Tall	$P^T P^t$ Tall
	P^t	$P^t P^t$ Short	$P^t P^t$ Short

Offspring: 50% tall, 50% small

Define 'codominance'
- *If two alleles in heterozygous genotype are expressed in the same phenotype*
  - *e.g. AB blood group*
  - *e.g. allele for red petals (P^R) and allele for white petals (P^W) combining to produce pink petals ($P^R P^W$)*

Outline codominance in ABO blood groups
- *A and B are codominant*
- *Both A and B are dominant over O*
  - *O is recessive*

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Outline how the different blood group phenotypes arise

Genotype	Phenotype (blood group)
I^AI^A Or I^AI^O	A
I^BI^B OR I^BI^O	B
I^AI^B	AB (co-dominant)
I^OI^O	O

Example 4: Inheritance of ABO Blood Groups

A heterozygous female with blood group A has a child with a heterozygous male with blood group B. Work out the possible blood groups of the offspring.

	Mother	Father
Phenotype	A	B
Genotype	I^AI^O	I^BI^O
Gametes	I^A or I^O	I^B or I^O

Punnett square:

		Father	
		I^B	**I^O**
Mother	**I^A**	I^AI^B AB	I^AI^O A
	I^O	I^OI^B B	I^OI^O O

Possible blood groups: AB, A, B, O (1:1:1:1 ratio)

What is a sex-linked characteristic?
- *Gene responsible for phenotype located on sex chromosome*
- *More likely to occur in one sex than the other*
  - *e.g. red-green colour blindness*

Why are sex-linked diseases usually associated with the X chromosome?
- *Y chromosome is much shorter than the X chromosome*
- *Comparatively few genes exist on the shorter Y chromosome*

Why are X-linked dominant traits more common in females?
- *Females have two X chromosomes = two alleles*
- *Either allele may be dominant and cause disease*
- *Can be either homozygous or heterozygous*

Why are X-linked recessive traits more common in males?
- *Males have only one X chromosome = one allele*
- *Condition cannot be masked by a second allele*

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For sex-linked diseases:
- *Only females can be carriers*
- *Males always inherit X-linked trait from mother*
- *Females cannot inherit X-linked recessive condition from unaffected father*

Example 5: Sex-Linked Inheritance

Red-green colour blindness is a recessive sex-linked disorder. The allele for colour blindness (X^c) is located on the X chromosome. A heterozygous female (X^CX^c) has a child with a normal-sighted male (X^CY). What are the possible genotypes and phenotypes of the offspring?

	Mother	**Father**
Phenotype	Female - carrier	Male - normal vision
Genotype	X^CX^c	X^CY
Gametes	X^C or X^c	X^C or Y

Punnett square:

		Father	
		X^C	Y
Mother	**X^C**	X^CX^C Female - normal vision	X^CY Male - normal vision
	X^c	X^CX^c Female - normal vision (carrier)	X^cY Male - colour blind

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18. VARIATION AND SELECTION

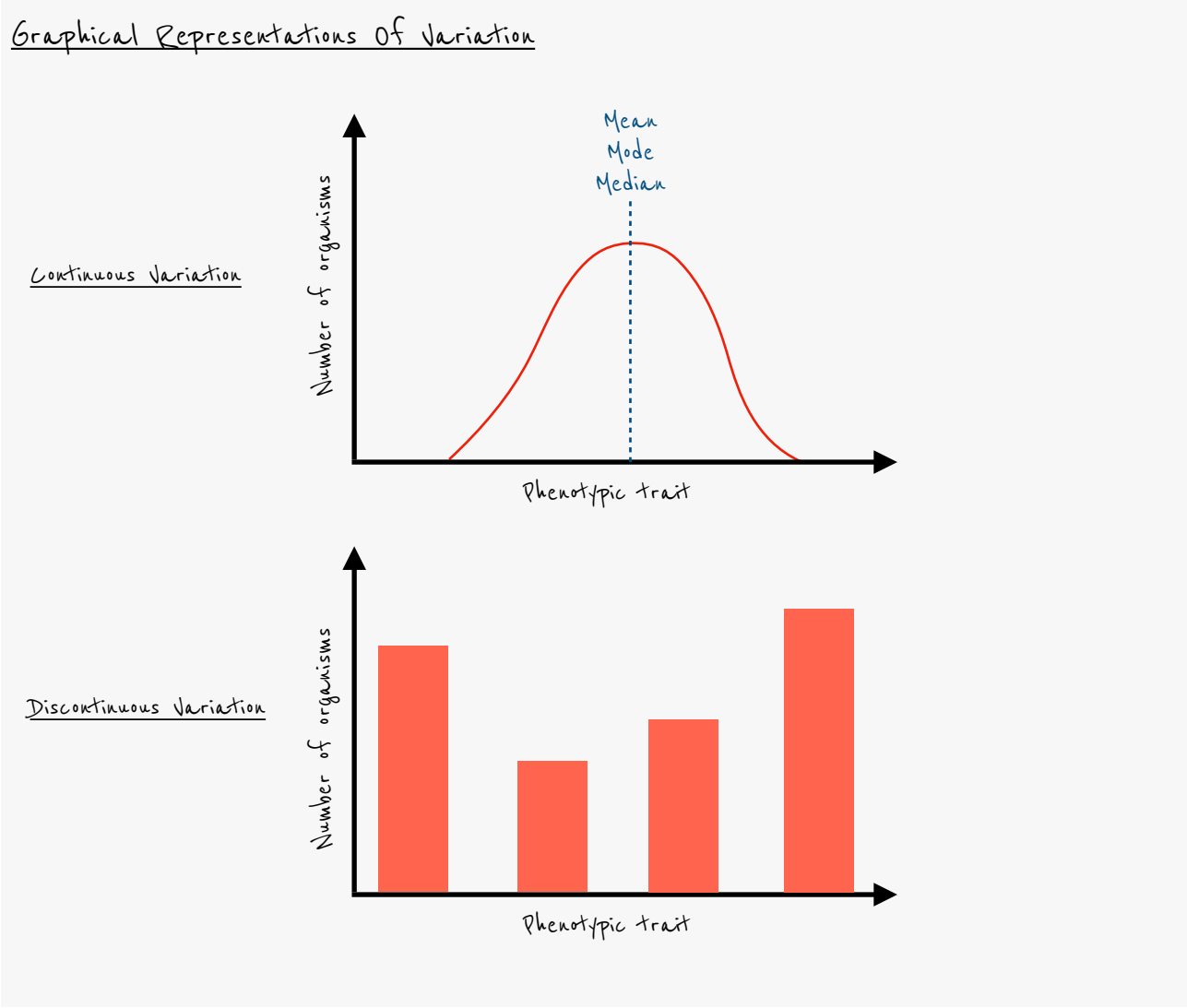
18.1 Variation

What is variation?
- Differences between individuals of same species

What two types of characteristics caused by variation exist?
- Discontinuous (discrete)
- Continuous

Define continuous variation
- Data can take a range of values between two extremes
- It is not categoric
- May be affected by both genes and the environment
  - e.g. body length and mass

Define discontinuous variation
- Data can only take particular values with no intermediates
- It is categoric
- Usually affected by genes alone (not the environment)
  - e.g. blood groups are A, AB, B, O
  - e.g. seed shape and colour in peas, fur colour in animals



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Explain the difference between continuous and discontinuous variation

Continuous	Discontinuous
Characteristic can take any value within a range	Characteristic can take only specific values
Affected by environmental and genetic factors	Affected by only genetic factors
e.g. height - genes affect potential height but diet can limit this potential	e.g. ability to roll tongue - people do or do not have this ability, it cannot be learnt

What is phenotypic variation?
- Different observed characteristics
- Caused by genetic and environmental factors

What is genetic variation?
- Different genes between individuals
- May have the same phenotype

Define ‘mutation'
- Genetic change

Define ‘gene mutation’
- *Random change in the base sequence of DNA*

How are new alleles made?
- Through mutation

How is the rate of mutation increased?
- By ionising radiation
- Certain mutagenic chemicals

How does genetic variation occur?
- *Random fertilisation of gametes*
- *Random mating → mixing of alleles from both parents*
- *Meiosis*
- *Mutation*

18.2 Adaptive features

Define ‘adaptive feature’
- Inherited feature
- Helps an organism to survive and reproduce in its environment

Define ‘fitness’
- Probability of an organism surviving and reproducing in their environment

How is a camel adapted to live in hot, dry conditions?
- Large feet - decrease pressure - prevent sinking into sand
- Long eye lashes - protect eyes
- Humps contain fat - can be converted to water during drought
- Short fur, thin fat layer increases heat loss
- Large SA:Volume ratio

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How is a polar bear adapted to live in cold conditions?
- Large feet - decrease pressure - prevent sinking into snow
- Thick fur, thick fat layer - reduces heat loss
- Small ears - reduce heat loss
- White - camouflage
- Small SA:Volume ratio

Define 'hydrophyte'
- *Plant that lives on water*
  - *e.g. water lily*

Define 'xerophyte'
- *Plant that lives in very dry conditions*
  - *e.g. cactus*

Explain the adaptive features of hydrophytes and xerophytes

Hydrophyte (e.g. water lily)	***Xerophyte (e.g. cactus)***

- *Little lignin*
  - *Plant supported by water so does not need additional strength in stem*
- *Very thin cuticle*
  - *Surrounded by water*
  - *Water loss not therefore a problem*
- *Stomata on upper surface*
  - *CO_2 absorbed from atmosphere*
  - *Bottom of leaf is on/in water*
	- *Green stem*
	  - *Stem can carry out photosynthesis*
	- *Leaves reduced to spines*
	  - *Reduced surface area to limit water loss*
	- *Swollen stem*
	  - *Stores water for times of drought*
	- *Deep roots*
	  - *Increases ability to absorb water*

18.3 Selection

Describe the process of natural selection
- Genetic variation within any population due to mutation
- Many offspring produced
- Leads to competition for resources
- Individuals better adapted more likely to survive and reproduce
- Alleles passed onto offspring
- Repeats over many generations
- Selected for alleles become more prominent in population

Define 'evolution'
- Change in adaptive features of a population over time
- Result of natural selection
- An example is bacterial resistance to antibiotics

Describe the process of adaptation
- *Process resulting from natural selection*
- *Populations become more suited to their environments*
- *Takes place over many generations*

How may natural selection lead to development of antibiotic resistant bacteria?
- *Genetic variation means some bacteria have mutations for antibiotic resistance*
- *If antibiotic used, these bacteria better adapted to survive and duplicate*
- *Favourable alleles passed on to future bacteria*
- *Soon whole population of bacteria is resistant to the antibiotic*

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Describe the process of selective breeding
- Humans select individuals with desirable features
- These are crossed to produce next generation
- Offspring that show desirable traits are selected and crossed again

Describe selective breeding in plants
- Humans choose plants with desirable characteristics (e.g high yield, disease/pest resistance)
- Cross pollinate selected plants
- Plants that grow with desirable characteristics are chosen and crossed
- Process repeats over many generations

Describe selective breeding in domesticated animals
- Humans choose individual animals with desirable characteristics (e.g more milk production, better quality fur)
- Make them breed (or use artificial insemination)
- Offspring with desirable characteristics are bred
- Process repeats over many generations

Describe how selective breeding could be used to increase milk production
- Cow with high milk yield chosen
- Bull with high milk yield mother chosen
- Cow and bull bred
- Repeat process with high milk yield offspring
- Over many generations

Describe the differences between selective breeding (artificial selection) and natural selection
- *Humans choose parents in selective breeding*
- *Selective breeding is a faster process*
- *No survival of the fittest with selective breeding*

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19. ORGANISMS AND THEIR ENVIRONMENT

19.1 Energy flow

What is the main energy source for biological systems?
- The sun

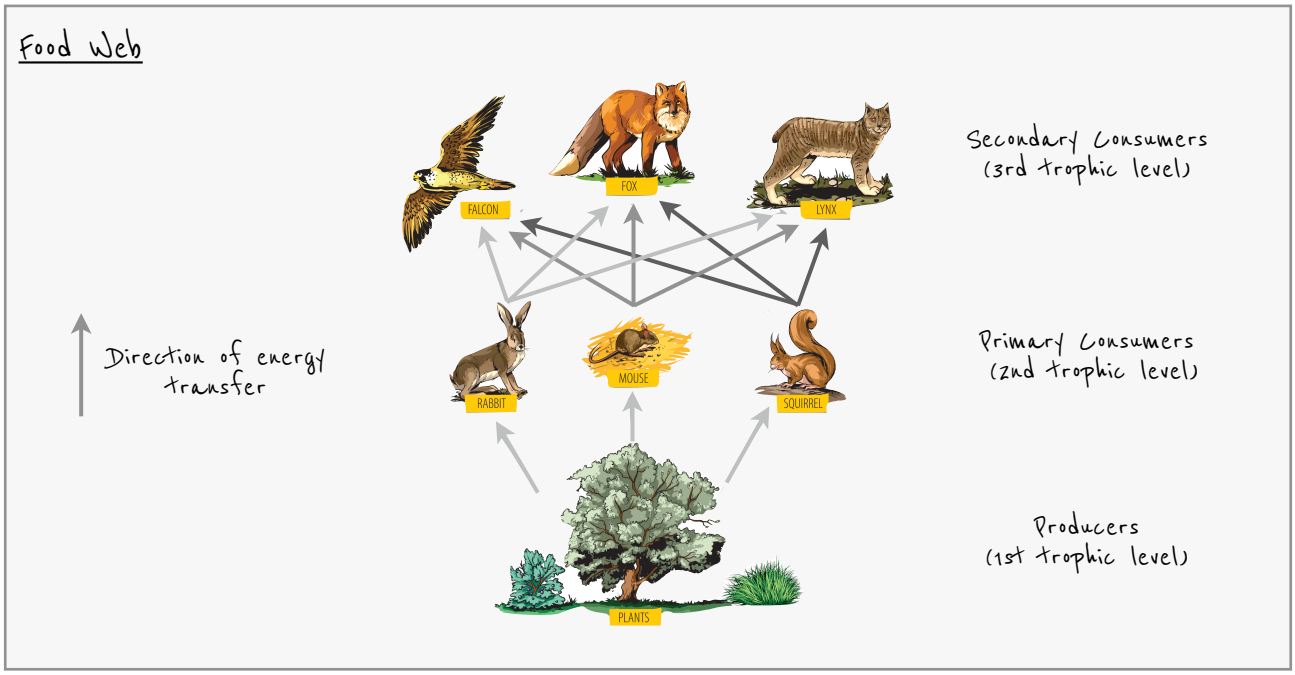
Describe the flow of energy through living organisms
- Light energy from Sun transferred to chemical energy by plants
- Energy flows through living organisms as one organism eats another
- Eventually energy transferred to the environment
  - By excretion, decomposition, respiration

19.2 Food chains and food webs

Describe a food chain
- Shows transfer of energy from one organism to the next
- Begins with a producer (plant / photosynthetic organism)

Describe a food web
- Network of interconnected food chains

What do the arrows in a food chain/web represent?
- Direction of energy transfer



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Define 'trophic level'
- Position in a food chain / web
  - e.g. producer, primary consumer, secondary consumer, tertiary consumer

Define 'producer'
- Organism that makes its own organic nutrients
  - e.g. plants produce food by photosynthesis using light energy from Sun

.

Define 'consumer'
- Organism that eat plants or other animals to obtain energy

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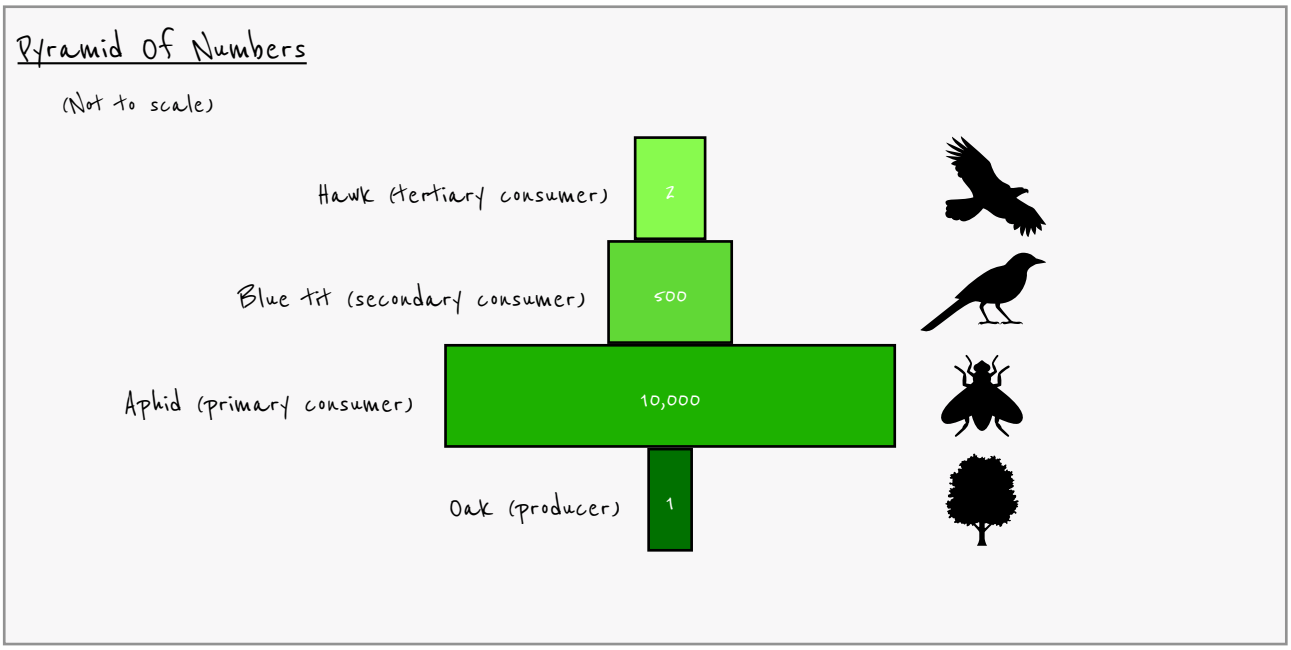
What is a herbivore?
- Animal that gets its energy from eating plants

What is a carnivore?
- Animal that gets energy by eating other animals

What is a decomposer?
- Organism that gets its energy from dead or waste organic material
- Help to recycle nutrients

What impact have humans had on food chains?
- Over harvesting of food species deprives consumers of food
  - Consumers may switch to eating other foods
- Introducing foreign species means more competition for food
  - Less food available for others

What is a pyramid of numbers?
- Diagram representing numbers of organisms at each trophic level
- In a given ecosystem at any one time



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What is a pyramid of biomass?
- Represents the biomass (number of individuals x their mass)
- At each trophic level at any one time

What is biomass?
- The total amount of living material in an organism

How is biomass measured?
- Organism killed
- Heated to remove water
- Constant dry mass measured

Why are pyramids of biomass always pyramid shaped?
- Mass of organisms has to decrease up a trophic level
- Energy transferred must support each population

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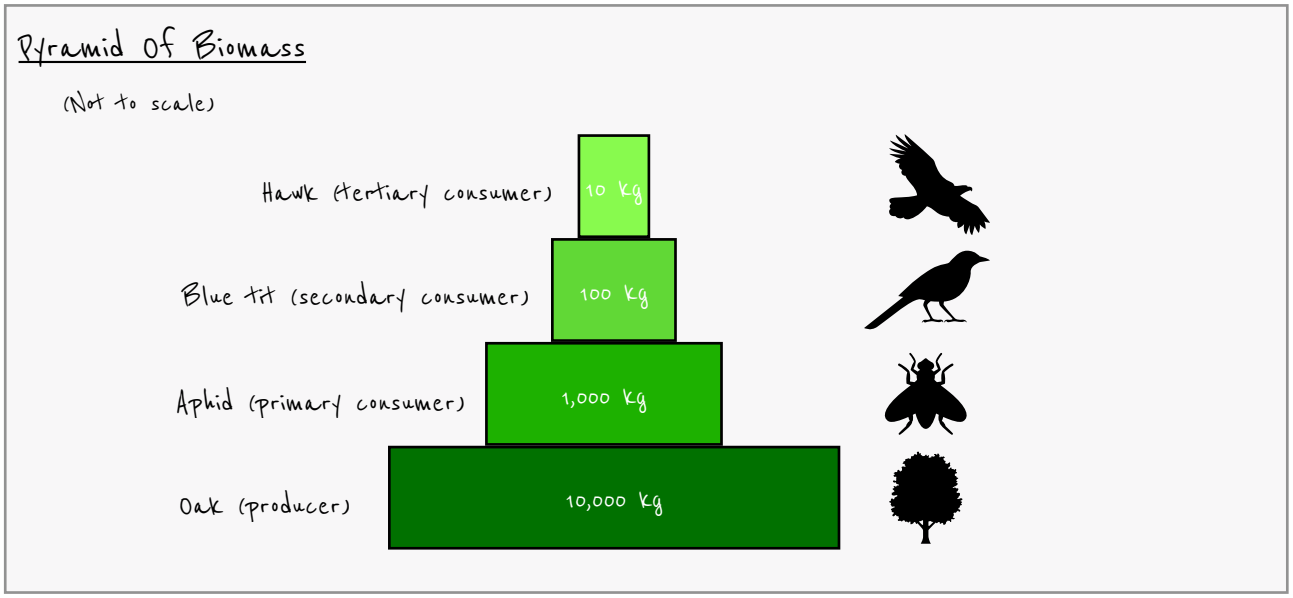

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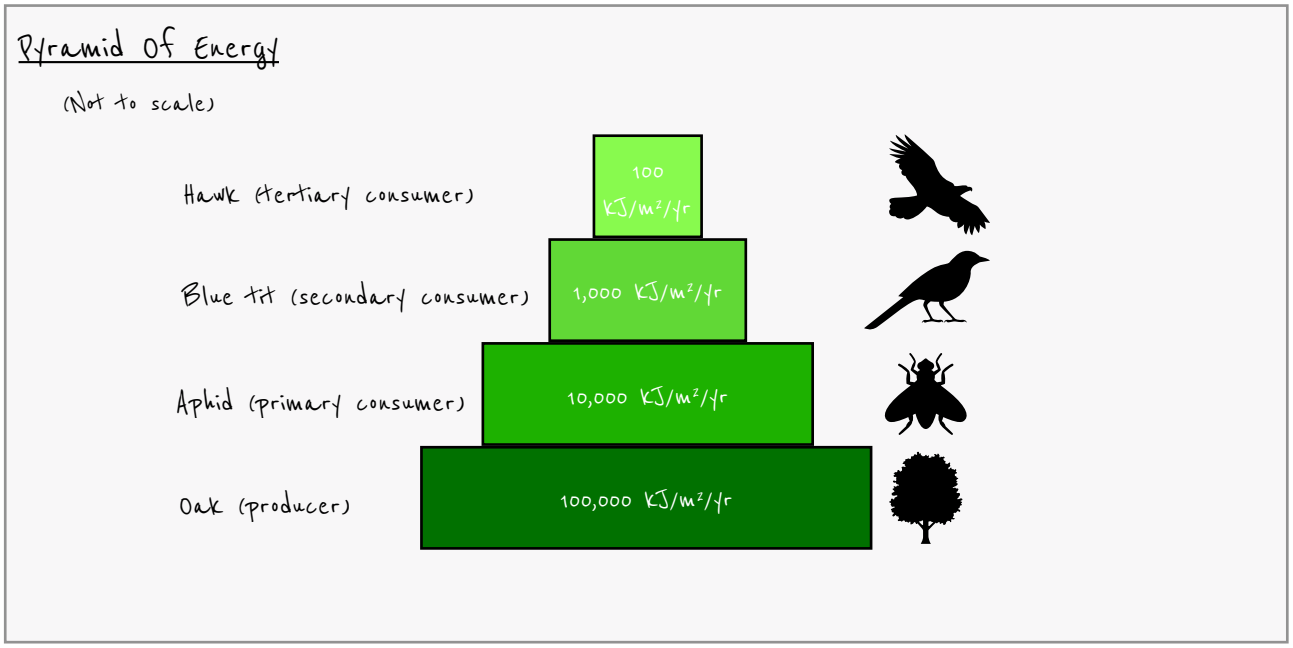
Give the advantages and disadvantage of using a pyramid of biomass
- Advantage
  - More accurate as organism's size taken into account
  - Solves scale and inversion problems with pyramid of numbers
- Disadvantage
  - Data difficult to obtain as dry mass required

What is a pyramid of energy?
- *Shows amount of energy trapped per unit time and area at each stage of a food chain*

What does the area of each box in a pyramid of energy represent?
- *Quantity of energy present*



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Give the advantages of using a pyramid of energy
- *Always forms a pyramid*
- *Allows comparison of species of similar biomass but very different lifespans*

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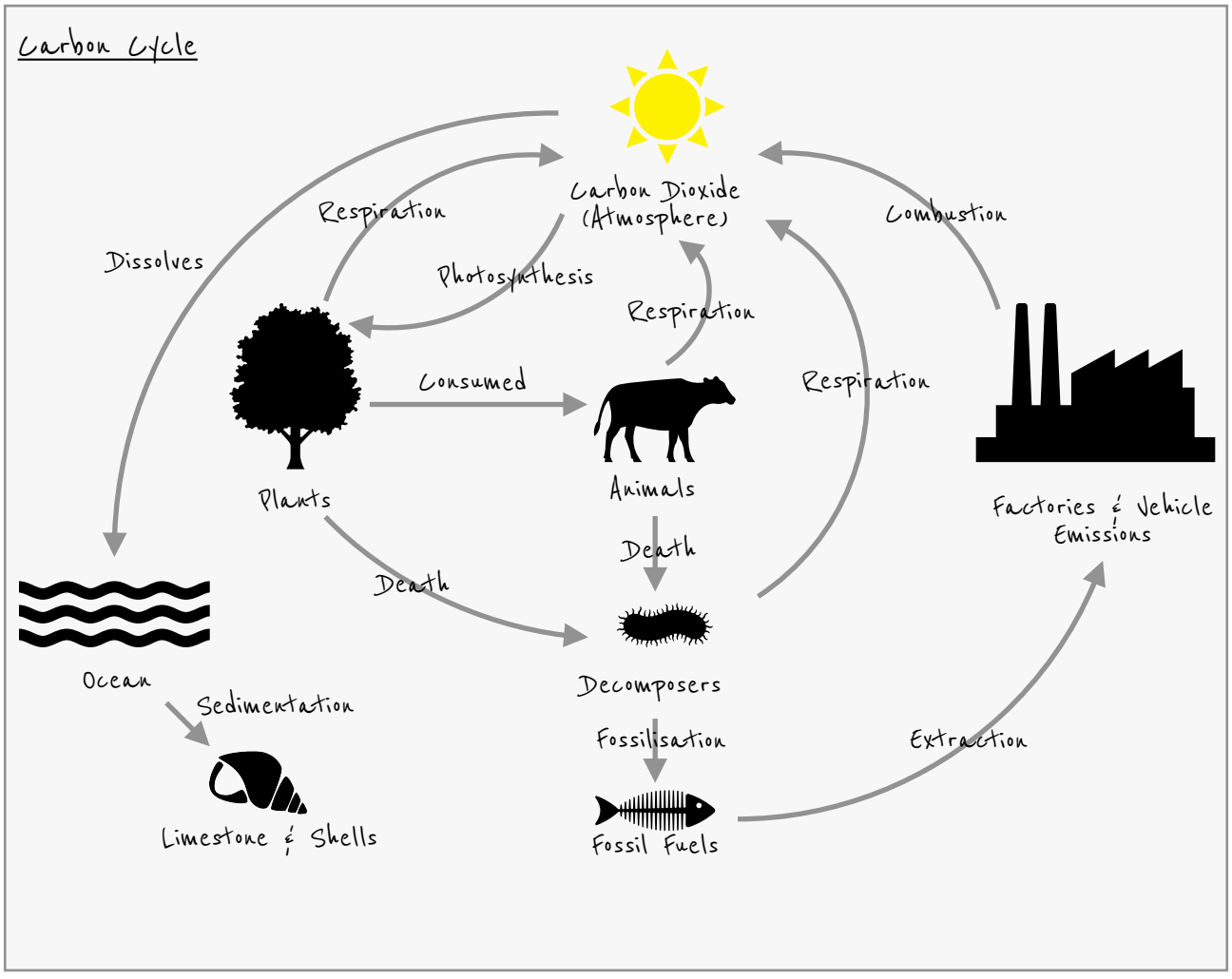
Explain why only 10% of energy is transferred from one trophic level to the next
- *Not all of the plant is eaten (in the case of producer → primary consumer)*
- *Some parts are indigestible (in the case of producer → primary consumer)*
- *Some energy lost in excretory products e.g. sweat, urine*
- *Respiration leads to loss of carbon dioxide and water*
- *Maintenance of steady body temperature (e.g. homeostasis in cows)*

Why do most ecosystems have large numbers/biomass at the bottom of the pyramid and less at the top?
- *Energy lost between trophic levels*
  - *e.g. through excretory products, respiration, homeostasis*
- *Not enough energy at the top of the pyramid to support large number of organisms*
- *Not all organisms are eaten at each trophic level*

Why are food chains usually less than 5 trophic levels?
- *Energy lost between each trophic level*
- *Too little energy left for upper levels to survive*

Why are plants more efficient than livestock for human food?
- *Plants are first trophic level (producers)*
- *Less energy lost by eating crop plants*
- *80-90% of energy lost in feeding plants to animals then eating the animals*

19.3 Nutrient cycles



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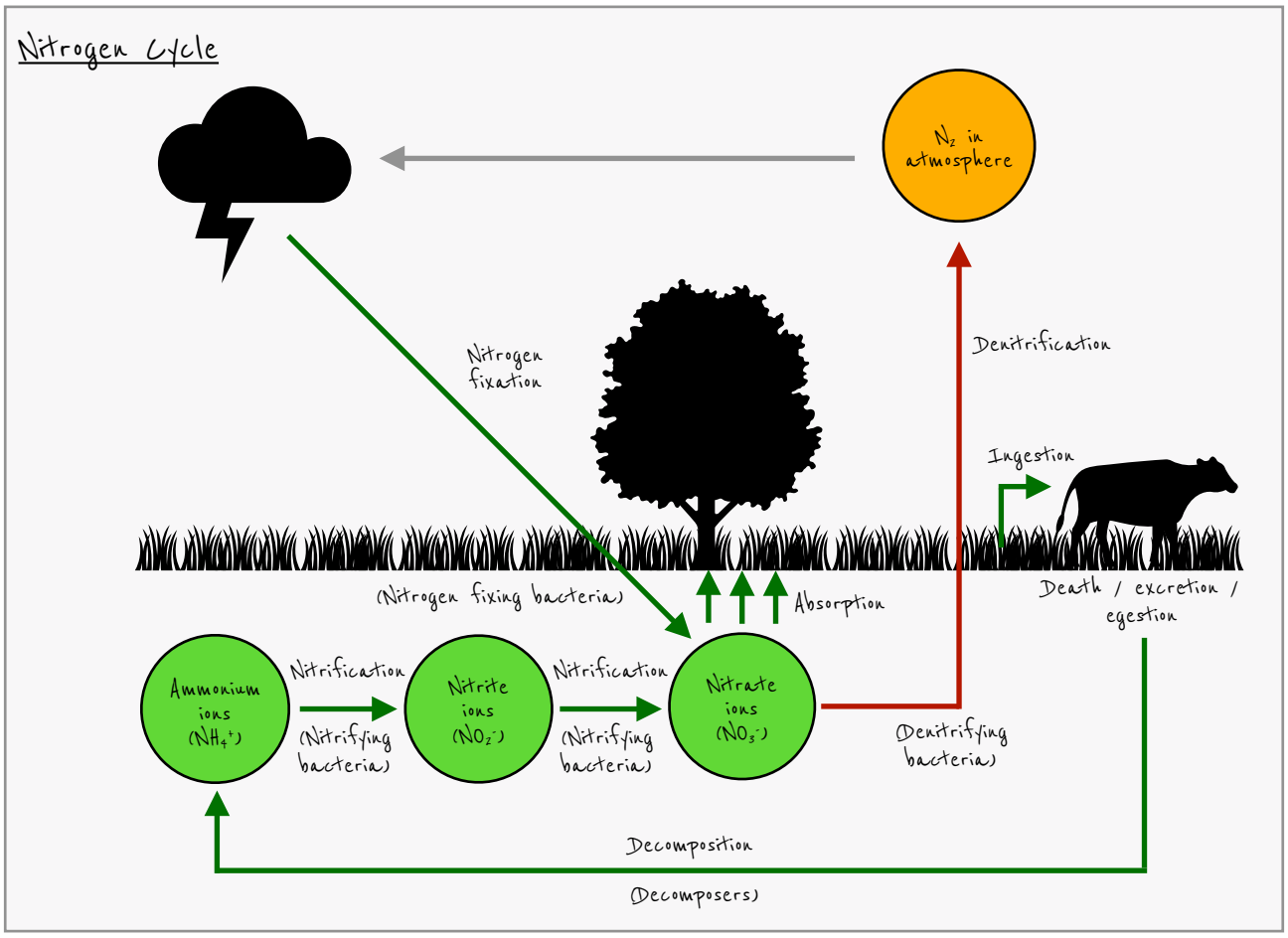
Describe the carbon cycle
- Carbon dioxide is absorbed by green plants in photosynthesis
  - Use carbon and light energy to make glucose and proteins
- Plants respire releasing carbon dioxide
- Plants eaten by animals and carbon becomes part of their bodies
- Animals respire releasing carbon dioxide
- Plants and animals die and are decomposed by microorganisms
- Microorganisms respire, releasing carbon dioxide
- Complete combustion of fossil fuels releases carbon dioxide

What is the effect of burning fossil fuels and cutting down forests?
- CO_2 in fossil fuels and trees is released into the atmosphere
- Levels of CO_2 increase
- Causes global warming and climate change



Credit: Martin Bailey for SwH Learning

Describe the nitrogen cycle
- *Nitrogen fixing bacteria are present on root nodules of beans and peas and convert nitrogen gas in air into nitrates which are added to the soil*
  - *Lightning and the Haber Process are other sources of nitrogen fixation*
- *Nitrates used to build plant amino acids and DNA*
- *Plants and animals die, decompose, and are converted to ammonium ions by decomposers*
  - *Nitrogen also returned to soil in the waste product urea after deamination has occurred*
- *Nitrifying bacteria convert ammonium ions to nitrates*
- *Denitrifying bacteria convert nitrates to nitrogen gas*

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Explain how nitrates are absorbed into plants
- *By root hair cell*
- *Using active transport across cell membranes*
  - *From low concentration to high concentration*
  - *Requires energy and protein carriers*

How do nitrate ions help plants grow?
- *Used to build amino acids and DNA*

How does the nitrogen in a nitrate ion in the soil become the nitrogen in a protein in an animal?
- *Nitrate ions absorbed by root hair cell*
  - *By active transport*
- *Plant incorporates nitrogen into amino acids / protein*
- *Plant eaten by animal*
- *Animal digests protein using protease enzymes*
- *Amino acids assimilated into animal protein*

Describe how ammonium ions can be converted to nitrate ions in the soil
- *Nitrifying bacteria*
- *Convert ammonium ions → nitrites → nitrates*

What are the roles of microorganisms in the nitrogen cycle?
- *Decomposing bacteria produce ammonium ions*
- *Nitrogen fixing bacteria make nitrate ions from nitrogen gas*
- *Nitrifying bacteria make nitrate from ammonium ions*
- *Denitrifying bacteria make nitrogen gas from nitrate ions*

19.4 Populations

Define ‘population’
- Group of organisms of one species living in same area at same time

Define ‘community’
- All populations of different species in an ecosystem

Define 'ecosystem’
- Unit containing community of organisms and their environment interacting together

Define ‘environment’
- The total non-biological components of the ecosystem
  - e.g. water, soil, air

What are biotic factors?
- Biological (living) factors
  - e.g. predation, parasitism, food availability, nesting sites, disease

What are abiotic factors?
- Non-biological (non-living) factors
  - e.g. temperature, pH of soil, light intensity, number of daylight hours

What factors affect the rate of population growth for an organism?
- Food supply - abundance of food increases rate of population growth
- Competition - increased competition for resources reduces rate of population growth
- Predation - more predation reduces rate of population growth
- Disease - reduces rate of population growth

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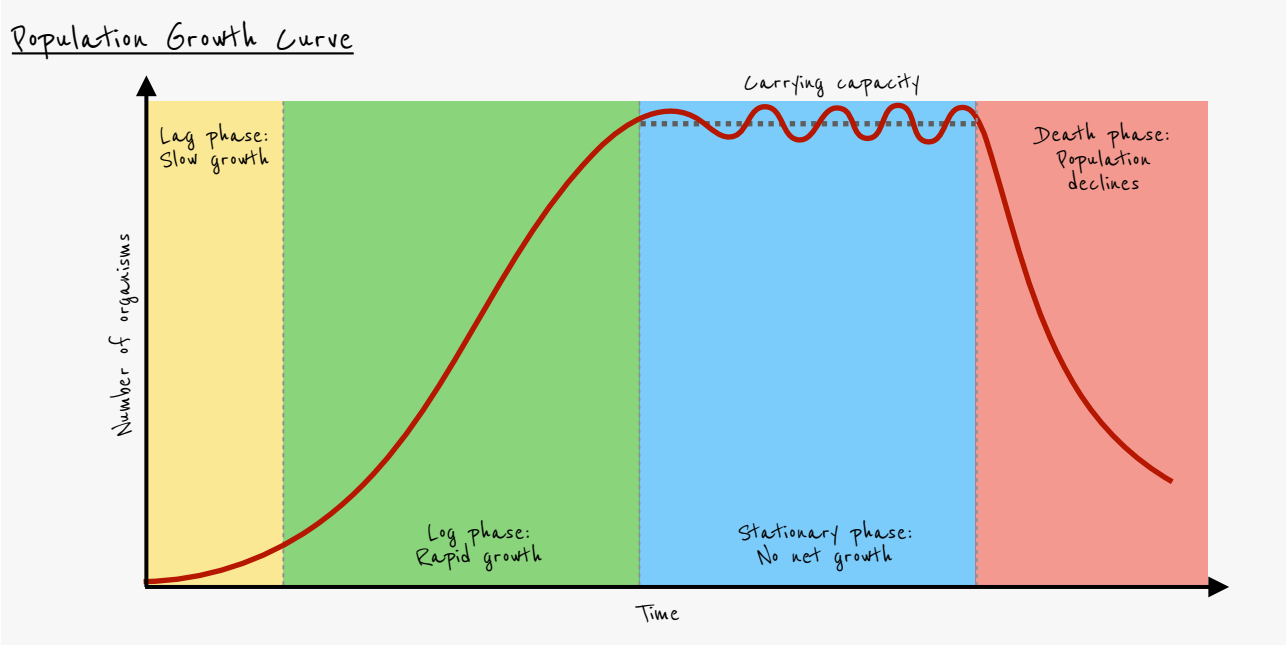
Define carrying capacity
- Maximum population size an environment can support

Give examples of abiotic factors that limit population size
- Temperature
- Light
- pH
- Water or oxygen availability

Give examples of biotic factors that limit population size
- Predators
- Disease
- Competition

Describe the shape of a population growth curve
- Sigmoid (S) shaped



Credit: Martin Bailey for SwH Learning

Describe and explain the phases of a population growth curve
- *Lag phase - Slow growth*
  - *Small numbers of individuals initially present*
  - *Reproduction increases total population*
  - *Birth rate > death rate*
- *Log phases - Rapid growth*
  - *Number of breeding individuals increase*
  - *Total population multiplies exponentially*
  - *No limiting factors present*
  - *Birth rate >> death rate*
- *Stationary phase - Stable state*
  - *Limiting factors prevent further population growth*
  - *Population fluctuates*
  - *Overall size stays relatively stable*
  - *Birth rate ≈ death rate*
- *Death phase - Population declines*
  - *Population crashes*
  - *Caused by sudden change in environment (e.g. drought causing food shortage)*
  - *Process begins again (or competing population increases)*

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20. HUMAN INFLUENCES ON ECOSYSTEMS

20.1 Food supply

How has modern technology increased food production?
- Agricultural machinery - crops can be planted over larger areas, more efficient process
- Chemical fertilisers - increases nutrients in soil → improved crop yields
- Insecticides - kill pests → improved quality and yield of crops
- Herbicides - reduce competition with weeds → increased crop yields
- Selective breeding - improves production by crop plants and livestock

Define 'monoculture'
- Only one type of crop grown

Describe the advantages and disadvantages of large-scale monoculture of crop plants

Advantage	Disadvantage
- Easier for farmers to manage	- Loss of habitats for other animals
- More efficient	- Disease can spread from crop to wild plants
- Offers higher earnings for farmers	- Loss of genetic variety in crops
	- Loss of suitable food sources for animals

Explain how monocultures of crop plants can result in the extinction of some animals
- Loss of habitat
- Addition of pesticides/chemicals
- Human animal conflict
- Crop is often an introduced species
- Loss of biodiversity / loss of suitable food sources
- Outbreaks of diseases

Describe the process of intensive livestock farming
- Large numbers of livestock kept in small area
- Fed high energy foods, kept in warm temperatures/small spaces to reduce energy loss
- Regularly given antibiotics
- Animals reared for food or other uses
  - e.g. producing leather, wool, fertilizer

Describe the advantages and disadvantages of intensive livestock production

Advantage	*Disadvantage*
- Provides food security	- Deforestation used to clear land - loss of habitat, reduces soil fertility
- Improved earnings for farmers	- Removal of hedges - shelter, feeding, breeding sites for wildlife
	- Disease more likely to spread
	- Welfare issues surrounding livestock living conditions
	- Reduces biodiversity

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20.2 Habitat destruction

Define 'biodiversity'
- Number of different species that live in an area

Describe the reasons for habitat destruction
- Increased area for food crop growth, livestock and housing
  - Increasing population require more food and living space
  - Deforestation used to increase land available
- Extraction of natural resources
  - Wood, metals, stone etc. required for building materials and products
- Freshwater and marine pollution
  - Oil spills, sewage, fertilisers can all enter water systems
  - Causes decrease in aquatic biodiversity

Explain how altering food webs can have a negative impact on habitats
- Many habitats destroyed by humans for crop production and livestock farming
- Alters food chains/webs
  - If prey removed from food chains/webs → higher trophic levels may die
  - If predator removed from food chains/webs → prey may rapidly increase, outcompeting other species

Define 'deforestation'
- Removal of trees and forests

Explain the effects of deforestation on habitats

Effect on habitat	Result
Reduced biodiversity & extinction	- Large number of plants, animal and habitats destroyed by deforestation - Can lead to extinction of entire species - Plants and animals with vital uses (e.g. medicines) may be lost - Food webs altered leading to decline/extinction of other species

Loss of soil	- Tree roots vital for stabilising soil and absorbing nutrients
	- Deforestation causes soil to be washed away
	- Nutrients leached into rivers/lakes
	  - Causes eutrophication and loss of marine life
	  - Difficult to replace nutrients in soil - new trees will not grow

Flooding	- Tree roots absorb water and stabilise soil - Soil erosion increases risk of flooding and landslides - Causes destruction of natural and human habitats
Increased atmospheric CO_2	- Fewer trees → reduced photosynthesis → less CO_2 absorbed from atmosphere - CO_2 also released when trees are burnt - CO_2 is a greenhouse gas - causes global warming

20.3 Pollution

Describe the effects of untreated sewage on aquatic ecosystems
- Microorganisms (decomposers) break down sewage
- Microorganism population increases
- Increased respiration of microorganisms decreases oxygen content of water
- Causes death of other aquatic life (eutrophication)

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Describe the effects of excess fertiliser on aquatic ecosystems
- Excess fertiliser can leach into water systems
- Causes eutrophication

Describe the process of eutrophication
- *Fertilisers and sewage washed (leached) into rivers*
  - *Increases availability of nitrates and other ions*
- *Water plants (producers) grow quickly - algal bloom*
- *Competition for sunlight*
- *Plants die*
- *Increased decomposition of dead producers*
- *Increased number of decomposers → more aerobic respiration*
- *Decreased oxygen concentration dissolved in water*
- *Fish die as not enough dissolved oxygen in water*

Outline the environmental impact of non-biodegradable plastics
- Non-biodegradable plastic does not break down
- Animals consume plastics → harder to breathe/move/absorb nutrients → causes injuries/death
- Plastics can break down and enter food chain → toxic
- Blocked passages of water → water-logging/flooding of surrounding areas
  - Soils become less oxygenated → less fertile → harder for plants to grow
- Blocks sunlight from aquatic areas → producers cannot photosynthesise → less energy enters food chain
- Release toxins when in landfill → land cannot be reused for many years
- Release toxic smoke when burned

What is a greenhouse gas?
- Gas that traps heat by reflecting infrared radiation
  - e.g. methane, carbon dioxide

Explain how the enhanced greenhouse effect causes global warming
- Sun emits energy that enters Earth's atmosphere
- Energy absorbed and re-emitted by Earth's surface as infrared (IR) radiation
  - Some IR radiation reflected back out into space
- Some IR radiation absorbed by greenhouse gases
  - Heat is trapped within Earth's atmosphere
- As greenhouse gases levels increase, Earth's average temperature increases
  - Causing global warming (climate change)

How have humans contributed to the increase in atmospheric greenhouse gases?
- Carbon dioxide produced by combustion of fossil fuels
- Methane produced by grazing cattle
- Methane released by rice paddy fields
- Deforestation results in more CO_2 in atmosphere
  - Because less photosynthesis occurring

What possible effects does an enhanced greenhouse effect have?
- Global warming
- Ice caps melt
- Sea levels rise
- Low lying land floods
- Destruction of habitats
- Loss of biodiversity
- Extreme weather
- Change in bird migration patterns

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20.4 Conservation

Define 'sustainable resource'
- Resource that is produced as rapidly as it is removed
- Does not run out

Give examples of resources that can be conserved and managed sustainably
- Forests
- Fish stocks

How can forests be conserved?
- *Education - makes companies and consumers aware of sustainable practices*
- *Protected areas - protects areas with endangered species*
- *Quotas - legal limits to amount of deforestation that can take place*
- *Replanting - replaces cut down trees*

How can fish stocks be conserved?
- *Education - makes fishermen and consumers aware of sustainable practices*
- *Closed seasons (no fishing allowed) - protects fish at important times (e.g. breeding season)*
- *Quotas - legal limits to number of fish that can be caught*
- *Protected areas - protects areas with endangered species*
- *Controlled minimum net types/mesh size - ensures enough fish of breeding age left*
- *Monitoring - keeps track of fish numbers and success of conservation techniques*

Why do organisms become endangered or extinct?
- Climate change alters habitat
- Habitat destruction e.g. from deforestation
- Hunting / overharvesting
- Pollution
- Introduced species - outcompete native species for food/resources

How can endangered species be conserved?
- Monitoring and protecting species and habitats
  - Detects decreases in populations
- Education programmes
  - To protect habitats, to prevent pollution, to prevent hunting
- Captive breeding programmes
  - In zoos and reserves
  - Artificial insemination helps build up numbers
- Seed banks for plants
  - In botanic gardens
  - Store endangered seeds for long periods

What are the reasons for conservation programmes?
- *Maintaining/increasing biodiversity*
- *Reducing extinction*
- *Protecting vulnerable environments*
- *Maintaining ecosystem functions*
  - *e.g. nutrient cycling*
  - *e.g. resource provision (food, drugs, fuel and genes)*

Describe the process of artificial insemination (AI)?
- *Sperm from a male donor*
- *Kept at sperm bank*
- *Inserted to female uterus near time of ovulation*

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Describe the process of In Vitro Fertilisation (IVF)
- *Eggs and sperm collected*
- *Ovum fertilised outside the body*
- *In a petri dish in a laboratory*
- *Fertilised ovum placed into female's uterus*

How are AI and IVF used in captive breeding programmes?
- *Artificial insemination*
  - *Used for selective breeding*
  - *Reduces risk of in breeding or lack of interest in mating*
    - *e.g. the giant panda*
- *IVF*
  - *Females can be stimulated to produce many eggs using hormone injections*
  - *Fertilisation success monitored by scientists*
  - *Males and females do not have to be in close proximity for procedure*

What are the risks to a species if its population size decreases?
- *Fewer individuals*
- *Reduces genetic variation in population*
- *Less genetic variation can lead to inbreeding*
- *Less able to breed and produce healthy offspring*
- *Less able to adapt to changing conditions*

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21. BIOTECHNOLOGY AND GENETIC MODIFICATION

21.1 Biotechnology and genetic modification

Why are bacteria useful in biotechnology and genetic modification?
- Rapid reproduction rate
- Ability to make complex molecules
- *Few ethical concerns over manipulation and growth*
- *Plasmids present*

21.2 Biotechnology

How is yeast used to make biofuel?
- Used to produce ethanol
- Anaerobic respiration in yeast turns sugar and other nutrients to alcohol
- Alcohol distilled to make pure ethanol

How is yeast used in bread making?
- Yeast mixed into bread mixture
- In warm environment yeast ferments sugar
- Anaerobic respiration produces CO_2 bubbles
- Bubbles make dough rise

What is pectinase?
- Enzyme
- Breaks down pectin (polysaccharide found in plant cell walls)

How is pectinase used in fruit juice production?
- Chopping fruit does not break open all cells
- Pectinase added to break down more plant cell walls
- More juice able to be extracted from fruit
- Fruit juice is clearer - large polysaccharides broken down

Outline the use of enzymes in biological washing powders
- Biological washing powder contains enzymes such as lipase and protease
- Stains often made of lipids and proteins
- Enzymes break down large, insoluble molecules into smaller, soluble molecules
- Does not affect material - can be used on delicate fabrics
- Effective at lower temperatures - uses less energy, more cost effective

Outline an Investigation into how effective biological powders are at removing stains at different temperatures
- Independent variable: temperature
- Dependent variable: percentage of light reflected by material
- Control variables: Concentration/mass of washing powder, brand of washing powder, time spent washing, concentration and volume of staining substance used
- Method:
  - Stain pieces of cloth with a protein or lipid-based substance
  - Wash cloth at 10°C for 30 minutes
    - Control temperature using water bath
  - Use light meter to determine percentage of light reflected (100% = completely clean)
  - Repeat for 20°C - 60°C
  - Repeat each temperature 3 times and take average
  - Plot results on a graph

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Why are biological washing powders less effective at higher temperatures?
- Enzymes denatured at higher temperatures
- Active site changes shape
- Substrate can no longer bind - no enzyme-substrate complex formed

How is lactase used to produce lactose-free milk?
- *Lactase enzymes immobilized on fibres/beads*
- *Milk passed over immobilized lactase enzyme*
- *Enzyme breaks down lactose*
- *Product passes out lactose-free*

Why are the enzymes immobilized in the process of lactose-free milk production?
- *Can reuse the enzyme*
  - *Cheaper*
- *No enzymes left in milk*
  - *Milk does not need to be purified*
- *Enzymes more stable*
  - *Rate can be increased by increasing temperature*

Why is milk heated to a high temperature before the process starts?
- *To kill pathogenic bacteria*

Why is milk cooled to 20°C before adding lactase enzymes?
- *High temperatures denature enzymes*
  - *Shape of active site changed*
  - *Substrate will not fit enzyme*
  - *Lactose not broken down*

What is a fermenter?
- *Vessel containing microorganisms used for fermentation*
- *Used to produce large quantities of product from microorganisms*
  - *e.g. insulin, penicillin, mycoprotein*

How is temperature controlled in a fermenter?
- *Temperature recorder / monitor*
- *Cooling jacket*

What are the suitable conditions within a fermenter?
- *Nutrients*
  - *A controlled supply to feed microorganisms*
- *pH*
  - *Kept constant at optimum level by adding acid or alkali as necessary*
- *Air supply*
  - *Provides oxygen necessary for aerobic respiration*
- *Temperature*
  - *Respiration produces heat*
    - *Enzymes denature / microorganisms die if too hot*
  - *Maintains optimum temperature for growth and enzyme activity*
- *Agitation*
  - *Microorganisms constantly stirred*
  - *Gives more exposure to oxygen (for aerobic respiration) nutrients (for growth) and maintains even temperature (to keep it at optimum level)*
- *Waste products*
  - *Constantly removed to prevent toxic substances building up*
  - *Could kill microorganisms*

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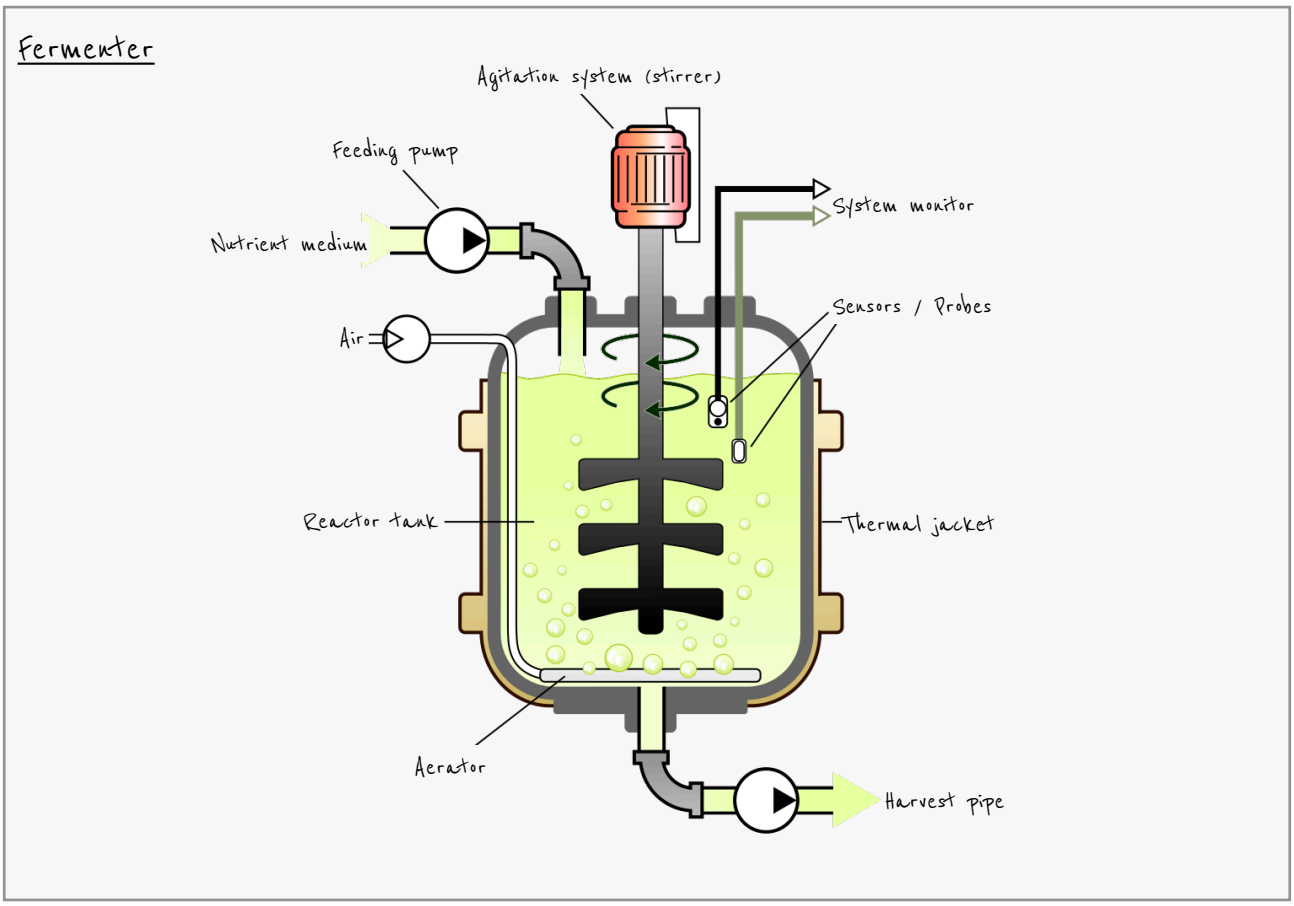

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How is fungus used to make penicillin?
- *Penicillum fungus produces antibiotic (penicillin) to kill off other microorganisms*
- *Made when growth of fungus is slowing down*
- *Penicillin made in industrial fermenters to grow fungus and harvest antibiotic*
- *Made by batch fermentation - batch collected and fungus filtered out*
- *Filtered liquid contains antibiotic*

21.3 Genetic modification

Define 'genetic modification'
- Changing an organism's genetic material
- By removing, inserting or changing individual genes

Give examples of genetic modification
- Inserting human genes into bacteria to make human proteins
  - e.g. insulin for controlling diabetes
- Inserting genes into crop plants to give herbicide resistance
  - Herbicides only kill weeds, increasing crop yields
- Inserting genes into crops to give pest resistance
  - Improves crop yields
  - Reduces need to use chemical pesticides
- Inserting genes into crops to improve nutritional qualities
  - e.g. golden rice produces additional vitamin A

Which human proteins are commonly produced using genetic modification?
- Insulin
- Growth hormone
- Factor VIII (haemophilia treatment)

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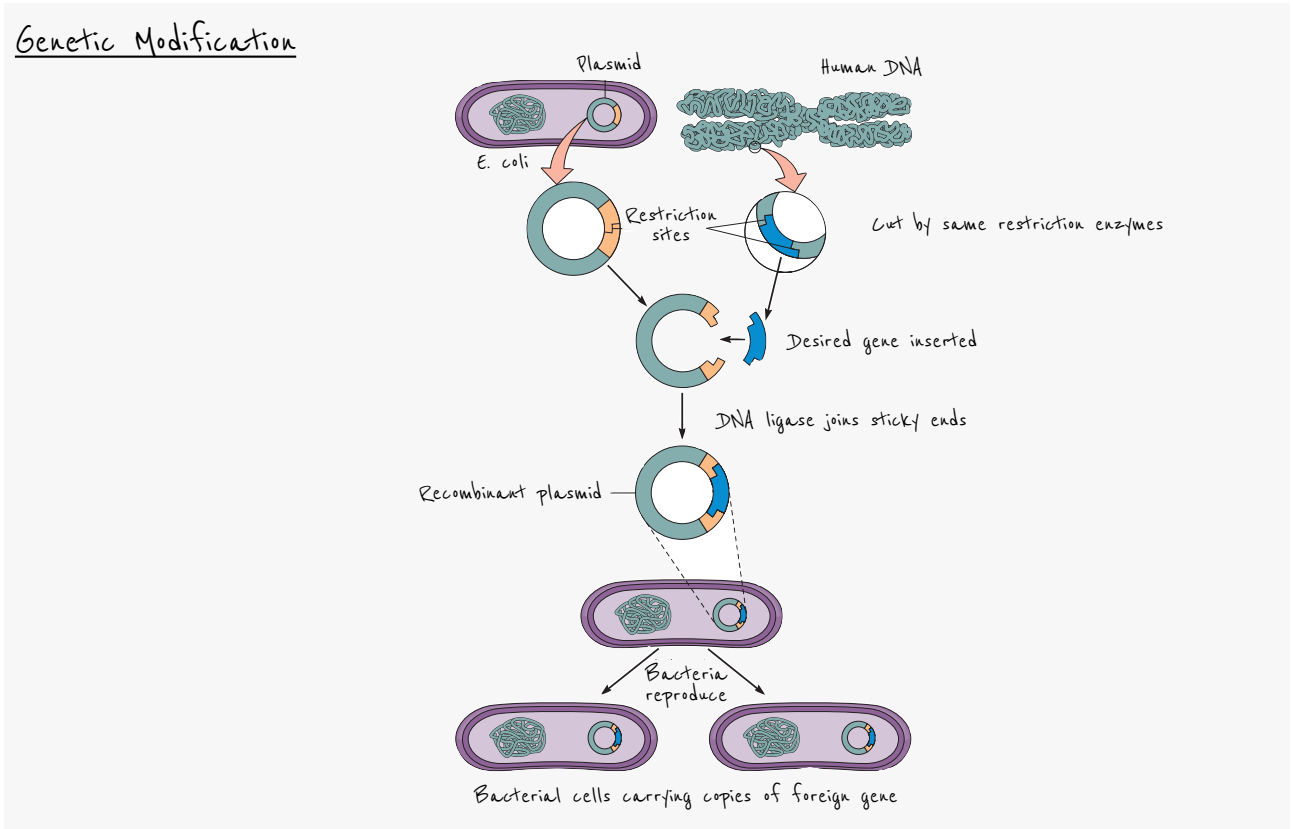
Which enzymes are used in genetic engineering?
- *Restriction enzymes - cut DNA at a specific point*
- *DNA ligase - joins the cut ends of DNA together*

What is a vector?
- *Anything used to transfer biological material*
  - *e.g. a plasmid is used to transfer genes in genetic engineering*
  - *e.g. mosquito that transfers plasmodium parasite to humans when it bites them*

Explain how plasmids can be used as vectors in genetic modification
- *Plasmids are small circular pieces of bacterial DNA*
- *Isolated from bacteria*
- *Desired gene inserted into plasmid to create recombinant plasmids*
- *Recombinant plasmids inserted back into bacteria*

Outline the process of genetic modification
- *Restriction enzymes isolate desired gene in human DNA*
  - *Forms 'sticky ends'*
- *Bacterial plasmid cut with same restriction enzymes*
  - *Forms complementary sticky ends*
- *Human DNA inserted into bacterial plasmid*
  - *DNA ligase joins complementary base pairs of sticky ends together*
  - *Creates 'recombinant plasmid'*
- *Recombinant plasmid inserted into bacteria*
- *Bacteria replicated in a fermenter*
- *Human protein produced when genes expressed*



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Describe how large amounts of insulin can be genetically engineered
- *Cut out insulin gene from human DNA using restriction enzyme*
- *Cut open plasmid in bacteria using same restriction enzyme*
- *Stick insulin gene into plasmid using DNA ligase (forming recombinant plasmid)*
- *Plasmid is the vector*
- *Place in fermenter*
- *Harvest the product (insulin)*

Why are genetically modified crops bred for several generations before commercial use?
- *To check that offspring inherit new gene*
- *To ensure new variety can grow in field conditions*
- *To make sure new gene does not cause any adverse effects*
- *To make sure modified plants have a high enough yield*
- *To build up a large quantity of seed to sell to farmers*

Outline the advantages and disadvantages of genetically modifying crops

Advantage	***Disadvantage***
- *Higher yields - reduced competition from weeds or damage from pests*	- *Cross pollination with weeds can make 'superweeds' also resistant to herbicides*
- *Crops grow in more extreme environments - more crops grown = less famine*	- *Expensive - small farms in poorer areas may not be able to afford GM seeds*
- *Reduces use of chemical herbicides and pesticides - better for environment, less time consuming and cheaper for farmers*	- *Reduces biodiversity by decreasing species of weeds/pests - less food for consumers higher up food chain*

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PRACTICAL SKILLS ASSESSED IN A WRITTEN EXAMINATION

When answering experimental design questions, you should always include…
- Independent variable
  - The variable that is being changed
- Dependent variable
  - The variable that is being measured
    - Include how the dependent variable would be measured
- Sensible time frame for taking measurements
- Control variables (minimum 5)
  - The variables that are being kept constant
- Methods of ensuring reliability

What is the purpose of a control?
- Allows a comparison to be made
- Shows what would normally happen so comparison can be made when independent variable is changed

Common ways of improving an investigation:
- Ensure equal sizes/volumes of samples are used
- Repeat the experiment at least 3 times and calculate the mean
- Test a wider range of values for the independent variable
- Replicate experiment using different samples/species
- Use larger sample size
- Use random sampling method (e.g. random number generator)

How to make an investigation more reliable:
- Repeat experiment at least three times to increase number of observations
- Identify anomalous results
- Calculate mean

How to make an investigation more accurate:
- Carry out more tests within existing range
- Introduce method to ensure no double counting occurs
- Use a narrower range (if appropriate)

How to increase the validity of an investigation:
- Make sure that all control variables are the same for each repeat/investigation
- Collect a wide range of measurements/results

To ensure calculations of mean values are reliable:
- Randomly choose sample areas/fields of view to count subject of investigation
- Count subject of investigation in several sample areas/fields of view
- Ensure all same species used/counted
- If taking samples from same organism, ensure same tissue/organ used
- Count a large number of sample areas/fields of view

When answering ‘describe’ questions:
- Write what the data is showing e.g. trends, changes in rate, increases and decreases etc
- If describing a graph, break the graph down into sections
  - Each section should be a describable feature
  - e.g. constant rate from A to B, increasing rate from B to C…
- Use data points provided in the question to illustrate description

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When answering ‘explain’ questions:
- Say why the results have come about
- Use scientific knowledge to explain any patterns and trends
- Make sure explanation is specific to the question

When answering ‘compare’ questions:
- Each statement should include both pieces of data
  - e.g. both A and B remained constant for 2 hours
  - e.g. the rate of increase of A was greater than that of B from 2 to 4 hours
- If comparing results from a graph, break the graph down into clear sections
  - e.g. biological washing powder is more effective than non-biological between 10 and 40°C. Non-biological washing powder is more effective between 44 and 60°C

When drawing diagrams:
- Include a title
- Use a sharp pencil
- Labels should be outside the diagram
- Use ruled label lines
  - Do not cross label lines
- Include a scale bar
- State magnification
- Do not use shading
- Use at least 50% of the available space

When drawing graphs:
- Label the x and y axis
  - Include units
- Use sensible scale
  - Use at least 50% of the available space
- Plot points accurately using an ‘X’
- Draw line of best fit if required

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