IGCSE

(0610)

Biology Notes



Source : Astra

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UNIT 1: CHARACTERISTICS, CLASSIFICATION & FEATURES

ASTRA

7 CHARACTERISTICS

DEFINITION

(a) Movement: action by an organism or part of an organism causing a change of position or place

(b) Respiration: chemical reactions in cells that break down nutrient molecules and release energy for metabolism

(c) Sensitivity: ability to detect and respond to changes in the internal or external environment

(d) Growth: a permanent increase in size and dry mass

(e) Reproduction: the processes that make more of the same kind of organism

(f) Excretion: removal of the waste products of metabolism and substances in excess of requirements

(g) Nutrition: taking in of materials for energy, growth and development

FEATURES OF ORGANISM

THE 5 KINGDOMS

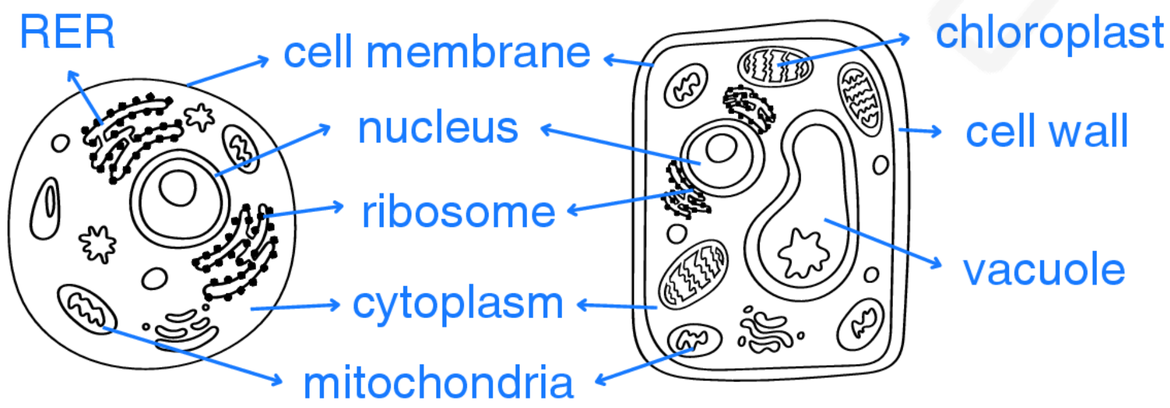
- animals, plants, fungi, protoctists, prokaryotes

Animals

- multicellular ingestive heterotrophs (consumes living organisms)
- eukaryotic (has nucleus)
- has membrane-bound organelles
- stores glycogen as food

Plants

- multicellular photosynthetic autotrophs (produces own food via photosynthesis)
- eukaryotic (has nucleus)
- cell wall made of cellulose
- stores starch as food



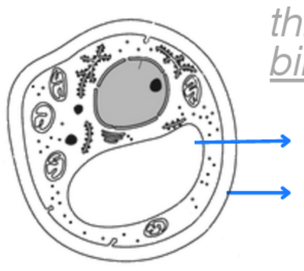
Fungi (Yeast/Mucor)

- saprotrophs nutrition (feed off dead organisms)
- does not photosynthesise
- secrete enzymes onto food

Prokaryotes (Bacteria)

- unicellular • no nucleus
- has cell wall: peptidoglycan
- has plasmid (circular DNA)
- flagella (for movement)
- binary fission (asexual)

Yeast

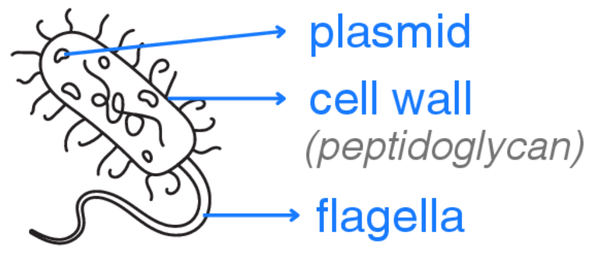


reproduce through binary fission

vacuole

cell wall *(made of chitin)*

Unicellular



Protoctists (Amoeba)

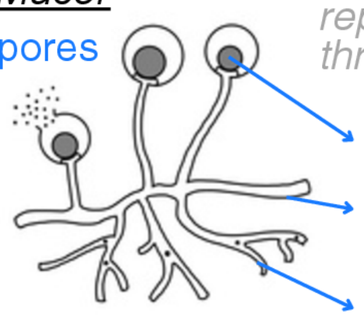


contractile vacuole *(contains organelles & chromosomes)*

- unicellular
- has nucleus
- move with cilia, pseudopodia *(locomotion)*
- photosynthesise own food or feed on organic matter

Mucor

spores



reproduce through spores

sporangium

hyphae *(thread-like)*

mycelium *(network)*

Multicellular

CLASSIFICATION

SPECIES

a group of organisms that can reproduce to produce fertile offspring

(classified into groups by the features that they share)

BINOMIAL SYSTEM

Linnaeus system of classification

General	Kingdom	*(Animal)*
	Phylum	*(Chordates)*
	Class	*(Mammals)*
	Order	*(Primates)*
	Family	*(Hominids)*
	Genus	*(Homo)*
Specific	Species	*(Homo sapien)*

Genus: • *capitalised* • *italicised*
Species: • *lowercase* • *italicised*

DICHOTOMOUS KEYS

identify organisms based on a series of questions about their features

(branching into two & leads to the name of the organism by giving 2 descriptors at a time)



keys

1a)	black fur	*go to 2*
b)	brown fur	*Felis nigripes*
2a)	blue eyes	*Felis catus* ☑
b)	grey eyes	*go to 3*

How to navigate a key:

(a) Pick a single organism to start with
(b) Follow statement from beginning
(c) Match info with image features
(d) Once identified, rinse & repeat

TAXONOMY

Traditional approach (based on features)

- *Morphology: overall forms & shapes*
- *Anatomy: detailed body structures determined by dissection*

Modern approach (using DNA)

- Compare sequence of bases in DNA
- The more similar the base sequence, the more closely related those two species are

Recent Ancestor: *More similar base sequence in DNA*

Distant Ancestor: *Less similar base sequence in DNA*

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UNIT 1: CHARACTERISTICS, CLASSIFICATION & FEATURES

ASTRA

ANIMAL KINGDOM

VERTEBRATES (have backbones)

Classes	Features
(a) Mammals	• fur / hair • external ear / pinna • mammary gland • placenta • whiskers
(b) Amphibians	• moist skin • gas exchange occurs through skin & lungs • larva have gills; adult have lungs • larvae live in water; adults live on land • 2 stage life cycle
(c) Reptiles	• dry & scaly skin • eggs with dry / leathery shell
(d) Birds	• wings • feathers • lay hard eggs • has beak
(e) Fish	• wet scales • external fertilisation • gills to breathe • fins: streamlined

INVERTEBRATES (no backbones)

Arthropods	Features
(a) Insects	• 3 body regions *(head, thorax, abdomen)* • 3 pairs of jointed legs • 1~2 pairs of wings
(b) Crustaceans	• exoskeleton • 2 pairs of antennae • > 4 pairs of jointed legs • mandible (piercing jaw)
(c) Arachnids	• 2 body segments • 4 pairs of jointed legs • simple eyes
(d) Myriapods	• Segmented body • > 70 pairs of legs • 1 pair of antennae

PLANT KINGDOM

presence of chlorophyll in all photosynthetic plants to absorb sunlight for photosynthesis

NON–FLOWERING PLANT

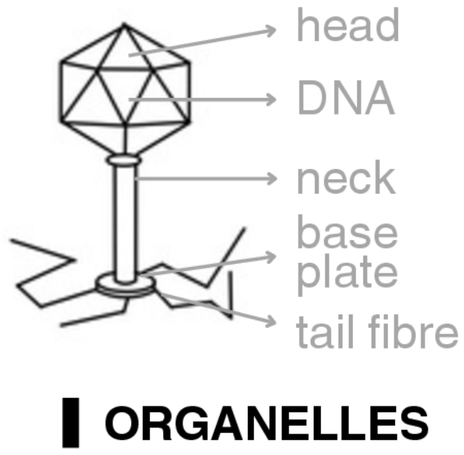
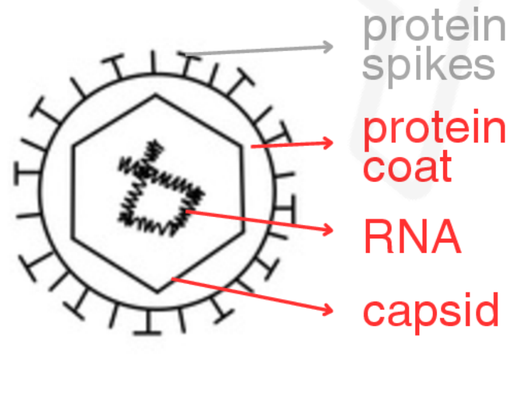
Ferns
- have leaves called fronds
- reproduce by spores (underside of fronds)

FLOWERING PLANTS

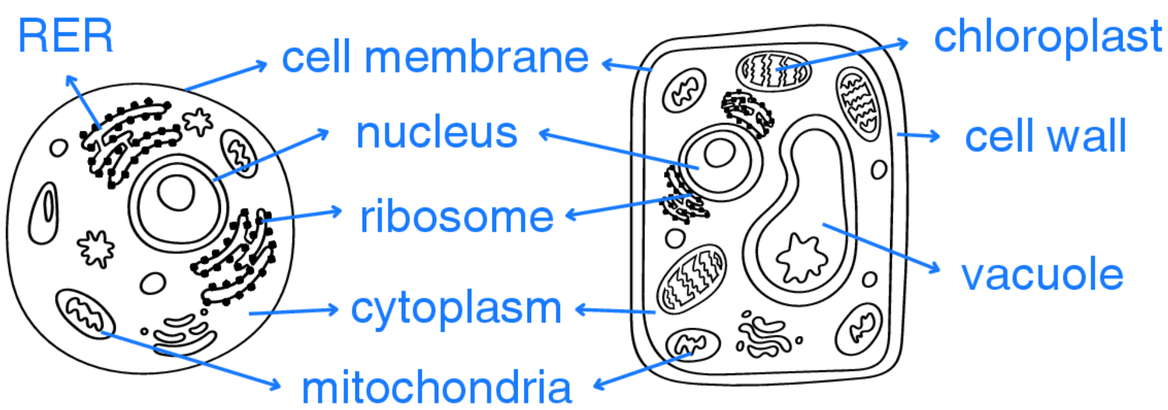
	Monocotyledon	Dicotyledon
Cotyledon	 *(1 cotyledon)*	 *(2 cotyledons)*
Roots	 *(fibrous roots)*	 *(tap roots)*
Vascular Bundle	 *(scattered)*	 *(ringed)*
Leaves	 *(parallel veins)*	 *(network veins)*
Flowers	 *(multiples of 3)*	 *(multiples of 4,5)*

VIRUS

non-living organisms | multiply inside living cells

Bacteriophage	Influenza Virus
	

CELL STRUCTURES



ORGANELLES

- **nucleus:** contains DNA | controls cell activities
- **cytoplasm:** site of chemical reactions | jelly-like
- **cell membrane:** controls substances in & out of cell
- **ribosomes:** protein synthesis
- **mitochondria:** site of aerobic respiration
- **chloroplasts:** absorbs sunlight for photosynthesis
- **cell wall:** rigid structure | provides support
- **vacuole:** stores water & mineral ions | turgidity

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LEVELS OF ORGANISATION

CELLS

basic functional & structural units in a living organism

Animal
- *ciliated cell*
- *goblet cell*
- *nerve cell*
- *red blood cell*
- *white blood cell*

Plant
- *palisade mesophyll*
- *root hair cell*
- *xylem vessel*
- *phloem vessel*

TISSUES

group of cells of similar structure working together to perform similar function

- *epidermis mesophyll*
- *xylem & phloem*
- *connective tissues*
- *epithelial tissues*

ORGANS

made from different tissues working together to perform specific functions

- *leaf / stem / flower / fruit*
- *stomach / intestine / oesophagus*
- *heart / artery / veins*
- *liver / kidney / lungs / skin*
- *ovary / cervix / vagina / penis*
- *brain / spinal cord*

ORGAN SYSTEMS

group of organs with related functions, working together to perform body functions

- *digestive system*
- *nervous system*
- *respiratory system*
- *reproductive system*
- *circulatory system*
- *root system*
- *excretory system*
- *immune system*

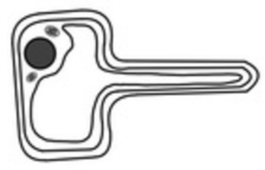
SPECIALISED CELLS

- new cells are produced by division of existing cells
- undergoes differentiation to develop certain structures & characteristics to perform particular functions



red blood cell

transport of oxygen



root hair cell

absorption of water & mineral ions



sperm cell

male gamete (reproduction)



nerve cell

conduction of electrical impulse



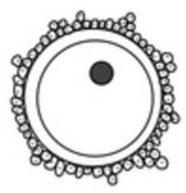
white blood cell

provide immunity



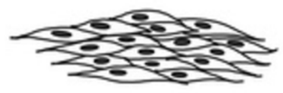
ciliated cell

movement of mucus



egg cell

female gamete (reproduction)



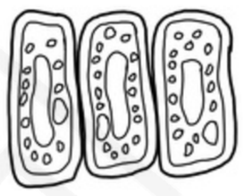
muscle cell

contraction & relaxation for movement



platelets

for blood clotting



palisade mesophyll

photosynthesis



goblet cell

secretes mucus

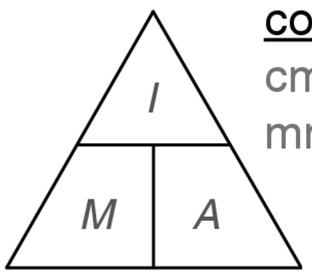


xylem vessel

transport water & mineral ions

SIZE OF SPECIMEN

MAGNIFICATION



conversion

cm to mm (x10)

mm to µm (x1000)

$$\text{magnification} = \frac{\text{image size}}{\text{actual size}}$$

formula

M - magnification
I - image / drawing size
A - actual size

DIFFUSION

Net movement of particles from a region of their higher concentration to a region of their lower concentration. Molecules move down a concentration gradient, as a result of their random movement

BROWNIAN MOTION

energy comes from:

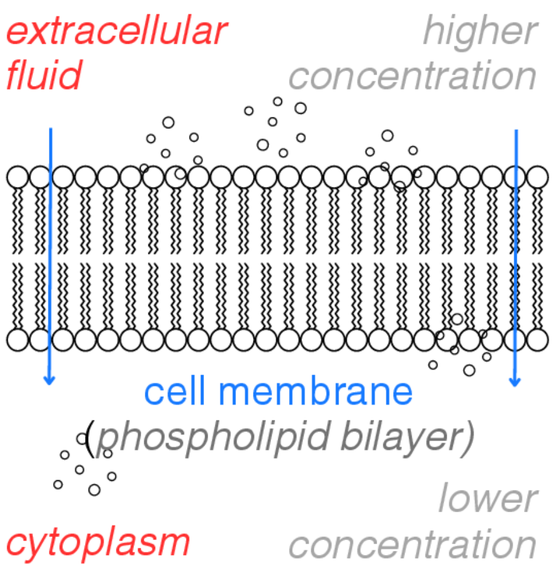
- kinetic energy of random movement of particles (brownian motion)

IN LIVING ORGANISM

diffusion occurs:

- fulfil living requirements
- removal of waste products
- gas exchange for respiration

Cell Membrane



FACTORS AFFECTING DIFFUSION

(a) Surface area to volume ratio

bigger the cell structure, smaller surface are to volume ratio

- *root hair cell: absorbs water & minerals*
- *intestinal epithelial cell: absorbs products of digestion*

(b) Concentration gradient
(c) Temperature (↑ KE,↑ collisions)
(d) Distance (1 cell thick)

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UNIT 3: MOVEMENT IN AND OUT OF CELLS

ASTRA

OSMOSIS

WATER

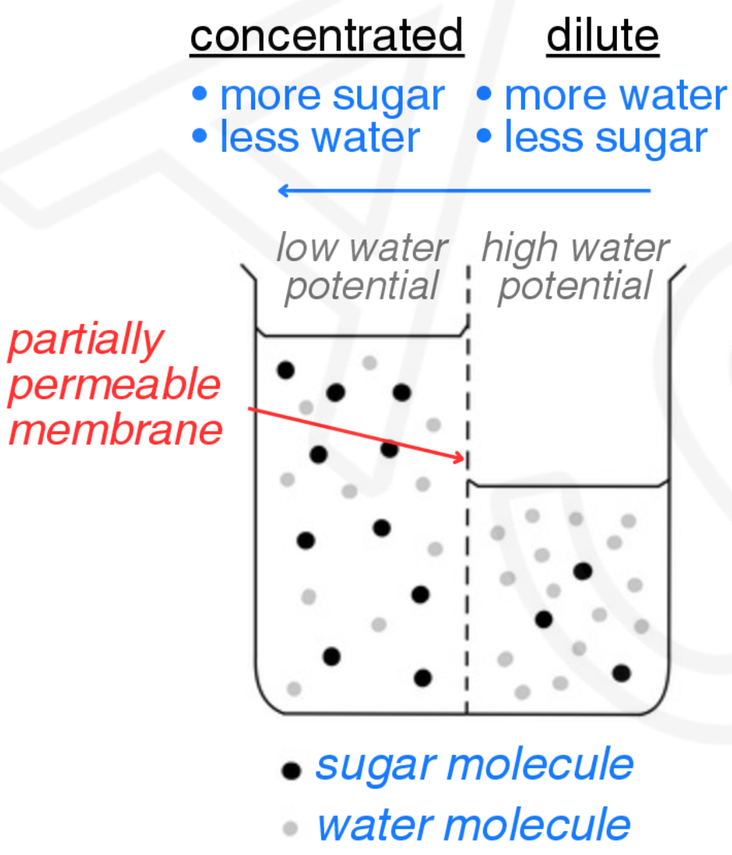
universal solvent: many substances can dissolve in it

(a) Transport dissolved substances
(xylem: water | phloem: sucrose)

(b) Moving digested food particles into the cells
(alimentary canal)

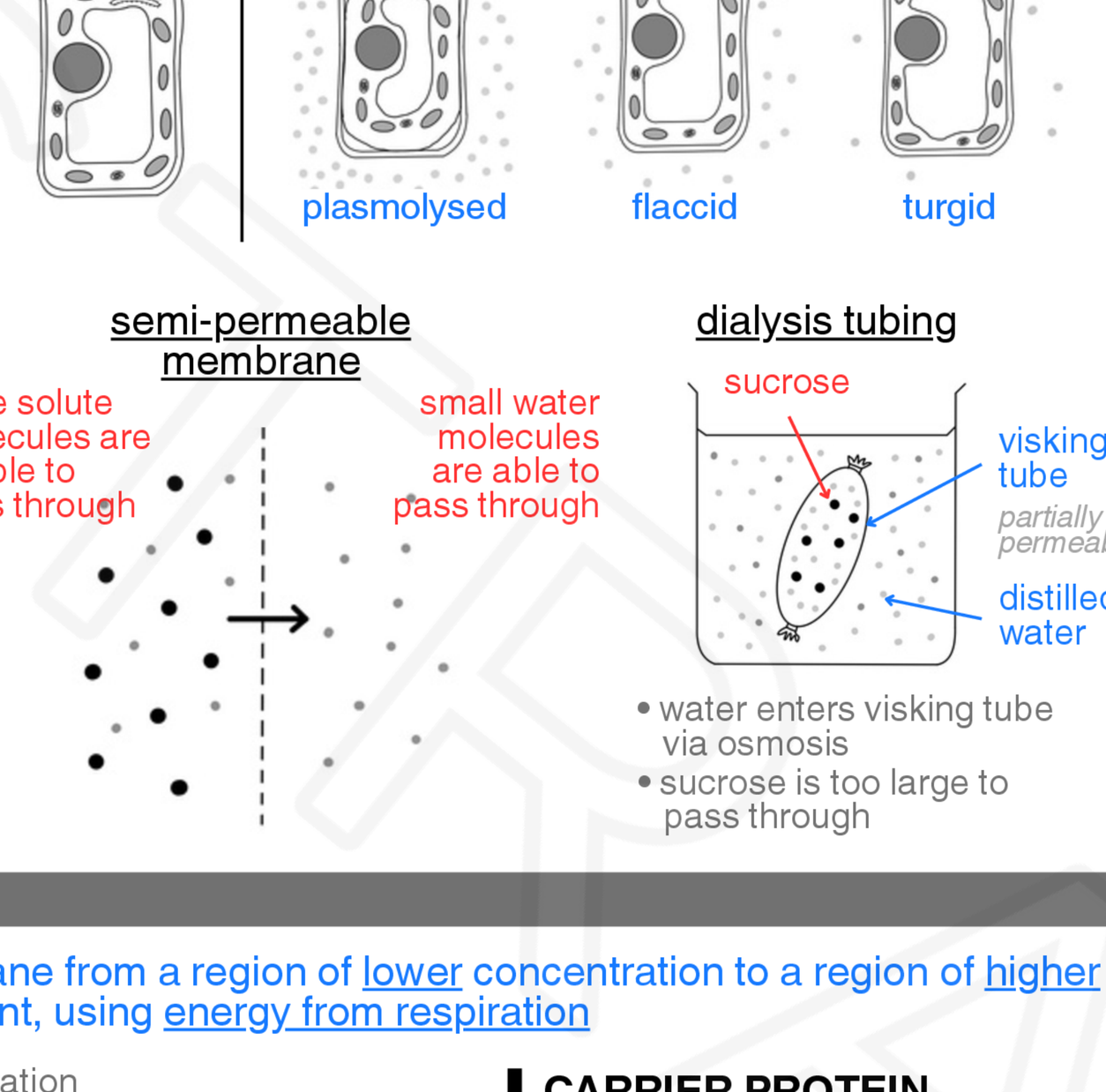
(c) Remove toxic substances
(excess salts & urea)

(d) Metabolic reactions in cytoplasm



OSMOSIS

net movement of water molecules from a region of higher water potential (dilute solution) to a region of lower water potential (concentrated solution), through a partially permeable membrane



Osmosis in plant cell

- water enters, pushing cell membrane against cell wall via osmosis
- provide support & strength for plant
- cell wall: prevents cell from bursting
- insufficient water to remain turgidity (wilt)

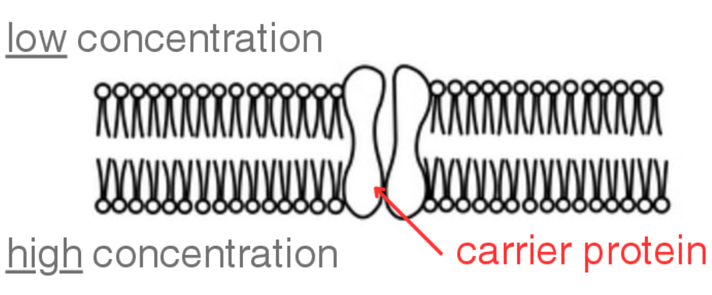
- water enters visking tube via osmosis
- sucrose is too large to pass through

ACTIVE TRANSPORT

movement of particles through a cell membrane from a region of lower concentration to a region of higher concentration against a concentration gradient, using energy from respiration

IMPORTANCE

- uptake of glucose in villi / kidney tubules in nephron
- uptake of ions from soil



CARRIER PROTEIN

- substance combines with carrier protein molecule
- uses energy to change shape, move substances through membrane

UNIT 4: BIOLOGICAL MOLECULES

ASTRA

CHEMICAL ELEMENTS

CARBOHYDRATES

carbon, hydrogen, oxygen
(polysaccharides: complex → starch)
(monosaccharides: simple → glucose)

PROTEIN

carbon, hydrogen, oxygen, nitrogen

FATS / LIPIDS

carbon, hydrogen, oxygen

LARGE MOLECULES TO SMALLER MOLECULES

Starch

Starch —(*salivary/pancreatic amylase*)→ Maltose —(*maltase*)→ Glucose

Protein

Protein —(*pepsin*)→ Polypeptide —(*trypsin*)→ Peptide —(*erepsin*)→ Amino acids

Fats/lipids

Fats/lipids (*fat globules*) —(*bile*)→ Fats/lipids (*fatty droplets*) —(*lipase*)→ *3 drops of* Fatty Acids + Glycerol

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UNIT 4: BIOLOGICAL MOLECULES

ASTRA

FOOD TESTS

SUBSTANCES

Food Substances	Food Tests	Colour Changes
(a) Starch	*Iodine Solution*	*Orange Brown → Blue-Black*
(b) Reducing Sugar	*Benedict's Solution*	*Blue → Orange / Brick Red*
(c) Protein	*Biuret Solution*	*Blue → Lilac / Purple*
(d) Fats/Lipids	*Ethanol Emulsion*	*Colourless → Cloudy Emulsion*
(e) Vitamin C	*DCPIP*	*Blue → Colourless* *(concentrated: decolourises faster)*

Experiment (reducing sugar):

Water Bath: Heat at 60-70°C for 5mins

Water Bath
- *easier to maintain constant temperature*

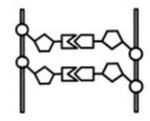
Heat at 70°C
- *optimum temperature & energy for reaction*

DNA

deoxyribonucleic acid



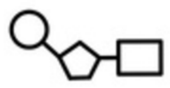
chromosomes



DNA strands



double helix



nucleotide

Base Pairings:

Adenine (A) Thymine (T)

Guanine (G) Cytosine (C)

UNIT 5: ENZYMES

ASTRA

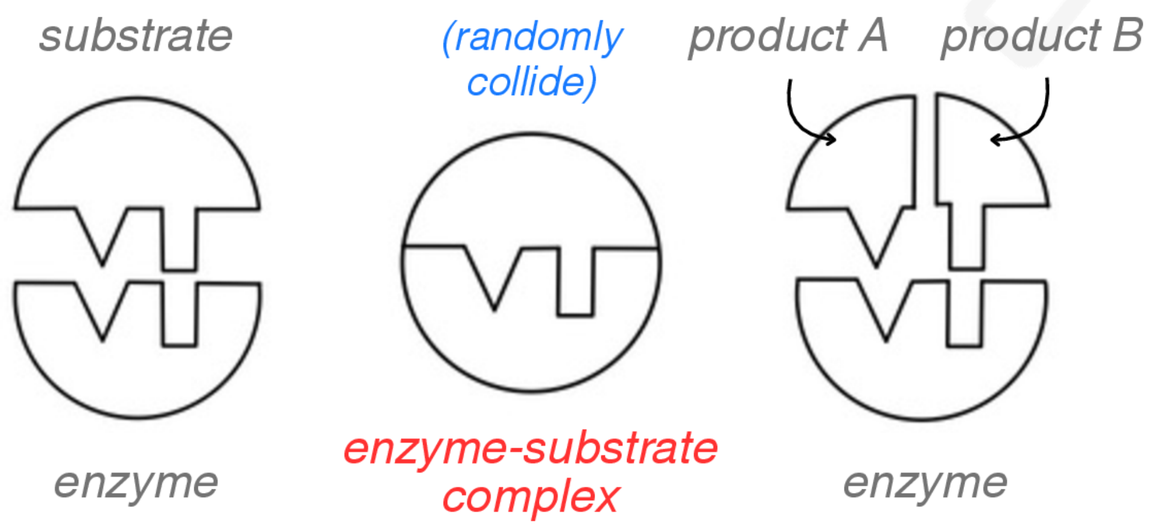
ENZYMES

Biological catalysts that speed up the rate of a chemical reaction without being changed or used up in the reaction

(necessary to all living organisms to maintain reaction speeds of all metabolic reactions: sustaining life)

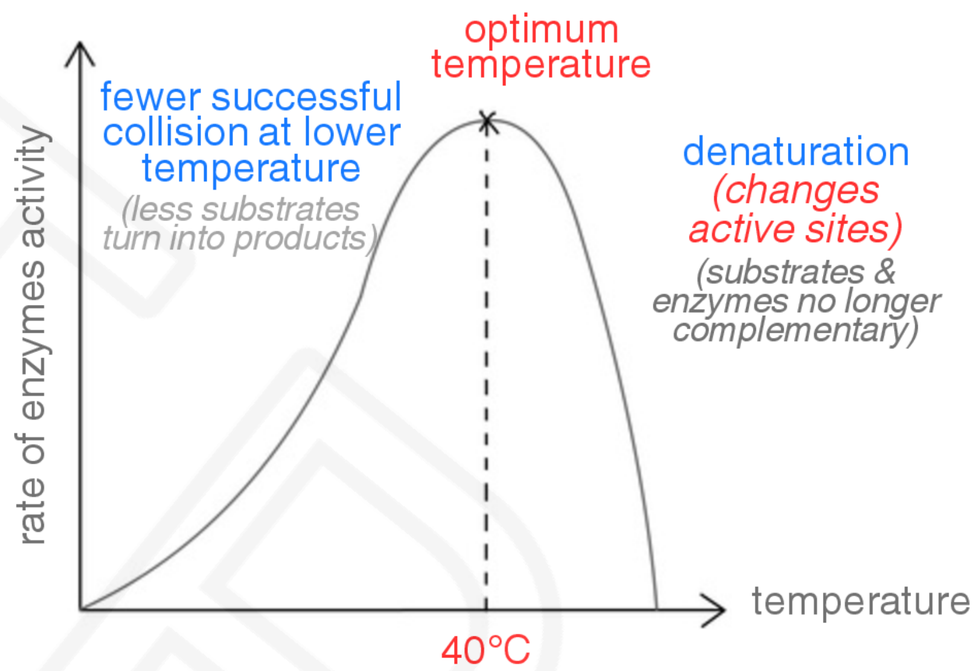
- *made from protein*
- *has specificity*
- *shape of active site is complementary to substrate*

Lock and Key Hypothesis



FACTORS AFFECTING ENZYMES ACTIVITY

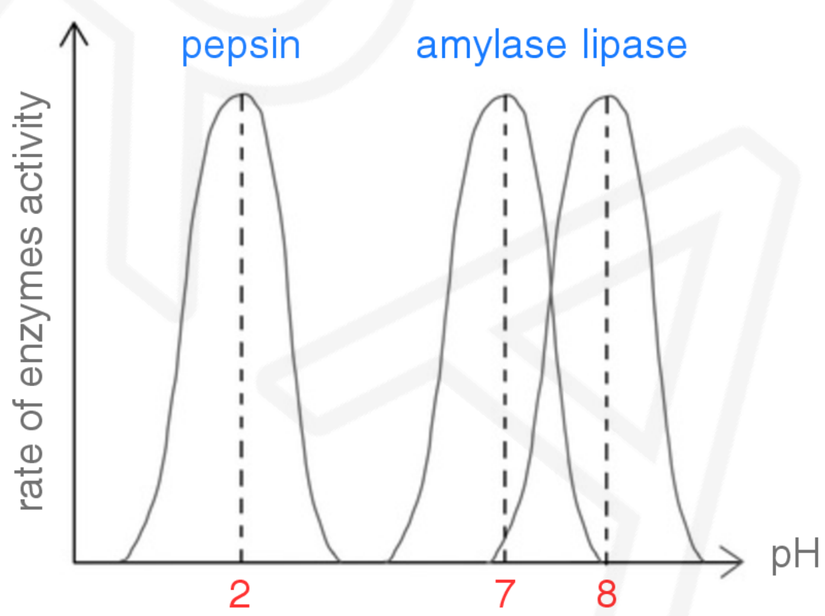
TEMPERATURE



PH

Moving away from optimum pH reduces rate of enzymes activity as active site gets distorted (denatured)

(extreme pH completely denatures enzymes)



UNIT 6: PLANT NUTRITION

ASTRA

PHOTOSYNTHESIS

WORD EQUATION

Carbon Dioxide + Water $\xrightarrow[\text{chlorophyll}]{\text{sunlight}}$ Glucose + Oxygen

(green pigment that transfers energy from light to chemical)

CHEMICAL EQUATION

$$6CO_2 + 6H_2O \xrightarrow[\text{chlorophyll}]{\text{sunlight}} C_6H_{12}O_6 + 6O_2$$

USE & STORAGE OF CARBOHYDRATES

GLUCOSE AS PRODUCT

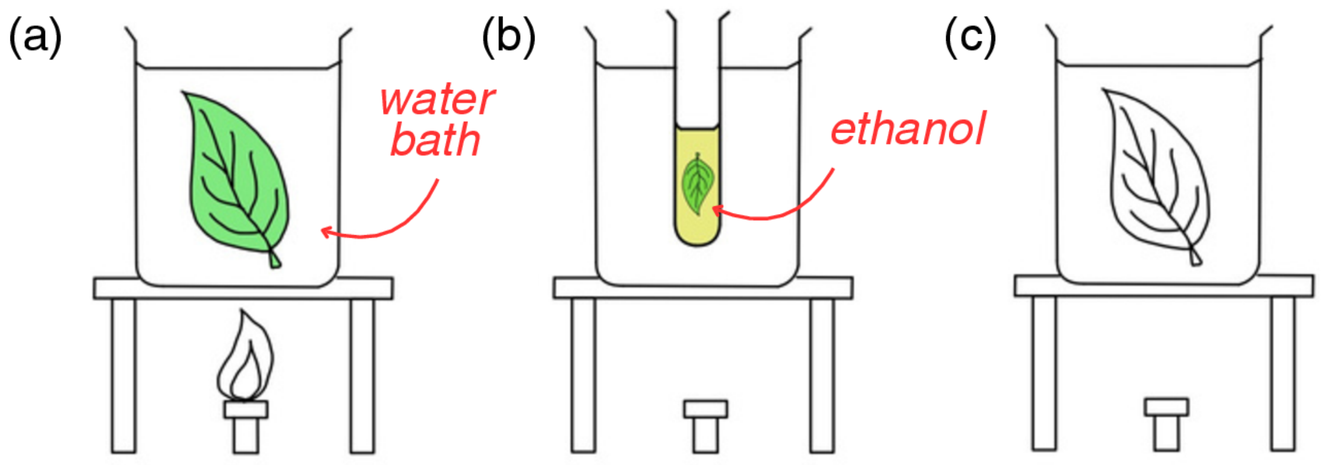
(a) Store energy as starch molecules
(b) Convert into cellulose to build cell walls
(c) Used in respiration to provide energy
(d) Convert into sucrose to transport in phloem
(e) Nectar to attract insects in pollination
(f) Made into lipids as energy source in seeds
(g) Combine with nitrates to make amino acids

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INVESTIGATING THE NEEDS FOR:

TEST FOR STARCH

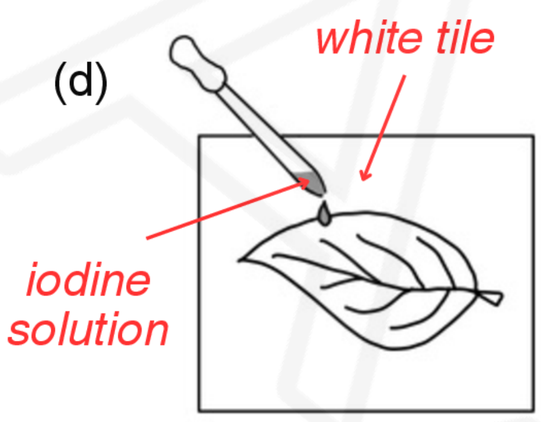
glucose is produced and quickly converted into starch



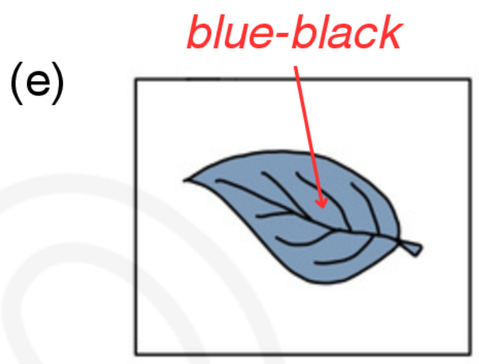
break down cell wall

remove chlorophyll using ethanol

to soften leaf



place decolourised leaf on white tiles



area with chlorophyll turns iodine into blue-black

(presence of starch)

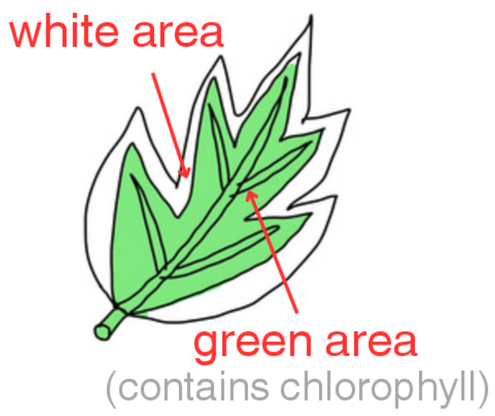
EXPERIMENTAL STEPS

(1) De-starch plant by keeping it in dark cupboard for 24 hours

(2) Ensure that any starch already present is used up

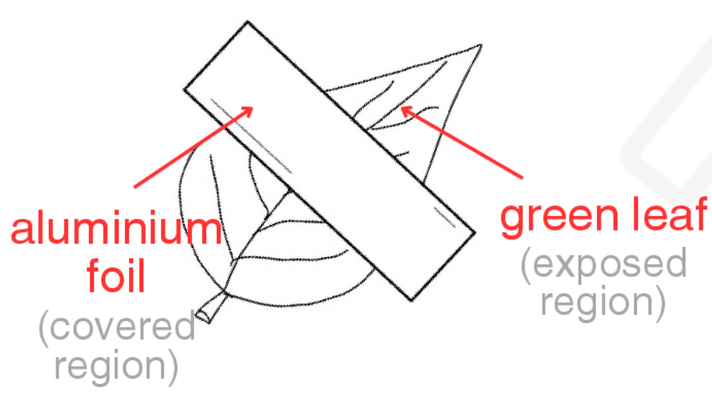
<u>*Chlorophyll*</u>

(3) Use variegated leaf
(partially white & green)



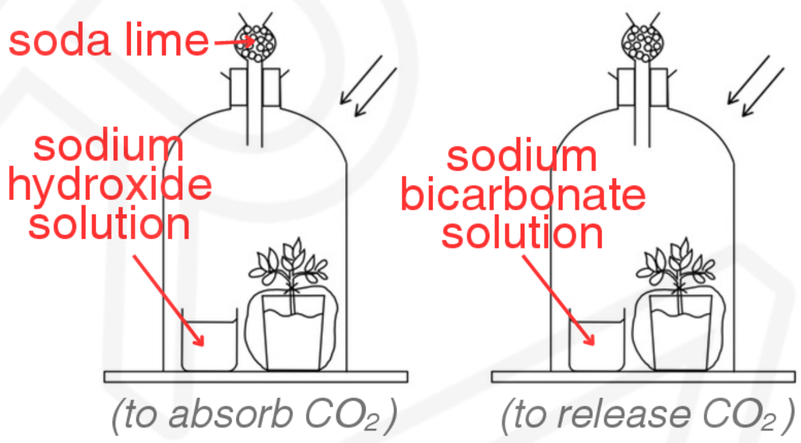
<u>*Light Intensity*</u>

(3) Place a stencil / Aluminium foil
(to cover part of leaf from sunlight)



<u>*Carbon Dioxide*</u>

(3) Place leaf into <u>bell jar A</u> & <u>bell jar B</u>



(4) Drop the leaf in boiling water to kill the cells and break down the cell membranes

(5) Leaf is left for 5-10 minutes in hot ethanol in a boiling tube to remove chlorophyll

(6) Dip the leaf in boiling water to soften cell walls

(7) Place leaf on white tile & add iodine solution to test for presence of starch

(8) <u>Presence</u> of starch: blue-black (green/exposed) | <u>Absence</u> of starch: orange-brown (white/covered)

- <u>*Carbon Dioxide*</u>

NaOH: absorbs CO_2
$NaHCO_3$: release CO_2

MINERAL IONS

mineral ions are actively absorbed from the soil by root hair cells

DEFICIENCIES

(a) <u>Magnesium Ion (Mg)</u>

Function: To make chlorophyll
Deficiency: Yellowing of leaves *(chlorosis)*

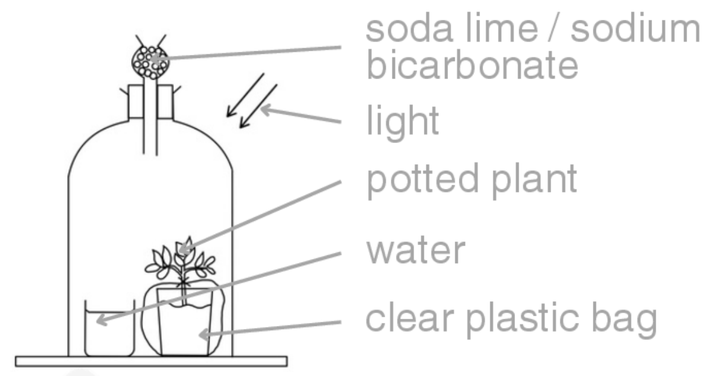
(b) <u>Nitrate Ion (NO_3^-)</u>

Function: To make amino acids
Deficiency: Stunted growth & yellowing of leaf

FERTILISERS

Minerals: nitrogen (N), phosphorus (P), potassium (K)

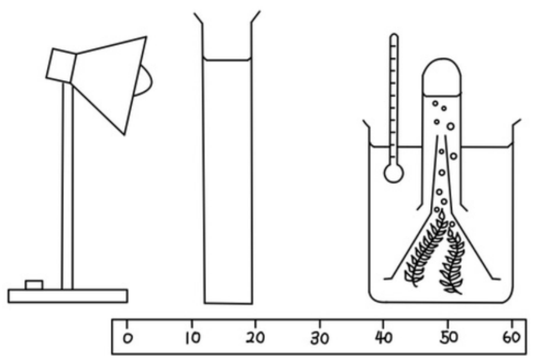
N: healthy leaves (up)
P: healthy roots (down)
K: healthy growth (fruits & flowers)



FACTORS AFFECTING RATE OF PHOTOSYNTHESIS

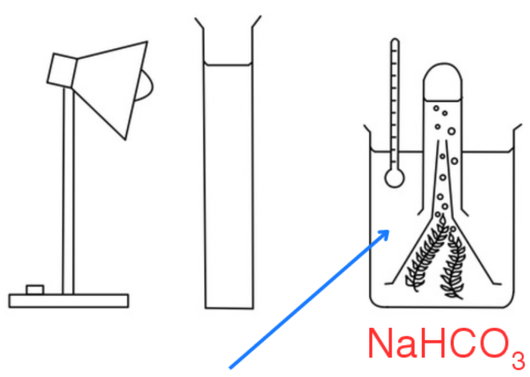
use pondweed to measure oxygen bubbles produced over a minute (DV)
(glass tank is placed between the lamp & beaker to absorb heat from lamp)

<u>*Light Intensity*</u>



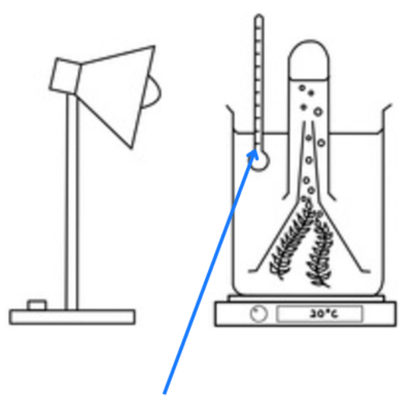
distance of lamp (IV)

<u>*Concentration of CO_2*</u>



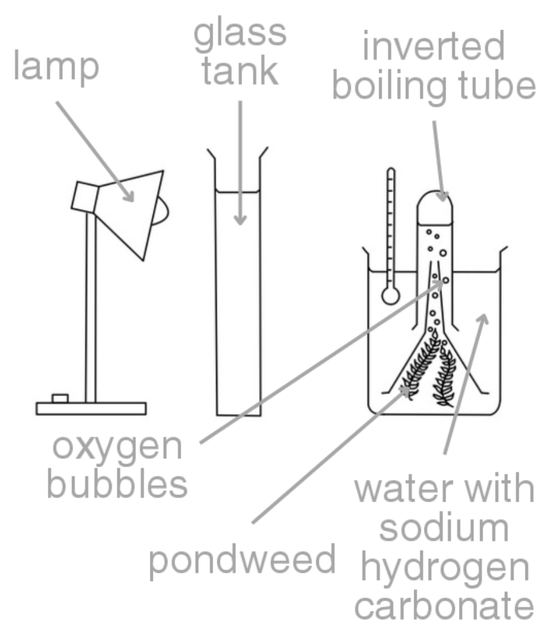
sodium hydrogen carbonate solution (IV)

<u>*Temperature*</u>



temperature (IV)

<u>Apparatus Set-Up</u>



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INVESTIGATING GAS EXCHANGE:

- photosynthesis (daylight): take in CO_2, release O_2

chloroplasts are found in
(a) Palisade mesophyll cell
(b) Spongy mesophyll cell
(c) Guard cell

- respiration (day & night): take in O_2, release CO_2

HYDROGENCARBONATE INDICATOR

shows the carbon dioxide concentration in solution
(carbon dioxide = acidic when dissolved in solution)

concentration of carbon dioxide	colour of hydrogen carbonate indicator	plant conditions
highest	yellow	respiration > photosynthesis *(lower pH)*
higher	orange	
atmospheric level	red	respiration = photosynthesis
lower	magenta	respiration < photosynthesis *(higher pH)*
lowest	purple	

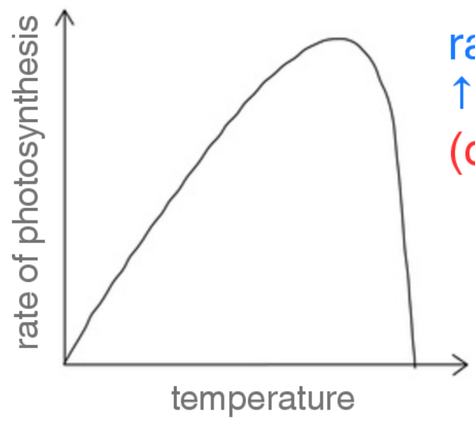
LIMITING FACTOR

something present in the environment in such short supply that it restricts life processes

rate of photosynthesis is limited by whatever factor (raw material) is the lowest at that time

FACTORS

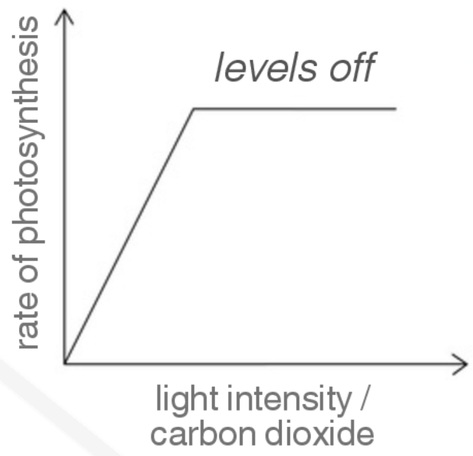
(a) Temperature



rate of photosynthesis ↑ as temperature ↑ (controlled by enzymes)

- *reaction ↓ as enzymes denature*

(b) Light Intensity

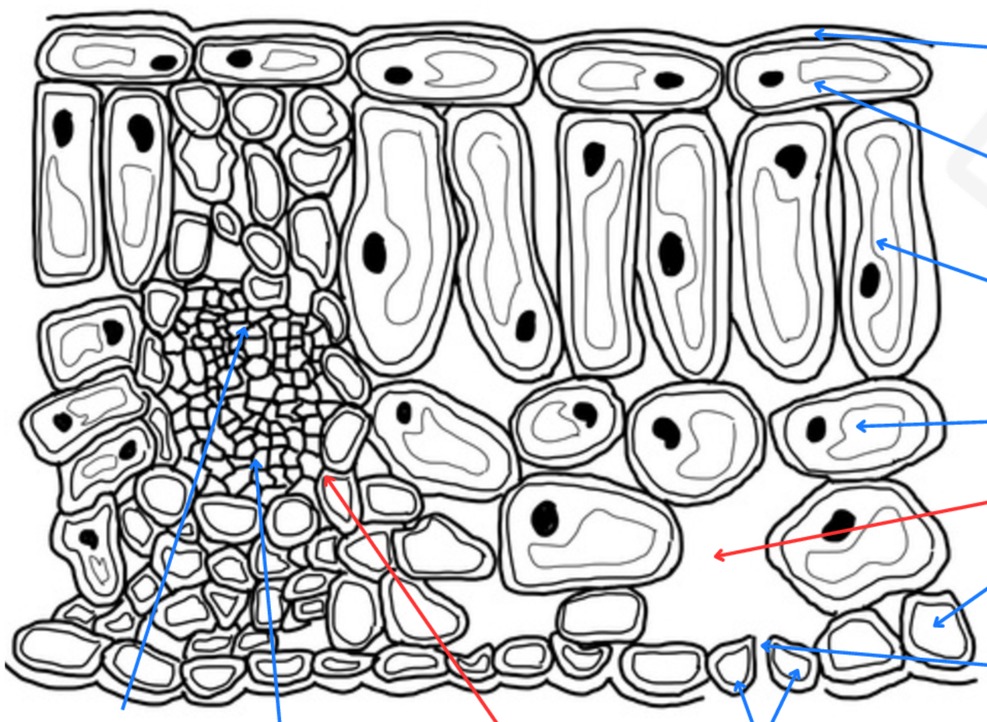


(c) CO_2 Concentration

graph levels off as other factors become limiting

- *↑ light, ↑ rate of photosynthesis*
- *↑ CO_2, ↑ rate of photosynthesis*

LEAF STRUCTURES & ADAPTATIONS



waxy cuticle	protective layer on top of the leaf, prevents water from evaporating
upper epidermis	thin and transparent to allow light to enter palisade mesophyll layer underneath it
palisade mesophyll	tightly packed with chloroplasts to absorb more light to maximise photosynthesis
spongy mesophyll	increases the surface area to volume ratio for the diffusion of gases
air spaces	
lower epidermis	contains guard cells and stomata
stomata	where gas exchange takes place, opens during the day, closes during the night
guard cells	open & close stomata to allow exchange of respiratory gases

vascular bundle

xylem: transports water & mineral ions
phloem: transports sucrose & amino acids

PATHWAY

from atmosphere to chloroplasts

atmosphere
(higher concentration of carbon dioxide compared to leaf)
↓
air spaces around spongy mesophyll
↓
leaf mesophyll
↓
chloroplast

ADAPTATIONS

(a) Large surface area: for faster diffusion of carbon dioxide & absorption of light
(b) Thin: allows carbon dioxide to diffuse to palisade mesophyll cells quickly
(c) Chlorophyll: for photosynthesis (palisade | spongy | guard cells)
(d) Network of veins: allows transport of water, minerals, sucrose & amino acids
(e) Stomata: allows carbon dioxide to diffuse in & oxygen to diffuse out
(f) Thin & transparent epidermis: more light to reach palisade cells
(g) Thin waxy cuticle: protect the leaf without blocking sunlight
(h) Palisade cell layer at the top: maximise absorption of light
(i) Spongy layer: air spaces (increase surface area for carbon dioxide to diffuse)
(j) Vascular bundles: thick cell walls to help support the stem & leaf

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BALANCED DIET

diet consists of food groups in correct proportions of carbohydrates, fats, protein, vitamins, minerals & water

PRINCIPLE DIETARY SOURCES

(a) Carbohydrates: Sources of energy *Sources (bread, rice, cereal, pasta, potatoes)*
(b) Protein: growth, repair of damaged cells, replacement of old cells *Sources (meat, fish, egg, nuts)*
(c) Lipid: insulates body, stores of energy, protect internal organ *Sources (butter, oil, lards)*
(d) Fibre: provides roughage/bulk for Intestine, prevents constipation, ↓ cholesterol *Sources (vegetables)*
(e) Vitamins: to maintain health (in small quantities) *Sources (fruits & vegetables)*
(f) Minerals: to maintain health (in small quantities) *Sources (fruits, vegetables, dairy products, meat)*
(g) Water: needed for chemical reactions *Sources (water, milk, fruits, vegetables, juice)*

VARYING DIETARY NEEDS

(a) age: use energy for growth
(b) activity levels: more muscle contractions, more energy is needed for respiration
(c) pregnancy: for development & growth of foetus (calcium & iron)
(d) breastfeeding: increase energy requirements & calcium

SCURVY & RICKETS

(a) Scurvy: vitamin C deficiency *(citrus fruits)*

symptoms:

- *bleeding gums*
- *gum ulcerations*
- *spontaneous bleeding*
- *anemia*
- *tooth loss*
- *swelling*
- *exhaustion*

(b) Rickets: lack of vitamin D *(sunlight)*

symptoms:

- *soft & weak bones*
- *lack of bone growth*
- *bone pain*
- *deformities*

DIGESTIVE SYSTEM

ALIMENTARY CANAL

- organs involved:
  (a) mouth
  (b) oesophagus
  (c) stomach
  (d) small intestine *duodenum & ileum*
  (e) large intestine *colon, rectum & anus*
- associated organs:
  (a) salivary gland
  (b) pancreas
  (c) liver
  (d) gall bladder

PHYSICAL DIGESTION

the breakdown of food into smaller pieces without chemical change to the food molecules (↑surface area for enzymes)

- chewing action of the teeth
- churning action of the stomach
- emulsification of fats by bile

STAGES OF FOOD BREAKDOWN

(a) Ingestion: – the taking of substances, e.g. food and drink, into the body
(b) Digestion: – the breakdown of food

- Mechanical Digestion:
  the breakdown of food into smaller pieces without chemical change to the food molecules
- Chemical Digestion:
  the breakdown of large, insoluble molecules into small, soluble molecules

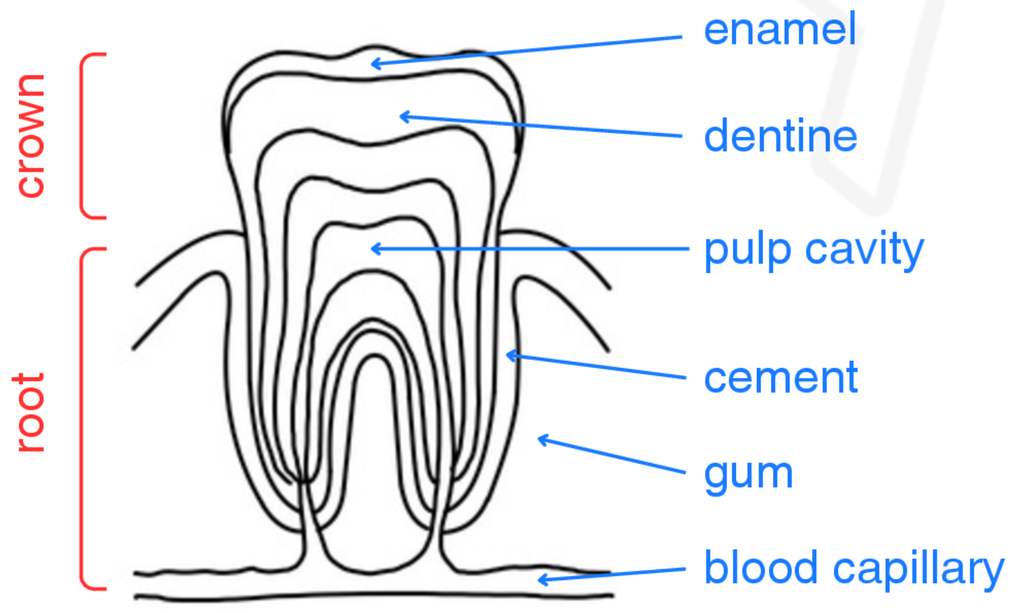
(c) Absorption: – the movement of nutrients from the intestines into the blood
(d) Assimilation: – uptake and use of nutrients by cells
(e) Egestion: – the removal of undigested food from the body as faeces

TYPES OF HUMAN TEETH



Incisor	Canine	Premolar	Molar
rectangular -shaped	sharp -pointed	larger, flat-surface with ridges at the edges	
• cutting • biting	• holding • tearing	• chewing • grinding • crushing	• chewing • grinding • crushing

TOOTH STRUCTURE



TOOTH DECAY

(a) sugar / food / plague left on teeth
(b) respiration (of sugar) by bacteria
(c) produce lactic acid
(d) dissolves enamel / dentine

pulp cavity:

(a) tooth-producing cells
(b) nerve endings
(c) blood capillaries

enamel & dentine:

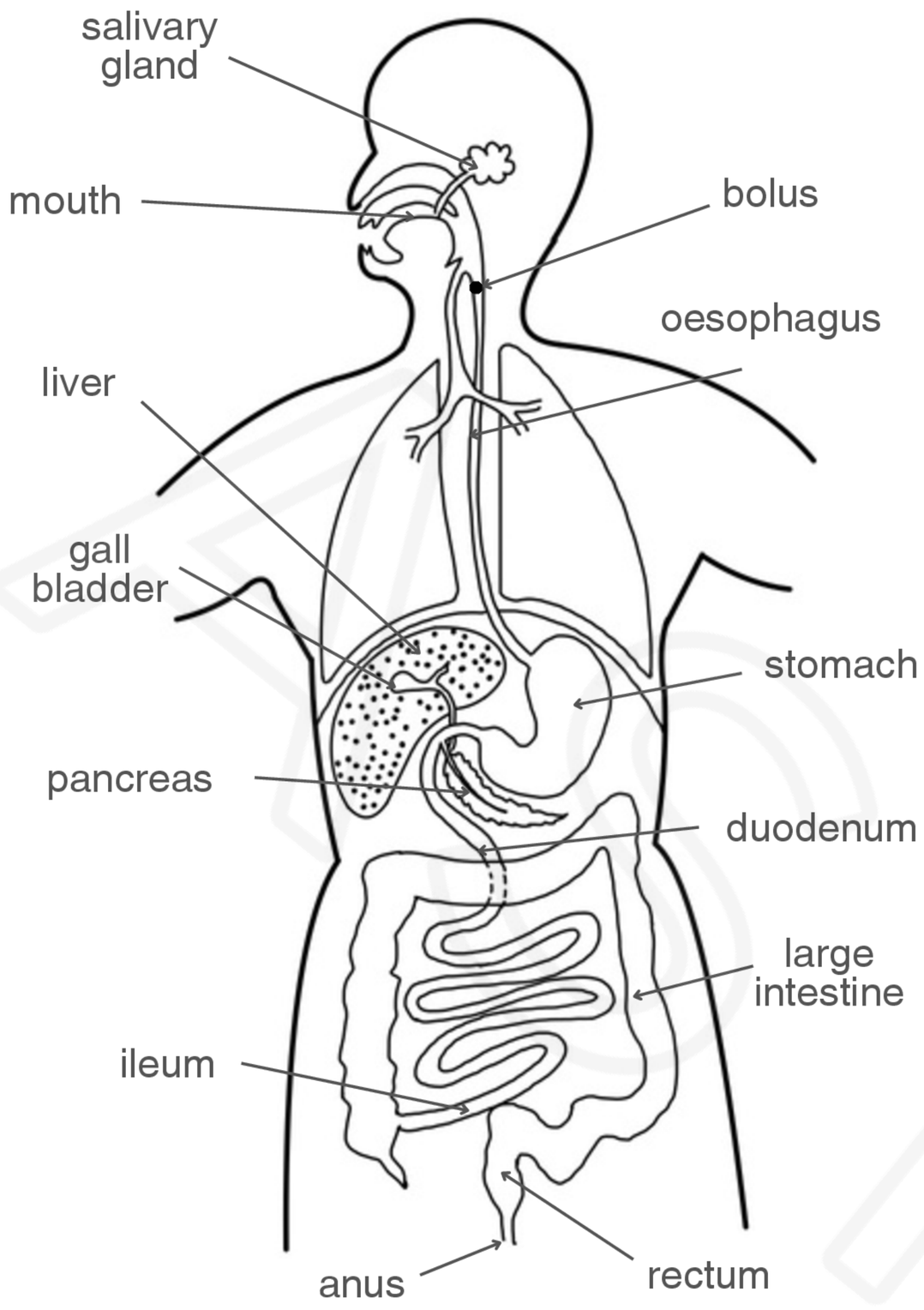
- strengthen by calcium salt (Ca^{2+}) & collagen fibre

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CHEMICAL DIGESTION

break down of large insoluble molecules into small soluble molecules that can be absorbed

COMPLETE DIGESTION PATHWAY



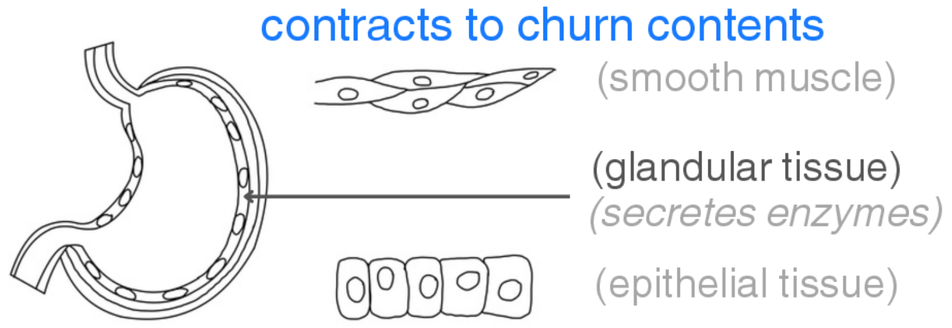
ACTIONS IN MOUTH → STOMACH

(a) mouth • mechanical digestion (teeth)
chew, tear, cut, grind food
(increase surface area of food)
• chemical digestion (salivary amylase)
starch ⟶ maltose

(b) salivary gland: secretes saliva (bolus)
(mixing of saliva with food)

(c) oesophagus: undergoes peristalsis
(contraction & relaxation of muscles)

(d) stomach: • mechanical digestion (forms chyme)
contracts to churn contents



• chemical digestion
secretes gastric juice (hydrochloric acid)
1. kill bacteria in food
2. provides acidic pH for enzymes
3. produces protease (pepsin)
protein ⟶ polypeptide

ACTIONS IN DUODENUM (1ST PART)

(e) liver: • mechanical digestion
produces bile
1. emulsification of fats/lipids (bile)
(breaks down large fat globules into fatty droplets: larger surface area allows lipase to chemically break down lipid faster)
2. neutralise hydrochloric acid
(alkaline in nature)

(f) gall bladder: stores bile

(g) pancreas: • chemical digestion
secretes pancreatic juice
1. break down starch (pancreatic amylase)
starch ⟶ maltose
2. break down polypeptide (trypsin)
polypeptide ⟶ peptide
3. break down fats/lipids (lipase)
fats/lipids *(soluble)* ⟶ fatty acids + glycerol

(i) large intestine (colon): absorbs water

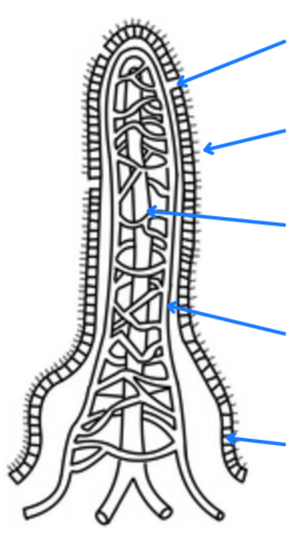
(j) rectum: stores faeces (k) anus: defaecation

ACTIONS IN ILEUM (LAST PART)

(h) ileum: • chemical digestion
1. break down maltose (maltase)
maltose ⟶ glucose
2. break down peptide (erepsin)
peptide ⟶ amino acids
• absorption
digested food molecules (nutrients) & 80% of water are absorbed in the small intestine

ADAPTATION OF SMALL INTESTINE

highly folded surface with millions of villi | very long
(finger like projections: increases surface area)



goblet cell (secretes mucus)
(easy diffusion)
microvilli (larger surface area)
(faster absorption, more efficient)
lacteal (transport fatty acids & glycerol)
(part of lymphatic system: vessel)
blood capillaries (transport glucose & amino acids)
(network of blood supply)
epidermis (one cell thick)
(shorter distance for absorption)

Diarrhoea • loss of watery faeces / dehydration
• salt water / oral rehydration therapy

vibrio cholerae (bacteria)
(a) bacteria secretes toxins
(b) stimulates release of chloride ions
(c) lower water potential in lumen
(d) osmotic difference moves water into lumen of small intestine

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VASCULAR BUNDLE

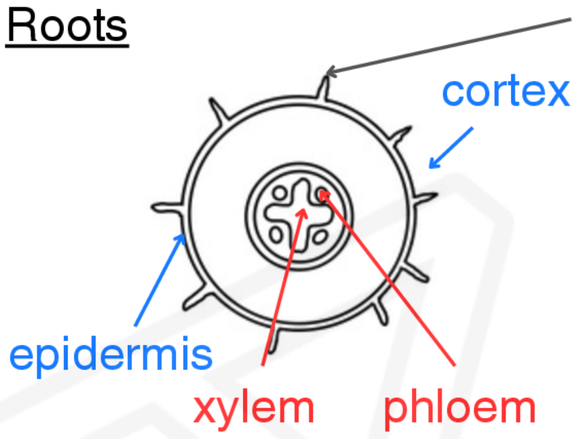
XYLEM & PHLOEM

Vascular Bundle

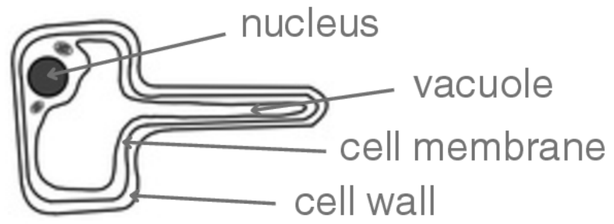
- xylem (transport water & mineral ions) — *osmosis* *active transport*
  - transpiration
- phloem (transport sucrose & amino acids)
  - translocation

Cross-sectional diagram

- Roots



root hair cell



- elongated *(larger surface area)*
- thin membrane *(shorter diffusion distance)*

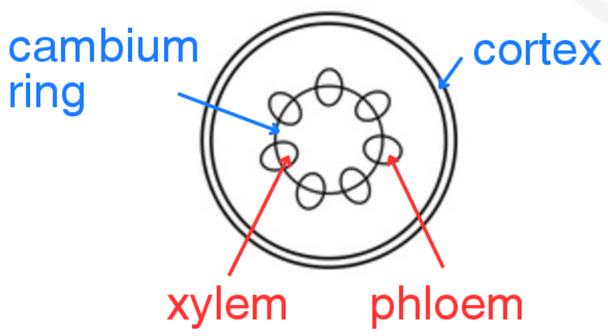
(a) soil water has a high water potential than the cytoplasm of root hair cell

(b) water enters root hair cells by osmosis mineral ions enter through active transport

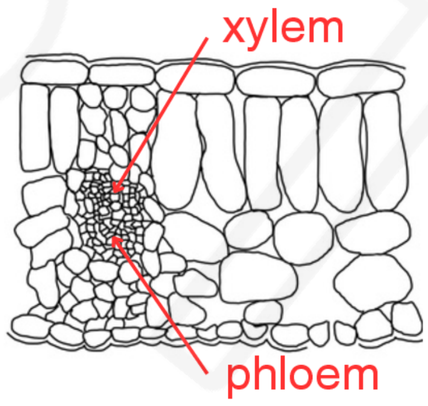
(c) water diffuses into adjacent cells & xylem

(d) root hair cell increases rate of absorption due to larger surface area

- Stem



- Leaf



FACTORS AFFECTING RATE OF TRANSPIRATION

(a) Temperature *(higher)* — • ↑kinetic energy, ↑evaporation • water diffuses faster • ↑ transpiration

(b) Wind Speed *(higher)* — • good air flow, removes water vapour • sets up concentration gradient • ↑ ROT

(c) Humidity *(lower)* — • moisture in air • concentration gradient is higher when less saturated • ↑ ROT

POTOMETER IN INVESTIGATING TRANSPIRATION

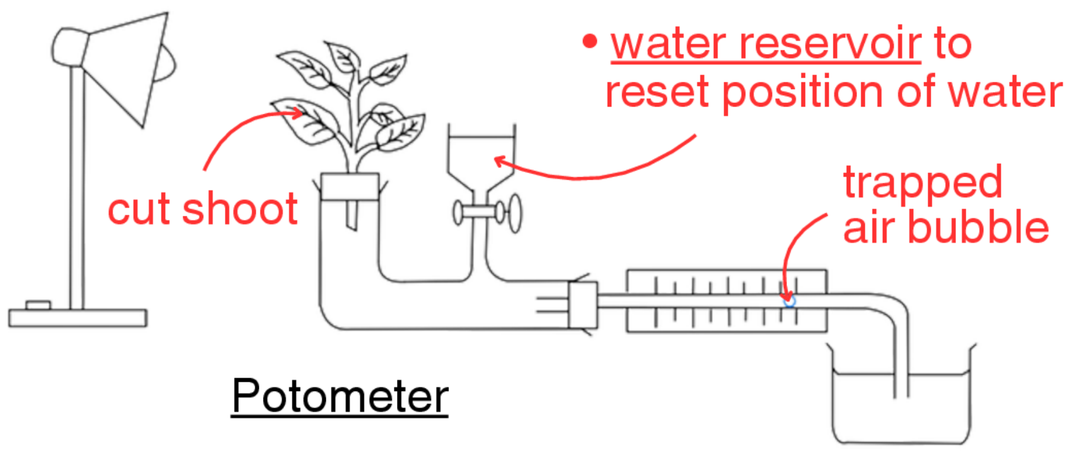
(a) Cut a shoot underwater to prevent air entering the xylem and place in tube

(b) Set up the apparatus (potometer), make sure is airtight

(c) Remove the capillary tube from the beaker to allow a single air bubble to form and place the tube back into the water

(d) Set up the environmental factors, and record the starting location, leave for a set time, & record end location of bubble

(e) Further the bubble travels, faster the rate of transpiration



Potometer

PATHWAY TAKEN BY WATER

root hair → *cortex* → *xylem* → *mesophyll*
(root) (root, stem, leaf) (leaf)

TRANSPIRATION

loss of water vapour from plant leaves by evaporation of water at the surfaces of the mesophyll cells followed by diffusion of water vapour through the stomate

water vapour loss:

many interconnecting air spaces between cells & stomata create a large surface area

Functions:

- transporting mineral ions
- keep cells turgid to provide mechanical support to plant
- provides water for photosynthesis
- keeping leaves cool

Adaptations of xylem



- dead plant cell
- uni-directional
- lignified wall • hollow
- waterproof • thin capillary
- no cross walls

(a) water molecules are attracted to each other by cohesion

(b) moves in continuous transpiration stream from roots to leaves

(c) produces tension, enabling water is pulled up through the plant

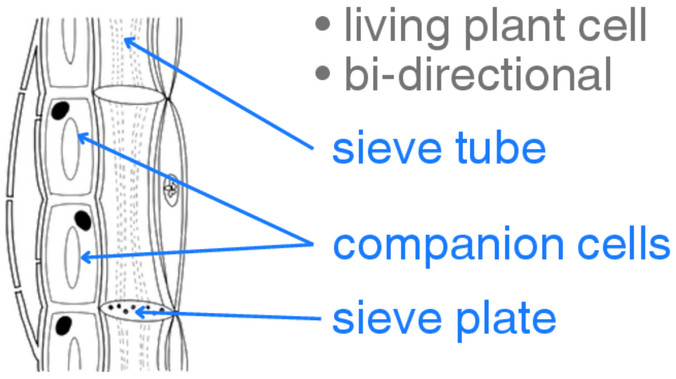
TRANSLOCATION

the movement of sucrose and amino acids in phloem from sources (regions of production) to sinks (regions of storage)

bi-directional: different seasons

- winter: *tap into storage for respiration*
- spring: *roots (source)* | *growth area (sink)*
- summer: *leaf (source)* | *roots (sink)*

Adaptations of phloem



WILTING

water evaporates faster than the movement of water from soil into roots

lack of water → cell loses turgidity → wilts

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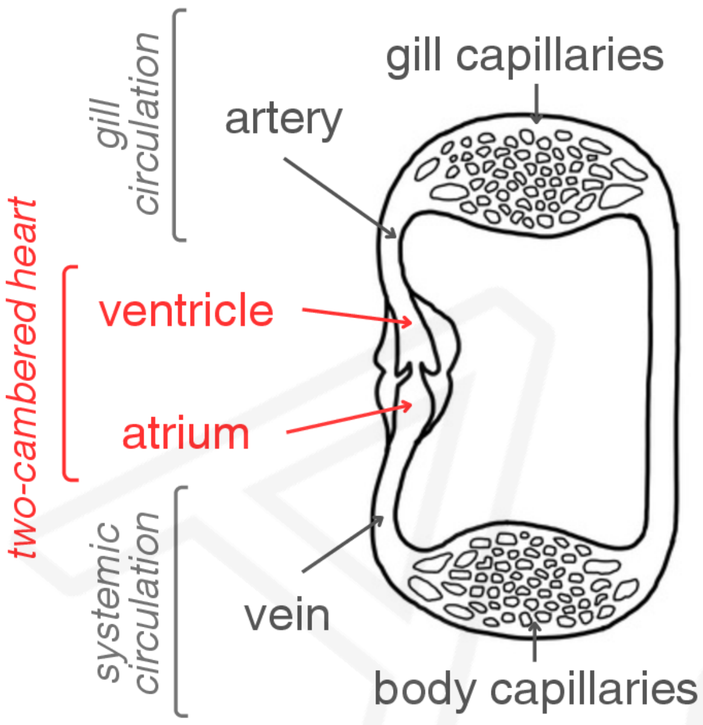
CIRCULATORY SYSTEM

transport blood around body and consists of heart, blood vessels, blood & valves

TYPES OF SYSTEM

Single circulatory system

blood passes through the heart once

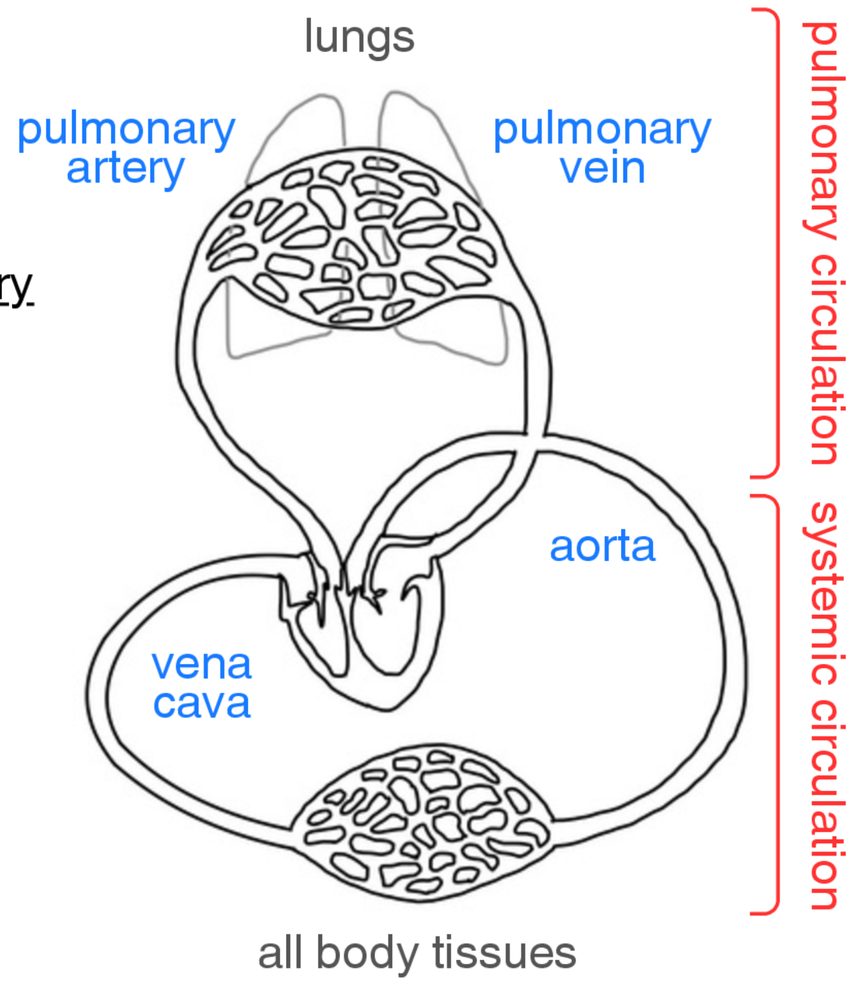


Double circulatory system

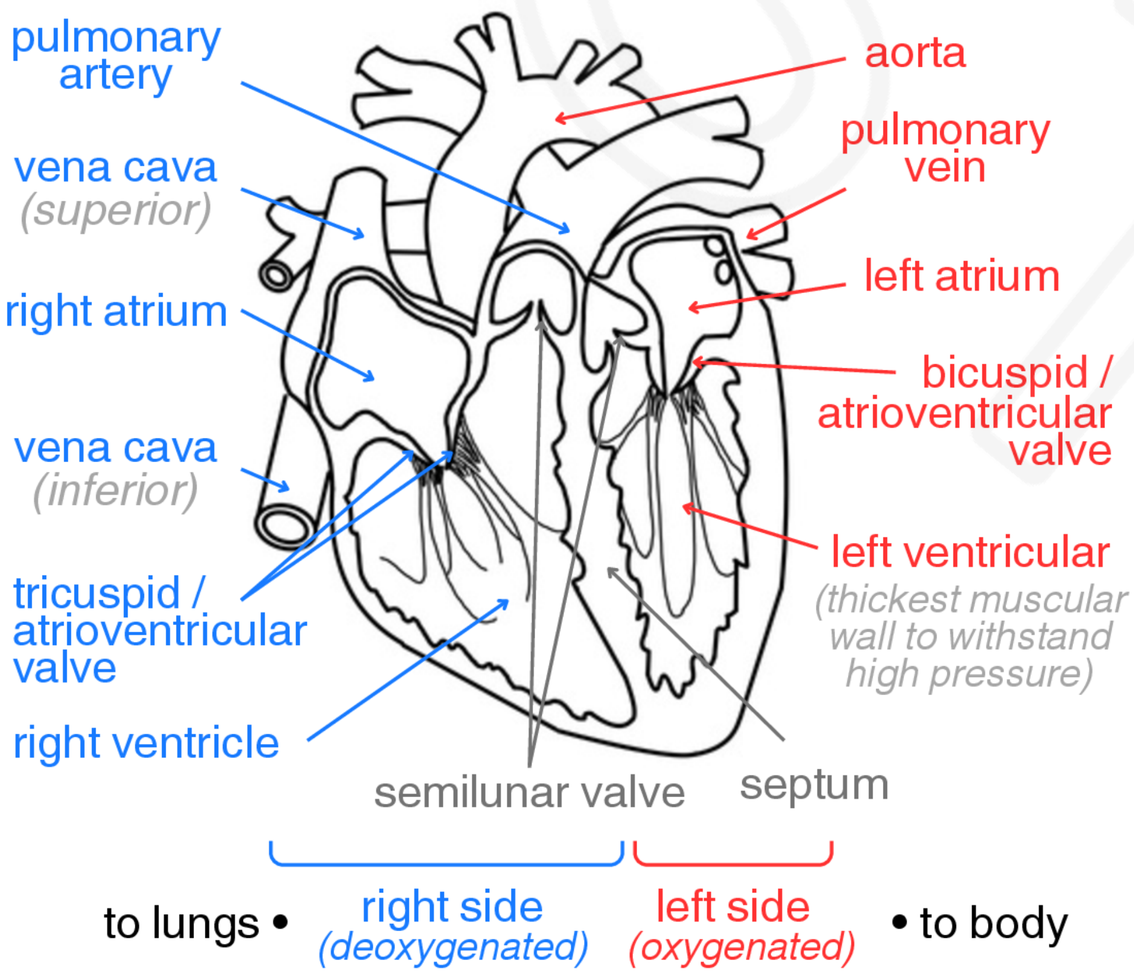
blood passes through the heart twice

Advantages of double circulatory

- higher blood pressure in body
- ensures efficient supply of oxygen & glucose
- lower pressure in pulmonary
- prevent damage of lungs
- allows more time for gas exchange
- oxygenated blood & deoxygenated blood are kept separated by septum
- high metabolic rate



HEART STRUCTURE



Functions:

(a) Septum: prevent mixing of oxygenated blood & deoxygenated blood

(b) Arteries: away from heart | Veins: back to heart

(c) Ventricles: thicker muscle walls than atria *(generates higher pressure)*

(d) Valve: prevent back flow of blood

- *atrioventricular - separate atria from ventricles*
  (open when atria contract, closes when ventricles contract)
- *semi-lunar valve - 2 blood arteries*
  (open when ventricles contract and blood gets squeezed out of the heart and close to avoid flowing back to heart)

CORONARY HEART DISEASE

blockage of coronary arteries by fatty deposits
(plaques formed from cholesterol)

: arteries become less elastic, unable to stretch

(a) partial blockage: severe chest pain - angina
- *restricted blood flow to cardiac muscles*

(b) complete blockage: heart attack
- *cells can't respire, heart is unable to contract*

Risk factors: *(builds up plague & blocks artery)*

(a) poor diet: more saturated fat, ↑ cholesterol levels
(b) stress: produce hormones, ↑ blood pressure
(c) smoking: nicotine, narrow vessel, ↑ blood pressure
(d) genetic predisposition: family history, ↑ likeliness
(e) age: older individual, higher risks
(f) gender: males are more likely to develop

Reducing risks: • quit smoking • diet • exercise

ACTIVITY OF HEART

Heart rate (pulse rate): beats per minute (bpm)

3 ways to monitor heart rate:

(a) ECG: electrocardiogram
(b) measuring pulse rate
(c) listening to the sounds of valves closing using a stethoscope

Investigate effect of exercise on heart rate:

(a) record pulse rate (bpm) at rest
(b) perform an activity / exercise
(c) record pulse rate until resting state (bpm)

- ↑ *heart rate (measure pulse)*
- ↑ *breathing rate (count breaths per minute)*
- ↑ *blood circulation (↑ glucose & oxygen)*

To explain effect of physical activity:

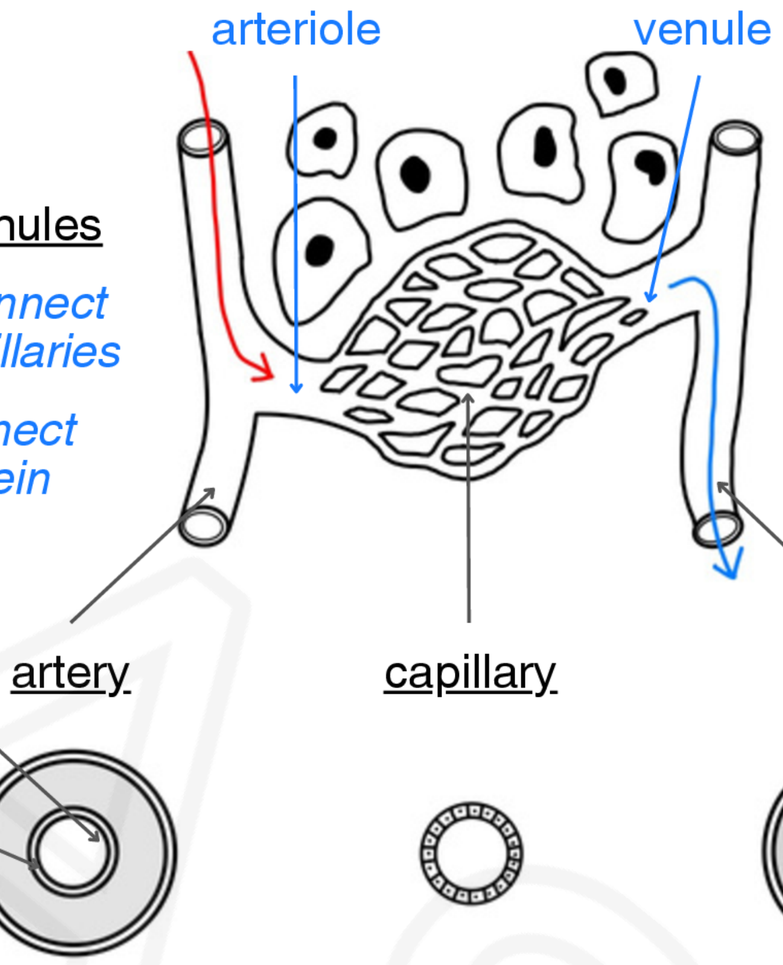
- sufficient blood to provide nutrients & oxygen
- ↑ in heart rate to remove waste product faster
- muscles respire anaerobically (oxygen debt)
- ↑ blood flow to supply more oxygen to muscles to break down lactic acid and remove CO_2

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BLOOD VESSELS

STRUCTURE OF VESSELS

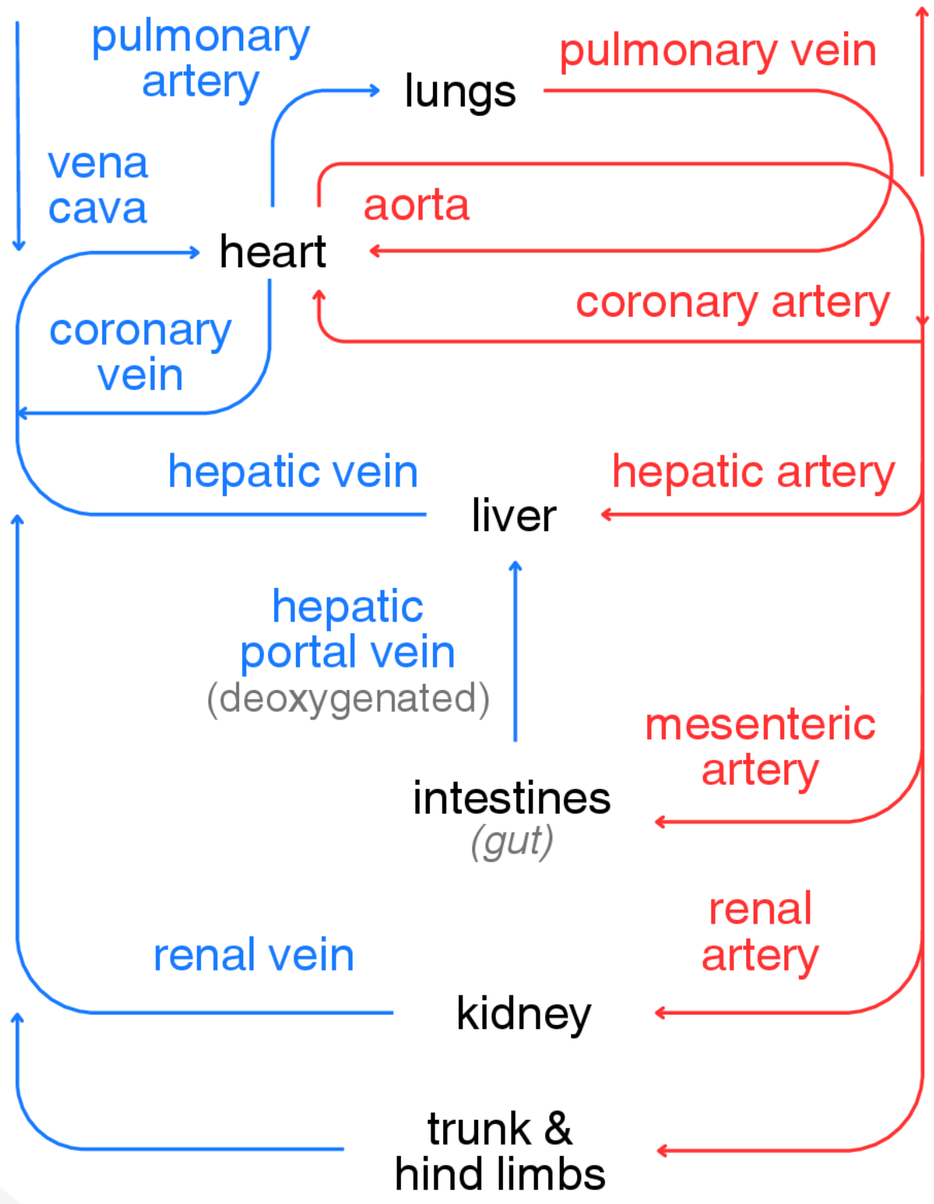


arterioles & venules

- *arterioles: connect arteries to capillaries*
- *venules: connect capillaries to vein*

	artery	capillary	vein
• blood	transport oxygenated blood away from heart	transport both oxygenated & deoxygenated blood	transport deoxygenated blood away from heart
• wall	thick muscular wall	leaky walls	thin muscular wall
• lumen	small lumen	one cell thick	large lumen
• blood pressure	high blood pressure	low pressure within tissue	low blood pressure
• valve	no valves	no valves	has valves

MAIN BLOOD VESSELS



Naming blood vessels

- heart to lungs : pulmonary
- heart to heart : coronary
- heart to liver : hepatic
- heart to kidney : renal

BLOOD

BLOOD COMPONENTS

blood composition

45% — *55%*

cells | platelets | plasma

(a) red blood cell



- transport oxygenated blood
- bi-concave disc-shaped

(larger surface area for faster diffusion)

- no nucleus

(more haemoglobin to transport oxygen)

- made in bone marrow

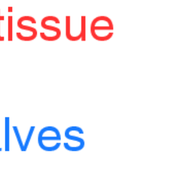
(b) white blood cell

- irregular-shaped
- defend the body against infection

phagocytes

- lobed nucleus
- kill bacteria by engulfing them

(phagocytosis)



lymphocytes

- round nucleus
- antibody production
- provides immunity

(antibodies & memory cells)



plasma

transport of carbon dioxide, digested food (nutrients), urea, mineral ions, hormones & heat

(a) water

(universal solvent, regulate body temperature & pH)

(b) dissolved substances

(glucose, amino acids, carbon dioxide)

(c) mineral ions

(Na^+, Ca^{2+} ions)

(d) plasma protein

(fibrinogen: blood clotting)

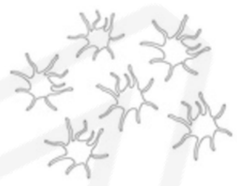
(e) hormones

(testosterones, adrenaline, progesterone etc..)

BLOOD CLOTTING

platelets

- fragments of cells
- blood clotting



Mechanism

open wound

↓ prevents continued / significant blood loss from wounds

platelets

↓ release chemicals that converts

soluble fibrinogen protein

↓ trapping red blood cells and therefore forming a clot

insoluble fibrin

↓ develops into a scab to protect the wound from bacteria entering

scab

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PATHOGENS & BARRIERS

- Pathogen: disease-causing organism
- Transmissible disease:

disease in which the pathogen can be passed from one host to another

METHODS OF TRANSMISSION

disease that can be passed on from 1 host to another

(a) By direct contact: HIV, hepatitis B & C

- *blood* • *other bodily fluid (semen)*

(b) Indirectly: carried by host / medium

- *contaminated surfaces: salmonella*
- *food & water: cholera*
- *animal & insects: malaria, rabies*
- *droplets in air: common cold, infleunza*

IMMUNITY

ACTIVE IMMUNITY

making antibodies and developing memory cells for future response to infection

- *slow acting* • *long lasting immunity*

Active immune response:

(a) Infected by Pathogens (natural)

- *lymphocytes develops antibodies specific to antigens*

(b) Vaccination (artificial)

1st: *Inject dead & weakened pathogens (with specific antigens) into the body*

2nd: *Antigens trigger an immune response by lymphocytes which produces antibodies*

3rd: *Memory cells are produced to provide long-term immunity with quick response*

↓

Herd immunity

a large enough percentage of the population is vaccinated, it protects the entire population as there is no place for pathogens to breed

- *prevents epidemics and pandemics from occurring in populations*
- *contain spread of contagious diseases*

PASSIVE IMMUNITY

short-term defence against a pathogen by antibodies acquired from another individual

- *fast acting* • *short-term immunity*

Passive immune response:

(a) Breastmilk: mother to infant
(b) Obtain across placenta — (natural)
(c) Injection from immune serum — (artificial)

BODY DEFENCES

(a) Mechanical: structures that make It difficult for pathogens to pass through

- *skin: sebum, scab*
- *hair: block entry of pathogens*

(b) Chemical: substances produced by body cells that trap or kill pathogens

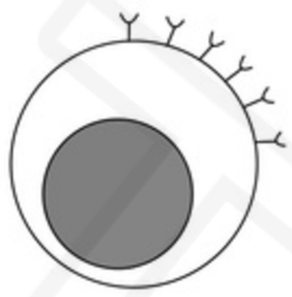
- *mucus: traps & remove pathogens*
- *hydrochloric acid: kill pathogens*

(c) Cells: white blood cells to prevent pathogens from replicating

- *phagocytes: engulf & digest pathogens*
- *antibodies: neutralisation (anti-toxin), agglutination & kill pathogens*

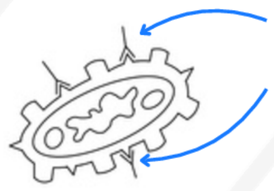
Roles of antibodies

proteins that bind to antigens leading to direct destruction of pathogens or marking of pathogens for destruction by phagocytes



lymphocyte

(a) agglutination: attach to antigens
(b) secretes chemicals: signal presence of pathogens to phagocytes
(c) neutralisation: secretes antitoxins to neutralise toxins
(d) direct destruction: memory cells



pathogen

- lymphocytes can recognise foreign antigens
- lymphocytes make antibodies which are complementary in shape to the antigens

CONTROLLING THE SPREAD OF DISEASE

stop pathogens from spreading using measures such as good hygiene and effective sanitation and waste disposal

Hygenic food preparation

- keep food cold to slow down reproduction of pathogen
- prepare food hygienically (cleaning work surfaces)
- cook food well at high temperatures to kill pathogens
- separate utensils from uncooked meat

Personal hygiene

- dispose used tissue as soon as possible
- wash hands with soap to remove substances
- use tissue to catch sneezes & coughs

Waste disposal

- cover rubbish bin & remove to landfill for disposal
- waste food is a food source for flies (vector for transmissible diseases), dispose in sealed container

Sanitation

- plumbing & drainages to remove wastes & faeces
- sewage treatment: filtration, sedimentation, + chlorine

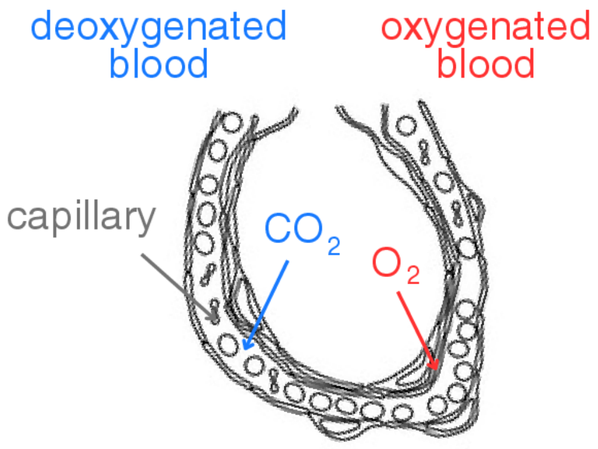
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UNIT 11: GAS EXHANGE IN HUMANS

ASTRA

FEATURES OF GAS EXCHANGE SURFACES

ALVEOLI

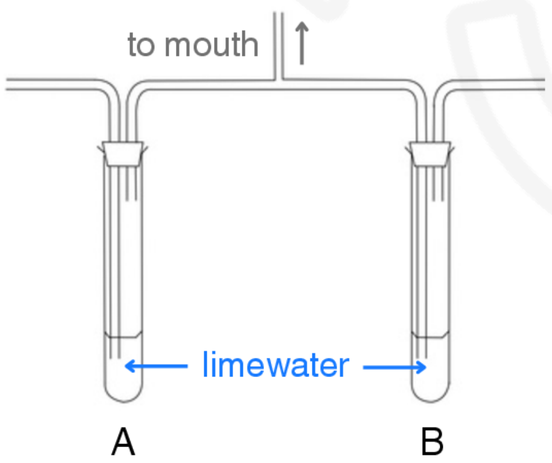


Adaptations:

- large surface area: *faster diffusion*
- thin surface: *short diffusion distance*
- good blood supply: ↑ *concentration gradient for faster diffusion*
- good ventilation with air: *maintain diffusion gradient*

LIMEWATER TEST

limewater turns cloudy in presence of CO_2



- air is drawn through boiling tube A when breathing in
- air is pushed out through boiling tube B breathing out
- limewater in A remains clear, limewater in B turns cloudy

AIR COMPOSITION

	Inspired Air *(inhaled)*	Expired Air *(exhaled)*
Oxygen	21%	16%
Carbon dioxide	0.04%	4%
Water vapour	0.2-4%	5-7%
Nitrogen	78%	78%

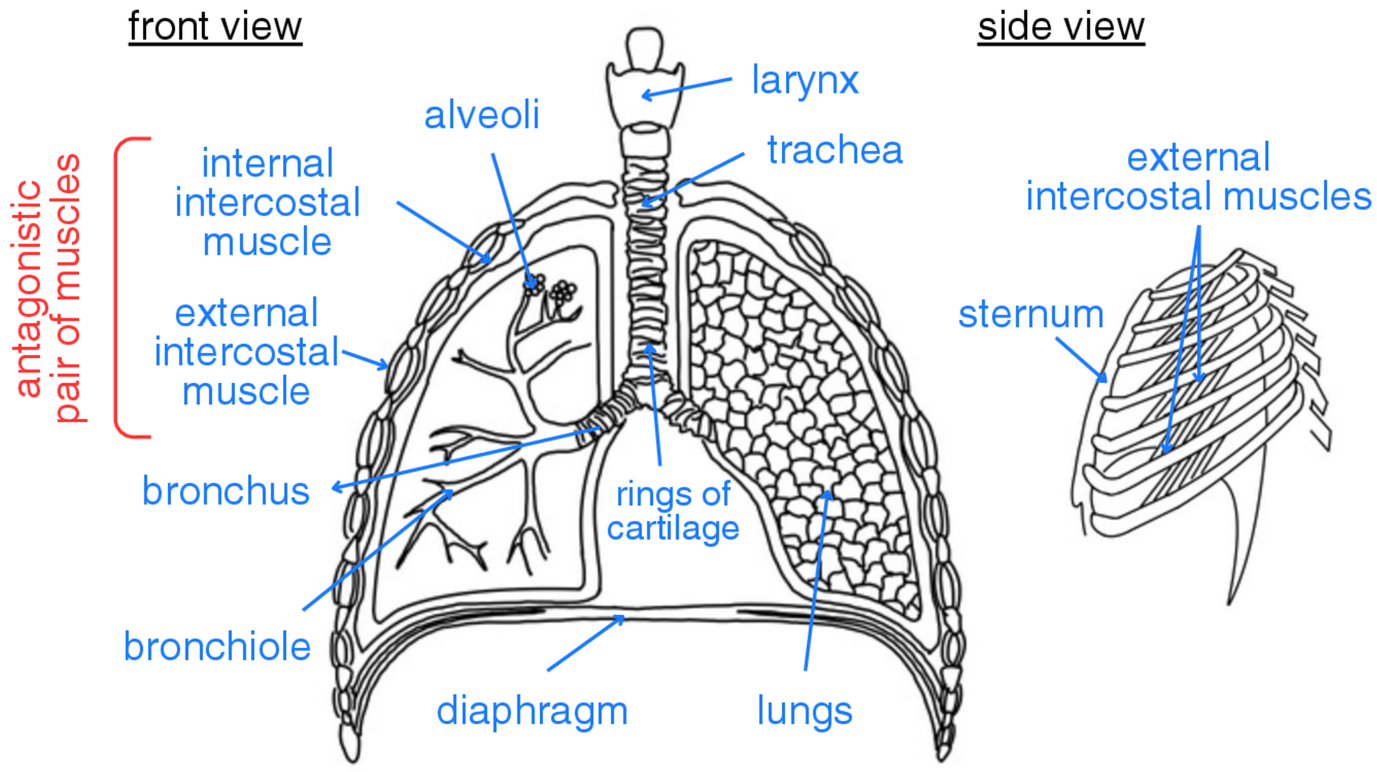
Oxygen is taken in for respiration & carbon dioxide is removed by body

PROTECTION

respiratory tract is lined with ciliated epithelial cells

- goblet cells: produces mucus
- mucus: traps particles, pathogens like bacteria or viruses, and dust
- cilia: move mucus away from lungs

LUNGS STRUCTURE



Parts:	Functions:
1) Trachea	windpipe that connects the mouth & nose to lungs (made of cartilage)
2) Larynx	voice box, air passes across to make sounds
3) Bronchus	large tube branching off the trachea with one bronchus for each lung
4) Bronchiole	bronchi split to form smaller tubes called bronchioles in the lungs connected to alveoli
5) Cartilage	support the airways and keep them open during breathing, prevent sides from collapsing inwards when air pressure in the tube drops
6) Alveoli	tiny air sacs where gas exchange takes place
7) Ribcage	bone structures that protect internal organs such as the lungs
8) Intercostal muscles	muscles between the ribs which controls their movement causing inhalation & exhalation *(upward, outward / downward, inward)*
9) Diaphragm	sheet of connective tissue & muscle at the bottom of thorax *(contracts → moves down | relax → moves up)*

VOLUME & PRESSURE CHANGES IN LUNGS

Inhalation	Exhalation
• external intercostal muscles contract	• external intercostal muscles relax
• internal intercostal muscles relax *(ribcage moves up & out)*	• internal intercostal muscles contract *(ribcage moves down & in)*
• diaphragm contracts *(volume of thorax ↑)*	• diaphragm relax *(volume of thorax ↓)*
• pressure in lungs ↓	• pressure in lungs ↑
• pressure in atmosphere > pressure in lungs	• pressure in lungs > pressure in atmosphere
• Air is drawn into lungs	• Air is pushed out of lungs

(a) rate of respiration ↑ → CO_2 levels ↑ in the muscle cells
(b) ↑ CO_2 in blood ↓ pH (acidic) → detects by chemoreceptor in brain
(c) brain sends impulse to ↑ the rate & depth of breathing
(d) anaerobic respiration → production of lactic acid → ↑ oxygen debt
(e) ↓ pH denatures enzymes → lactic acid is taken to liver by blood → oxidised to CO_2 & H_2O / converted to glucose

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UNIT 12: RESPIRATION

ASTRA

USES OF ENERGY

RESPIRATION

chemical process that involves the breakdown of nutrient molecules to release the energy (enzyme-controlled)

- occurs in all living cells

Uses of energy

a) muscle contraction b) active transport
c) protein synthesis d) cell division e) growth
f) the passage of nerve impulses
g) maintenance of constant body temperature

AEROBIC RESPIRATION

chemical reactions in cells that use oxygen to break down nutrient molecules to release energy

(complete breakdown of glucose releases a relatively large amount of energy)

word equation

glucose + oxygen ⟶ carbon dioxide + water

chemical equation

$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O$

ANAEROBIC RESPIRATION

chemical reactions in cells that break down nutrient molecules to release energy without using oxygen
(incomplete breakdown of glucose and releases a relatively small amount of energy)

In human:

glucose ⟶ lactic acid
$C_6H_{12}O_6$ ⟶ $2C_3H_6O_3$

In yeast: fermentation • *bread-making: rises dough* | • *wine*

glucose ⟶ ethanol + carbon dioxide
$C_6H_{12}O_6$ ⟶ $2C_2H_5OH$ + CO_2

UNIT 13: EXCRETION IN HUMANS

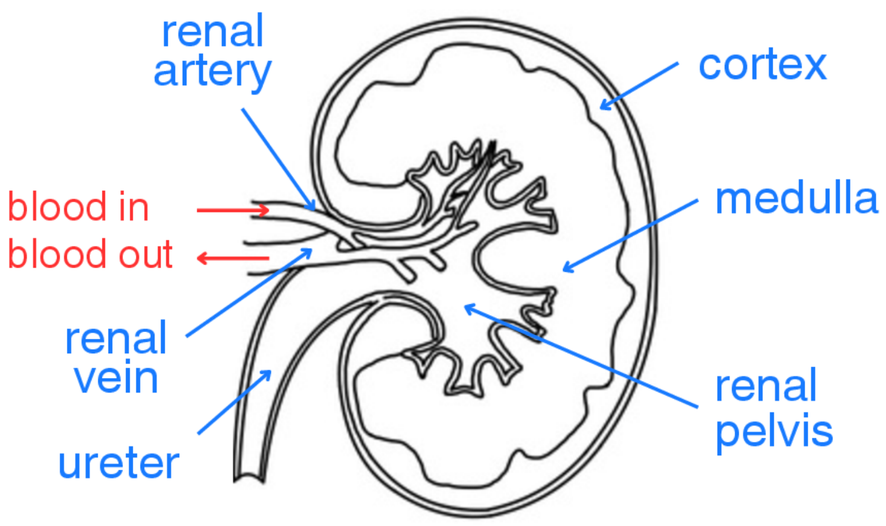
ASTRA

EXCRETORY SYSTEM

removal of the waste substances of metabolic reactions (the chemical reactions that take place inside cells), toxic materials and substances in excess of requirements

- lungs: carbon dioxide
- kidney: excess water, mineral salts & urea

KIDNEY STRUCTURE



- regulate the water content of the blood
- excrete the toxic waste products of metabolism

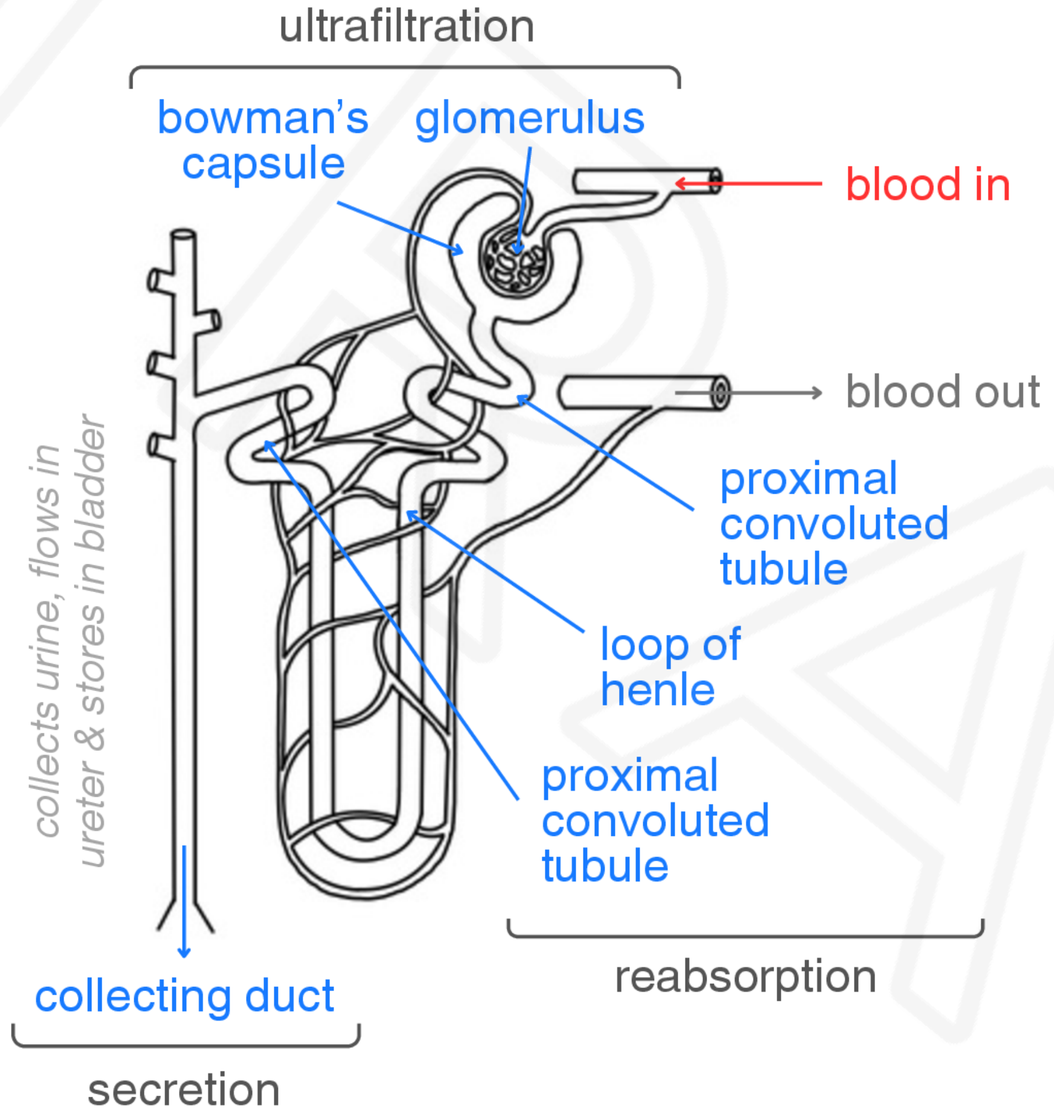
ROLES OF LIVER

- liver helps in the assimilation of amino acids by converting them into proteins
- excess amino acids absorbed in the blood cannot be stored & are broken down via deamination

excess amino acids → nitrogen part ⟶ ammonia *(highly toxic)* ⟶ urea
excess amino acids → carbon part ⟶ glycogen

high urea levels: • cell death • diabetes

NEPHRON start in the cortex, loop into the medulla



Ultrafiltration: • filtrate: glucose, water, urea, salts

renal artery → glomerulus → bowman's capsule
(narrow, ↑ pressure)

Reabsorption:

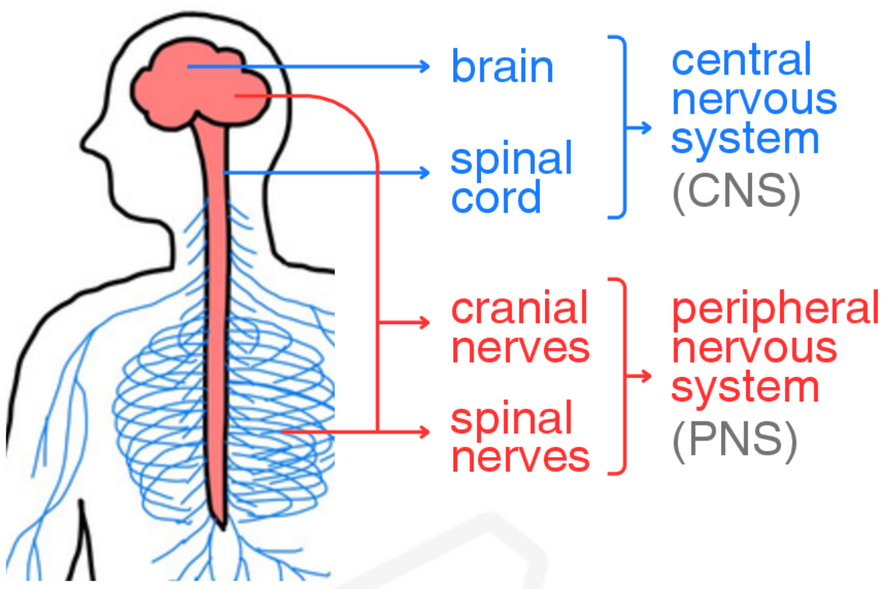
(a) Proximal: • reabsorption of glucose by active transport
• mineral ions & water (diffusion & osmosis)
(b) Loop of Henle: • excess minerals & water
(c) Distal: • excess minerals & water

Secretion: • forms urine (conc. urea) leads to ureter

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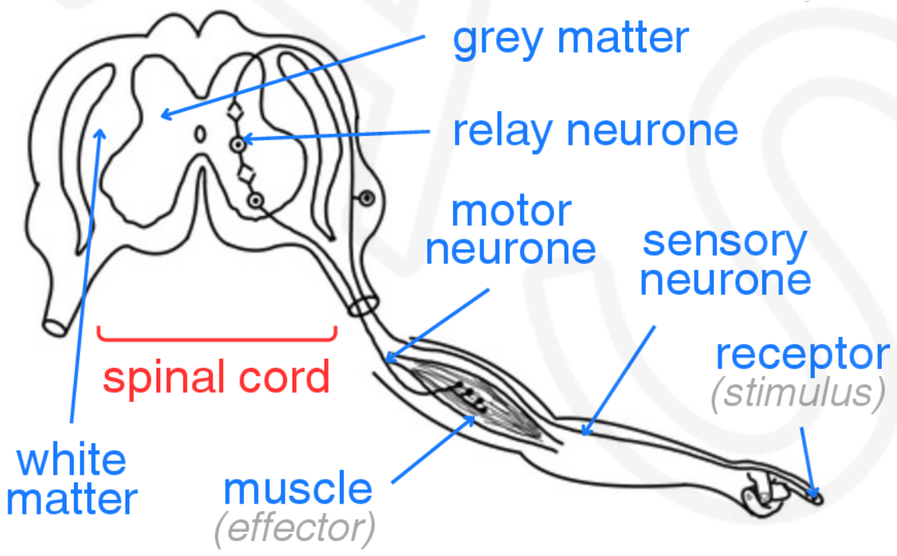
MAMMALIAN NERVOUS SYSTEM

CENTRAL & PERIPHERAL



VOLUNTARY AND INVOLUNTARY

Neural Pathway



voluntary action

- conscious decision
- involves brain

stimuli → receptor → sensory neurone → relay neurone → brain → relay neurone → motor neurone → muscles

reflex arc *(automatic + fast + protective)*

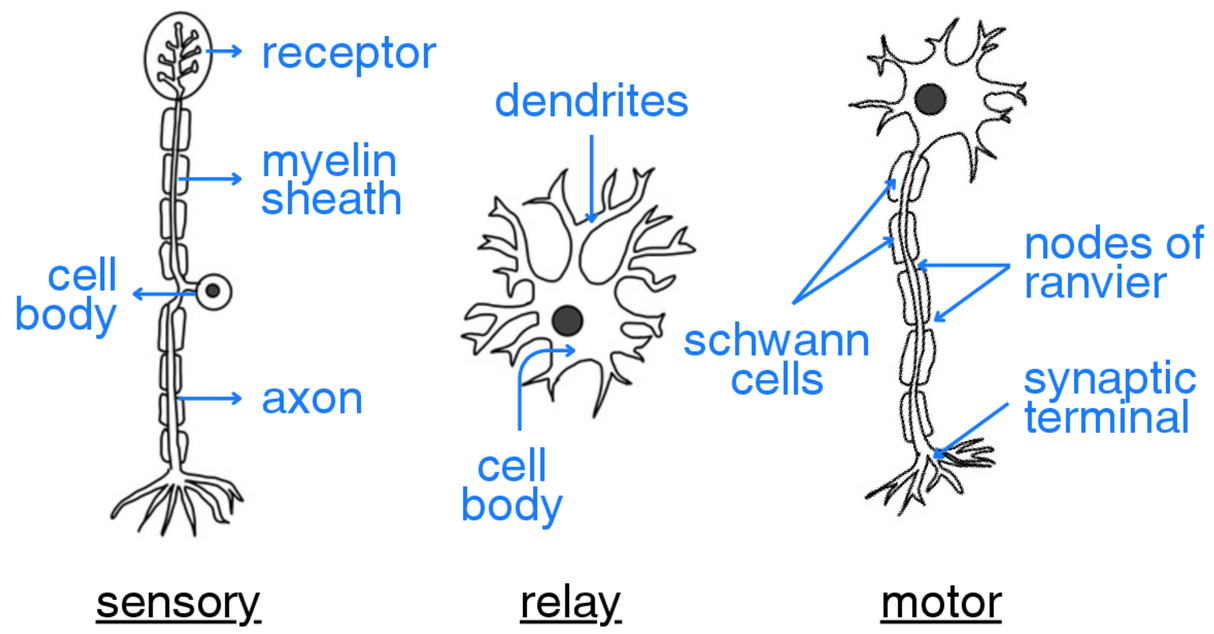
- does not involve the brain
- automatic & rapid responses
- minimise damage to body
- cant be controlled (not aware)

stimuli → receptor → sensory neurone → relay neurone → motor neurone → muscles

(a) Stimulus (pain/pressure/temperature) is detected by receptors in the skin
(b) Sensory neurone sends electrical impulses to the spinal cord (coordinator)
(c) Electrical impulse is passed on to relay neurone in the spinal cord → motor neurone → muscles (effector)
(d) Muscles contract and move (response)

TYPES OF NEURONES

NEURONES DIAGRAM



sensory relay motor

STRUCTURES & FUNCTIONS

(a) Dendrites:
- receive chemical signal from another neurone
- conducts electric impulse towards cell body

(b) Axon:
- long fibre to allow electrical impulse to transmit

(c) Myelin Sheath:
- an insulating layer made up of fatty substance
- allows electrical impulse to transmit quickly & efficiently

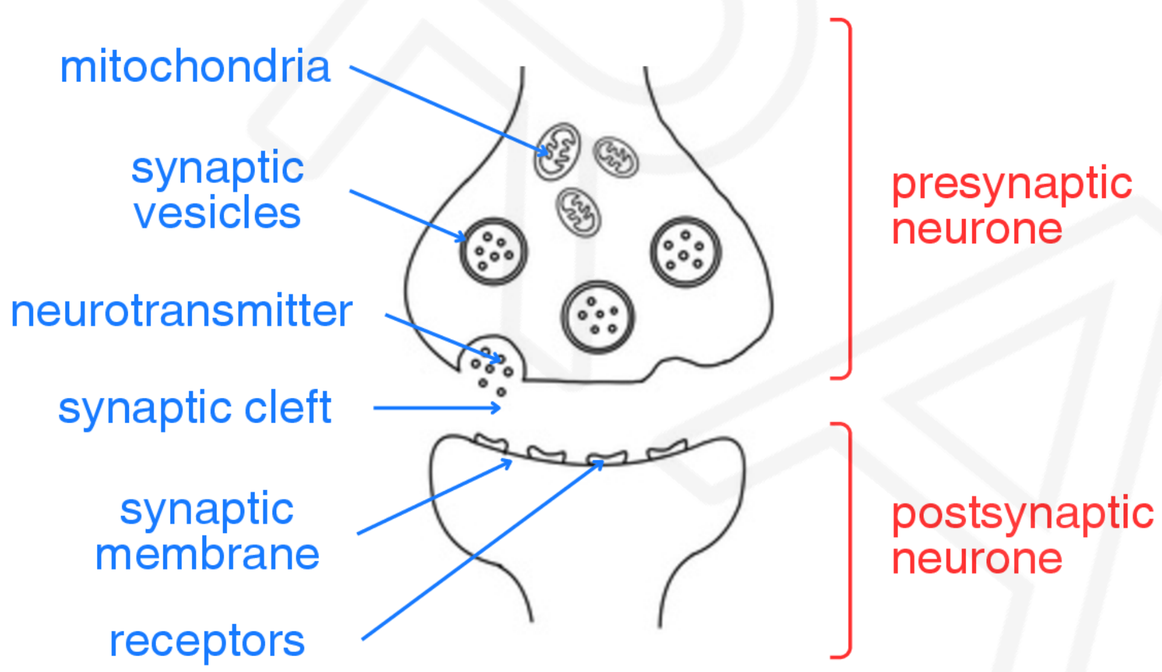
(d) Nodes of Ranvier:
- facilitates rapid conduction of electrical impulse

(e) Synaptic Terminal:
- releases neurotransmitters to relay signals across synapse

SYNAPSE

junction (gap) between two neurones

- neurotransmitters = chemical messengers *(ensure impulse only travels in one direction)*

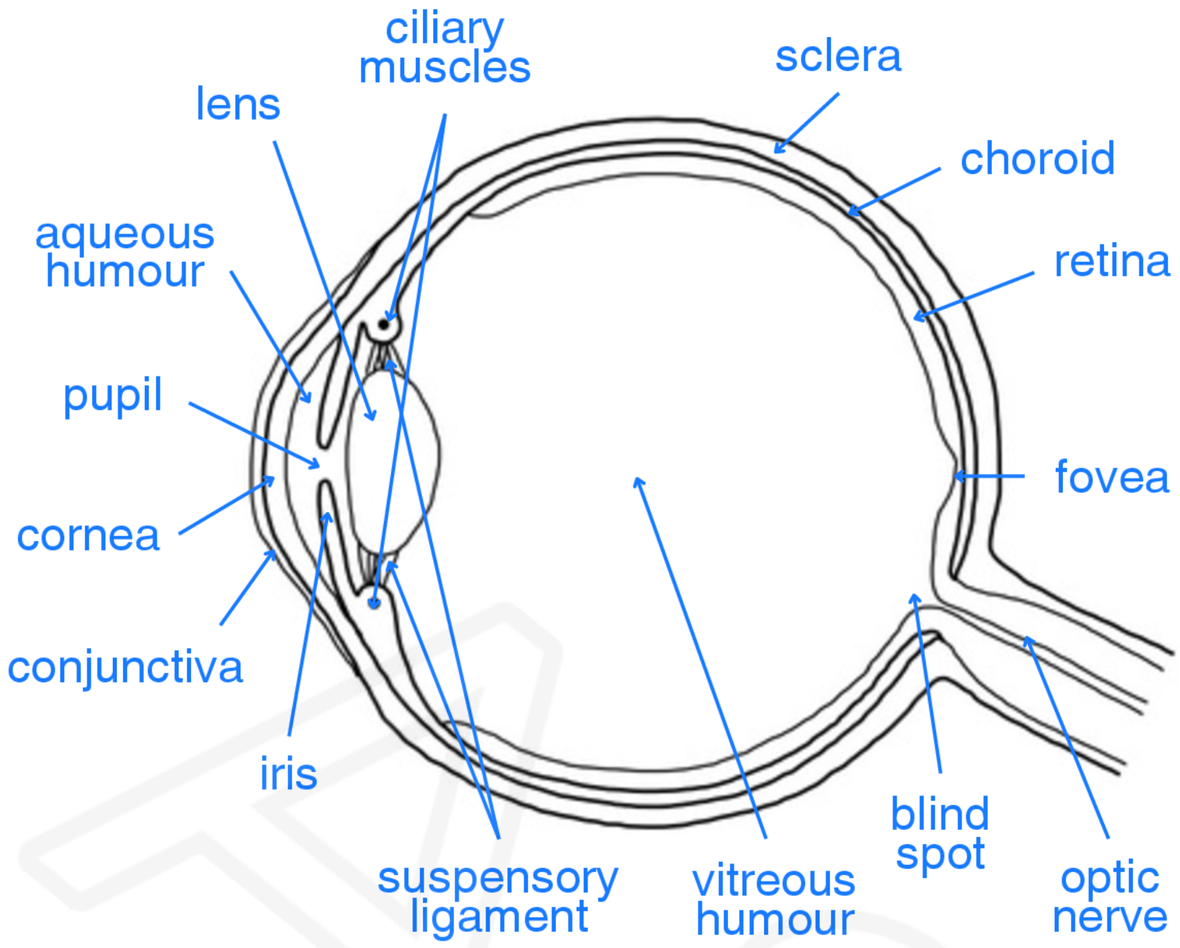


(a) electrical impulses arrive at the end of presynaptic neurone
(b) synaptic vesicles move to synaptic membrane and fuse with it
(c) releases neurotransmitters into the synaptic cleft and diffuse across it (down concentration gradient)
(d) neurotransmitters attach to receptors on the postsynaptic membrane
(e) triggers electrical impulse which travels along postsynaptic neurone
(f) neurotransmitters are recycled or destroyed once the impulse is sent (to prevent continued stimulation)

sense organs are receptors: • *skin (touch, temperature)* • *ear (hearing/balance)* • *tongue (taste)* • *nose (smell)* • *eye (sight)*

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EYE STRUCTURES

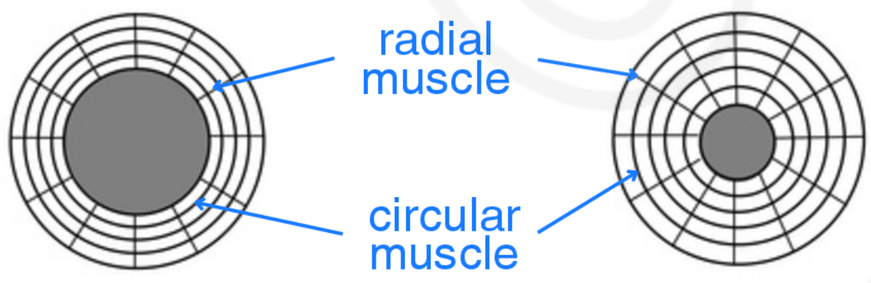


- cornea: refracts / bends light onto lens
  (transparent, covering front of eye)
- iris: control the size of pupil & entry of light
  (radial+circular muscles | eye colour)
- lens: focuses light onto the retina
  (transparent disc that changes shape)
- retina: contains light receptor cells that detect light intensity and colour
  (converts light energy to electrical impulse)
- optic nerve: transmit electrical impulse from eye (retina) to brain
- ciliary muscles: contract and relax to change the shape of lens
- suspensory ligament: connect lens with ciliary muscles
- fovea: sharp vision by maximising light
- sclera: maintains the shape of the eyeball

BRIGHTNESS (LIGHT INTENSITY)

iris muscles: circular & radial muscles

- antagonistic muscles | involuntary action
  (when 1 contracts, the other relaxes)



dim light

(a) photoreceptors detect change in environment
(b) circular muscles relax
(c) radial muscles contract
(d) pupil dilates *(diameter widens)*
(e) more light enters the eye

bright light

(a) photoreceptors detect change in environment
(b) circular muscles contract
(c) radial muscles relax
(d) pupil constricts *(diameter narrows)*
(e) less light enters the eye

PHOTORECEPTORS

2 types of receptor cells in the retina: rods & cones



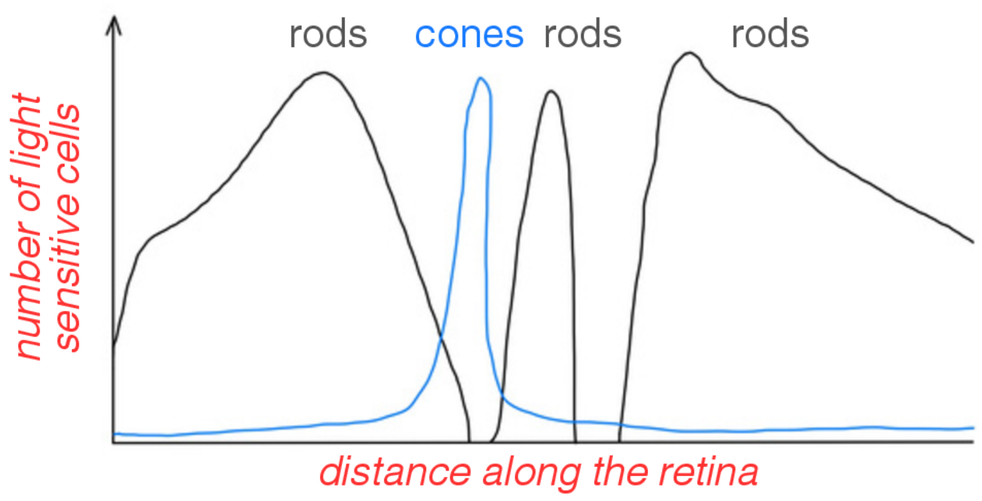
rods

- detect light of low intensity
- no colour
- black & white
- night vision



cones

- detect light of high intensity
- 3 different cones, detect 3 different wavelengths
- colour vision



DISTANCE (ACCOMMODATION)

eye focuses on near or distant objects by changing the shape of lens

- ciliary muscles: contraction / relaxation
- suspensory ligaments: adjustment of tension

near object:

refracts more by lens onto the retina

(a) ciliary muscles contract
(b) suspensory ligaments loosen/slacken
(c) lens become more rounded
(d) light is refracted more

far object:

refracts less by lens onto the retina



(a) ciliary muscles relax
(b) suspensory ligaments tighten
(c) lens become thinner
(d) light is refracted less

	near object	distant object
• ciliary muscles	contract	relax
• suspensory ligaments	slacken	tighten
• lens	fatter	thinner
• light	refract more	refract less

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HORMONES

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

HORMONES & GLANDS

adrenaline	gland: adrenal gland
role: fight or flight situation (in danger) *effect:* • ↑ *heart / pulse / breathing rate* • ↑ *pupil diameter (dilation)* • ↑ *blood glucose concentration*	
insulin	**gland: pancreas**
role: ↓ blood glucose level *effect:* *convert excess glucose into glycogen by the muscles & liver*	
testosterone	**gland: testes**
role: main sex hormone in males *effect:* • *grow body hair (pubic, armpit)* • ↑ *muscles mass* • *puberty*	
oestrogen	**gland: ovaries**
role: main sex hormone in females *effect:* • *grow body hair (pubic, armpit)* • *menstrual cycle* • *grow breasts*	

NERVOUS VS ENDOCRINE SYSTEM

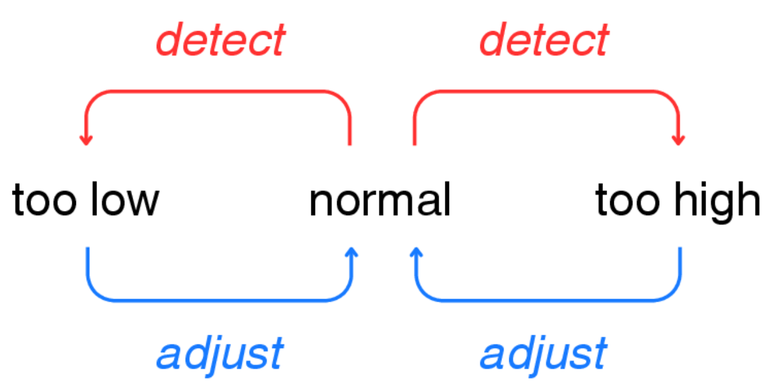
comparison	nervous	endocrine
similarity	• occurs in human body • involve in survival	
differences type of message	transmit electrical impulses	transmit chemical hormones
transport by	nerve cells	bloodstream
produced by	brain & spinal cord	gland
duration of effect	short term	long lasting
speed of action	rapid transmission	slow transmission
area of effect	target one destination *(localised)*	target multiple destination *(widespread)*

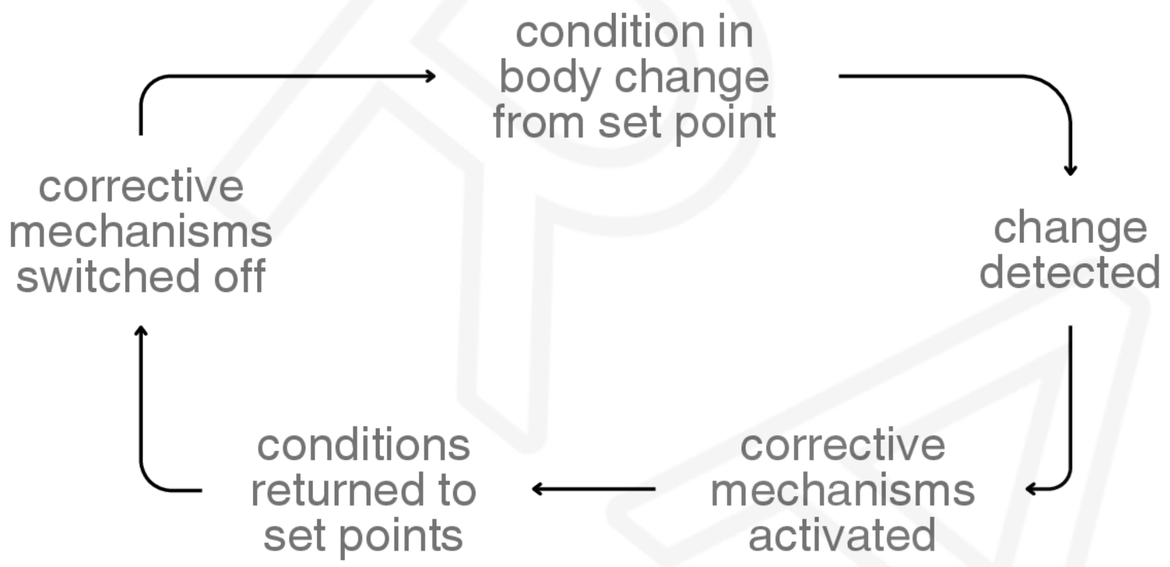
HOMEOSTASIS

• maintenance of a constant internal environment • control of internal conditions within set limits

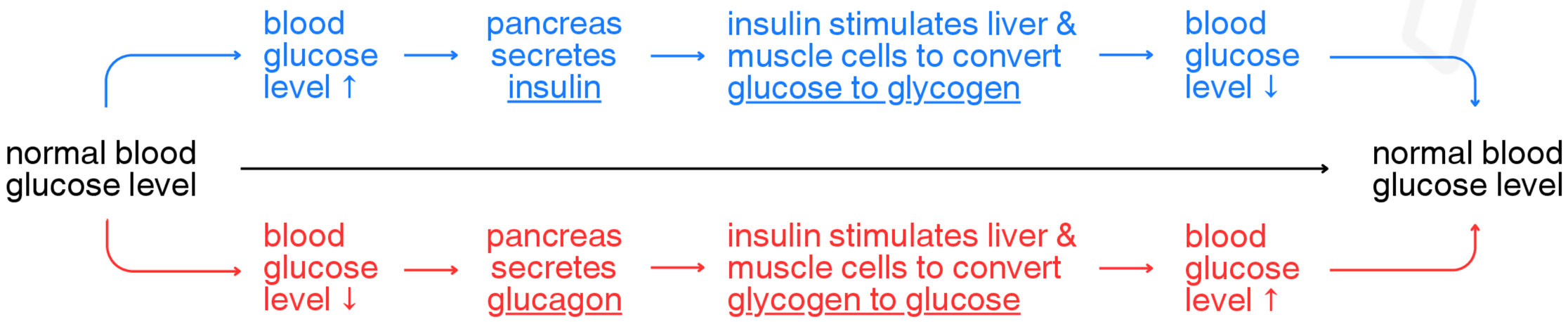
NEGATIVE FEEDBACK

when conditions change from the ideal or set point and return conditions to this set point





BLOOD GLUCOSE CONCENTRATION



TYPE 1 DIABETES

condition where the blood glucose levels are not able to be regulated as the insulin-secreting cells in the pancreas are not able to produce insulin

• treatment: injecting insulin

<u>symptoms</u>

• extreme thirst
• weakness / tiredness
• blurred vision
• weight loss

<u>diabetic patients</u>

• need to monitor:

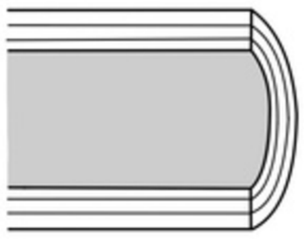
(a) physical activity
(b) diet (consumption of food)

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HOMEOSTASIS

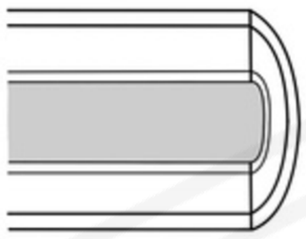
SKIN STRUCTURE

maintains the temperature at which enzymes work best, around 37°C



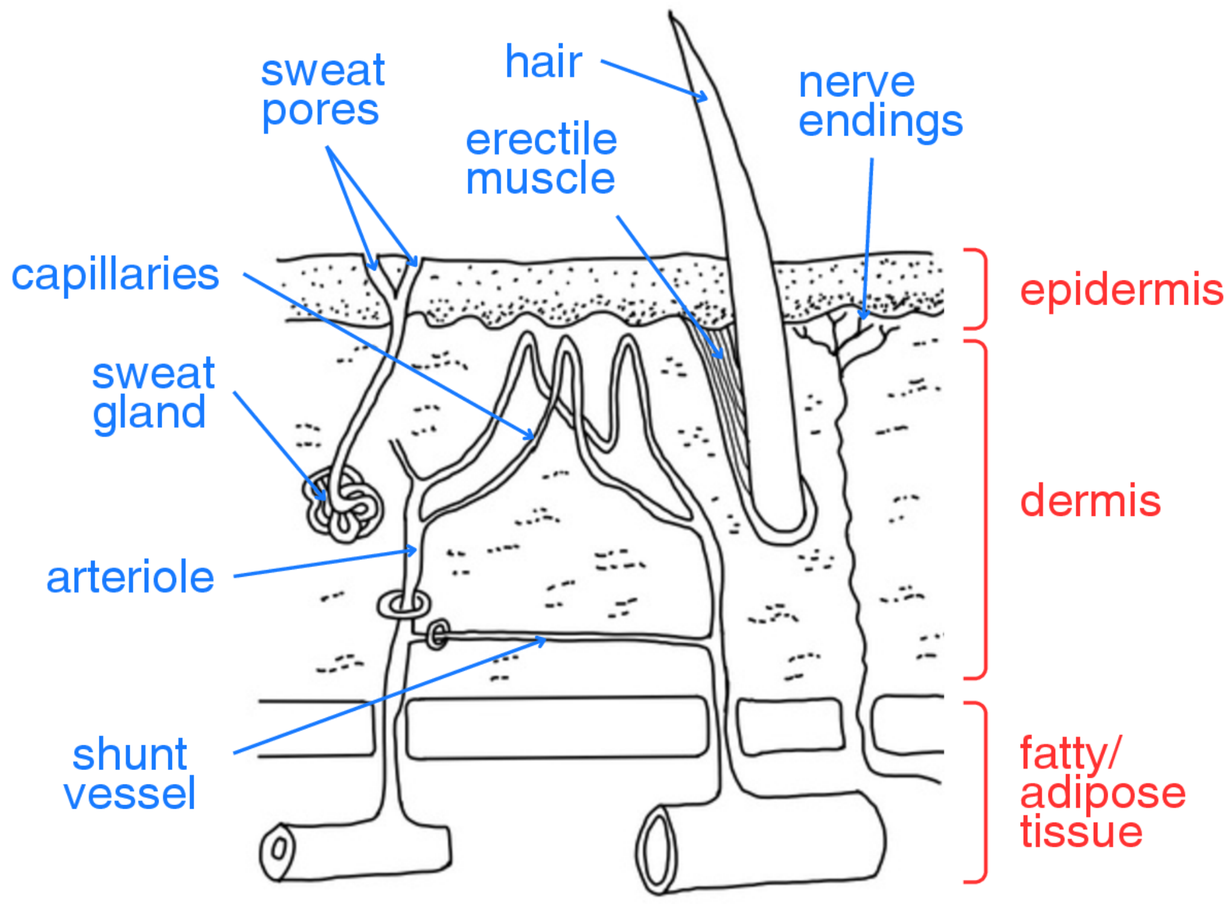
<u>vasodilation</u>

widening of blood vessel ↑ blood flow

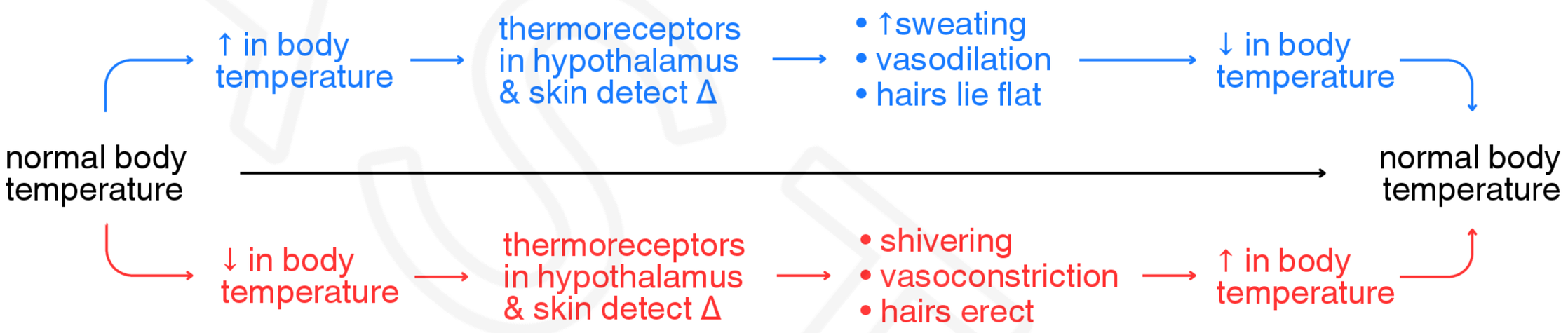


<u>vasoconstriction</u>

narrowing of blood vessel ↓ blood flow



TEMPERATURE



TROPIC RESPONSES

TROPISM

(a) positive response: towards a stimulus
(b) negative response: away from a stimulus

<u>phototropism</u>

growth towards or away from sunlight

- shoot: positive
- root: negative

<u>gravitropism</u>

growth towards or away from sunlight

- shoot: negative
- root: positive

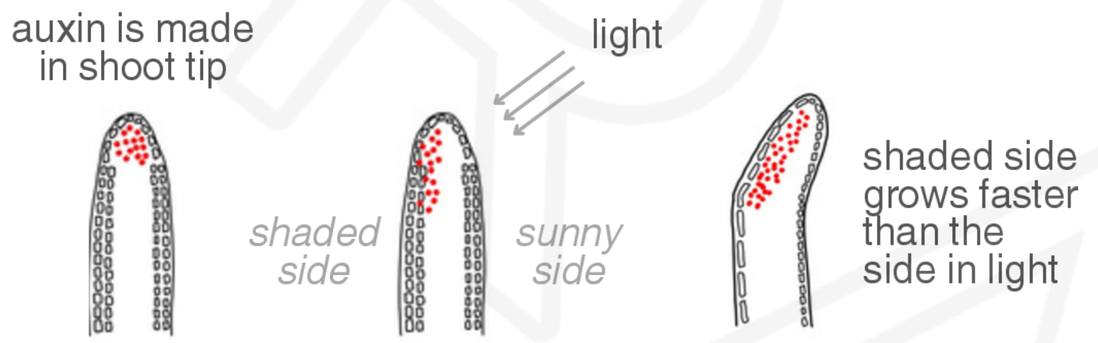
AUXIN (PLANT HORMONE)

growth hormone which controls direction of growth for root & shoot

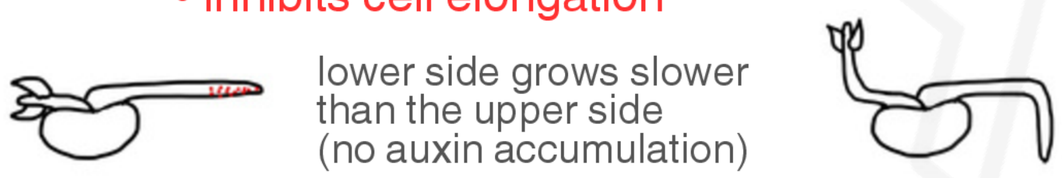
(a) made in tips of shoot
(b) diffuse to other parts of plant
(c) distributes in response to light & gravity

HOW AUXIN WORKS

In shoot:
- accumulates on the shaded side *(afraid of light, diffuse away)*
- promotes cell elongation



In root:
- accumulates on the lower side *(diffuse towards gravity)*
- inhibits cell elongation



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

ANTIBIOTICS (MEDICINAL DRUG)

chemical substances made by certain fungi or bacteria that affect the working of bacterial cells, either by disrupting their structure or function or by preventing them from reproducing

- treatment of bacterial infections
- no effect on viruses (capsid / protein coat)
- passive artificial immunity
- short term immunity

ANTIBIOTICS RESISTANCE

(a) only use when its essential
(b) complete full course of prescribed medication (to kill all bacteria)
(c) else, bacteria grow resistance to antibiotics
(d) limit the development of resistant bacteria such as MRSA

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UNIT 16: REPRODUCTION

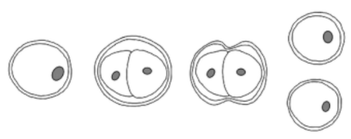
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ASEXUAL REPRODUCTION

process resulting in the production of genetically identical offspring from one parent

• no fusion of gametes • no mixing of genetics

EXAMPLES

binary fission	bulbing	tubers	runners
			
genetically identical daughter cells (replicate DNA)	lateral bud (new plant food storage organ)	underground stems buds	genetically identical plantlet (side shoot)
• bacteria	• onions	• potato	• strawberry

WILD SPECIES

• advantages: (a) rapid population growth
(b) exploit environment quickly
(c) time & energy efficient

• disadvantages: (a) limited genetic variation
(b) vulnerable to environmental Δ
(c) spread of disease

CROP PLANTS

• advantages: (a) produce desired characteristics
uniform, high yield, disease-resistant
(b) faster & cheaper production

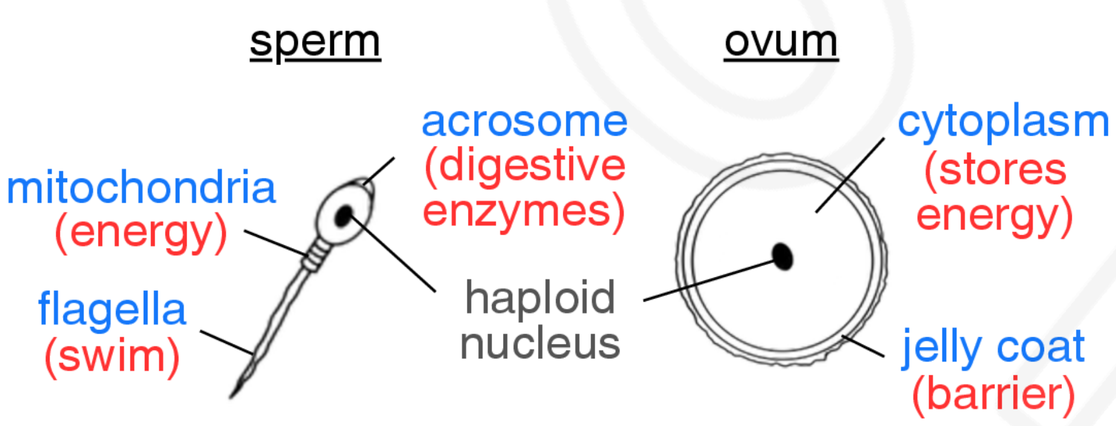
• disadvantages: (a) requires human management
(b) lack adaptation to Δ in climate
(c) vulnerable to disease or pests

SEXUAL REPRODUCTION

process involving the fusion of the nuclei of two gametes (sex cells) to form a zygote (fertilised egg cell) and the production of offspring that are genetically different from each other

• nuclei of gametes (haploid: 1 set of chromosomes) | • humans (sperm & ovum: 23 chromosomes each)
• nuclei of zygote (diploid: 2 sets of chromosomes) | • humans (somatic cells: 46 chromosomes)

FERTILISATION fusion of the nuclei of gametes



sperm	ovum
• very small (45µm)	• large in size (0.15mm)
• head (23 chromosomes)	• spherical, round cell
• elongated & has flagella	• move with the help of cilia
• locomotion	• has jelly coat
• 100 million sperms/day	• 1 is released every month

WILD SPECIES

• advantages: (a) increase in genetic variation
(b) better adaptation & survival
(c) reduce risk of extinction

• disadvantages: (a) takes time to find mates
(b) difficult for isolated species to reproduce
(c) requires 2 parents

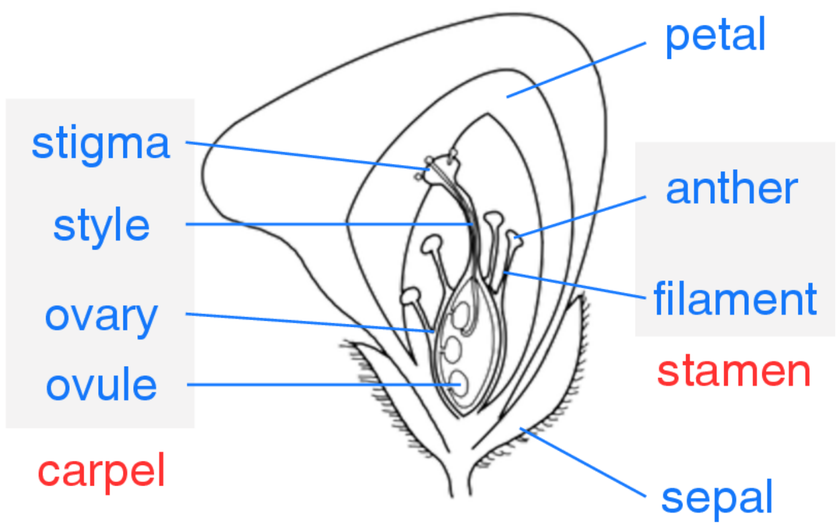
CROP PLANTS

• advantages: (a) increase in genetic variation
cope with weather Δ, higher yield

• disadvantages: (a) good & desired characteristics from parents might be lost
passes down less successful traits

SEXUAL REPRODUCTION IN PLANT

FLOWER ANATOMY



(a) anther: produces pollen grain (male gamete)
(b) filament: long stalk supporting anther
(c) stigma: sticky surface where pollens land
(d) style: stalk that connects stigma & ovary
(e) ovary: contains ovule (fruit)
(f) ovule: contains female gamete (seed)
(g) sepal: protects flower bud
(h) petals: attracts insects for pollination

POLLINATION

transfer of pollen grains from the anther to the stigma

self-pollination

transfer pollens to own stigma or stigma of another flower

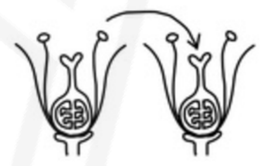
(same plant)



cross-pollination

transfer pollens to stigma of a different plant

(same species)



(reliance to pollinators)

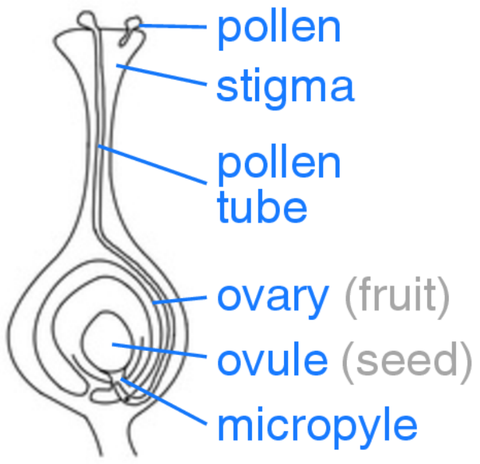
wind-pollination		insect-pollination
large, brightly-coloured	petal	small, dull-coloured
stiff filament within flower	stamen	long filament outside flower
big, spiky, few in numbers	pollen	tiny, numerous in number, light
sticky stigma, short style	style	long & feathery stigma
sweet, scented	nectar	no nectar

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GERMINATION

FERTILISATION

pollen nucleus fuses with an ovum nucleus



(a) pollen tube grows from the pollen grain down the style until it reaches the ovary

(b) nuclei from pollen travel down the tube

(c) nuclei enter ovule through micropyle

(d) fertilisation occurs

GERMINATION start of growth in the seed

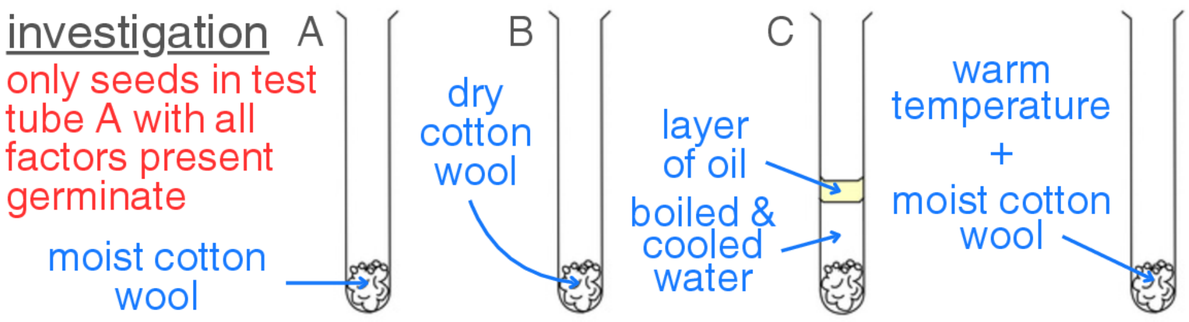
factors required for germination

(a) water: allows seed to swell up, get enzymes to work

(b) oxygen: release energy for germination

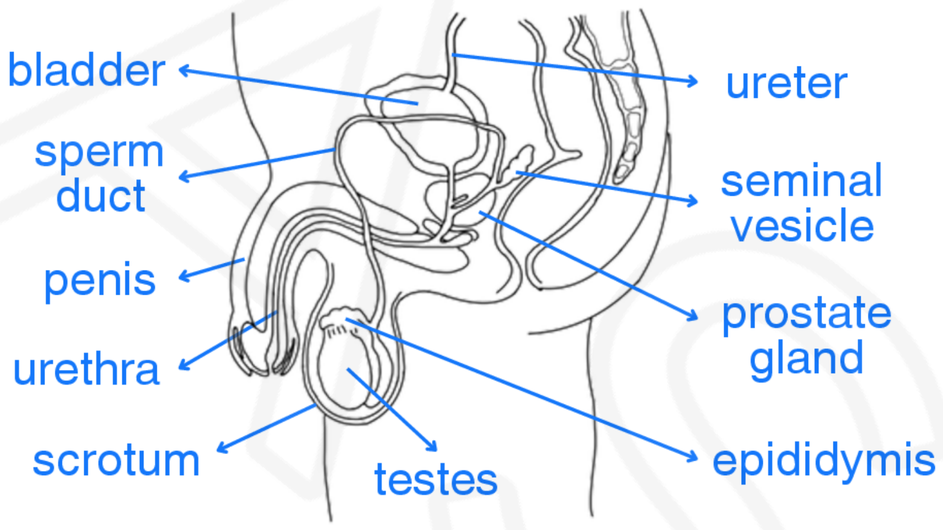
(c) warmth: optimum temperature for enzymatic reactions

investigation



SEXUAL REPRODUCTION IN HUMANS

MALE REPRODUCTIVE ORGAN



(a) penis: • passes urine out of body from the bladder
• allows semen to pass into vagina (during sexual intercourse)

(b) urethra: • carries urine & semen out of the body
• ring of muscle in urethra prevents urine & semen from mixing

(c) testes: • produce male gamete (sperm) & hormones (testosterone)

(d) scrotum: sac that holds testes outside the body

(e) prostate gland: produces seminal fluid (semen) that provides nutrients to sperm cell

(f) epididymis: stores sperm

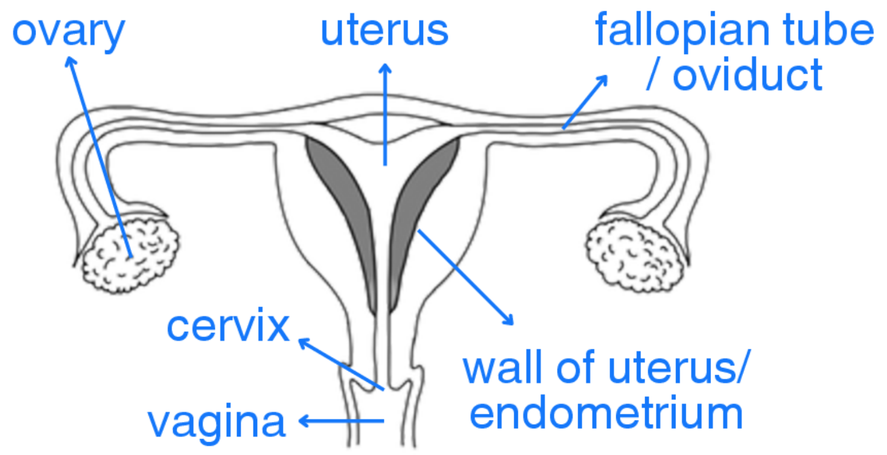
(g) sperm duct: transfer sperm from epididymis → urethra

(h) seminal vesicles: produces semen

(i) ureter: transport urine from kidney → bladder

(j) bladder: stores urine

FEMALE REPRODUCTIVE ORGAN



(a) ovary: contains follicle that develop into the female gamete (ova) and produces hormones (progesterone & oestrogen)

(b) fallopian tube: • transfer ovum to uterus
• site of fertilisation

(c) uterus: where the fetus develops

(d) cervix: ring of muscle (strong & rigid) at the opening of uterus to keep developing in place during pregnancy

(e) vagina: receives penis during sexual intercourse

ADAPTIVE FEATURES OF GAMETES

sperm

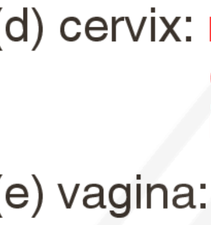


(a) has flagella
• allows sperm to swim towards egg

(b) contains many mitochondria
• provides energy for movement of the flagellum

(c) enzymes in acrosome
• digest jelly coat of egg, make route

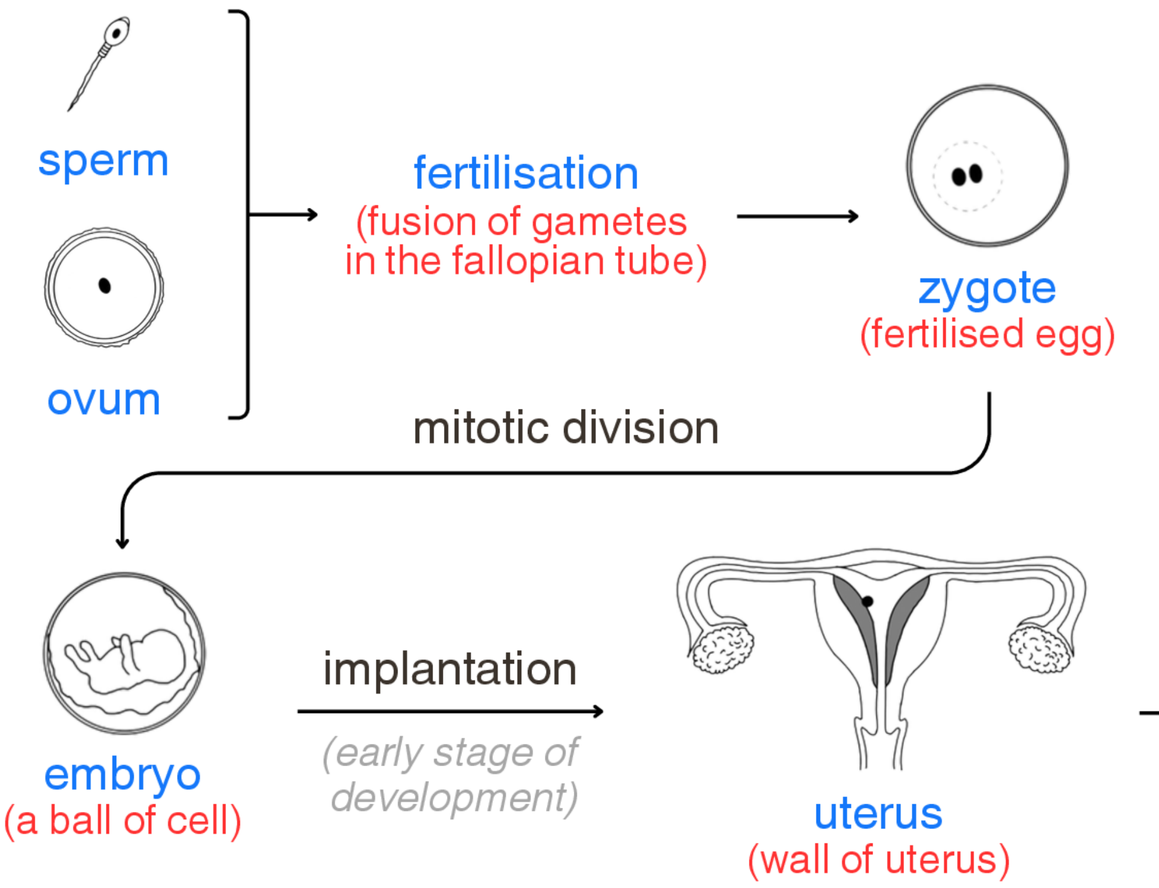
ovum



(a) cytoplasm as store of energy
• provide energy for cell division in developing zygote

(b) jelly-like coating
• make impenetrable barrier to prevent more sperms entering the egg cell (changes at fertilisation)

DEVELOPMENT OF FETUS



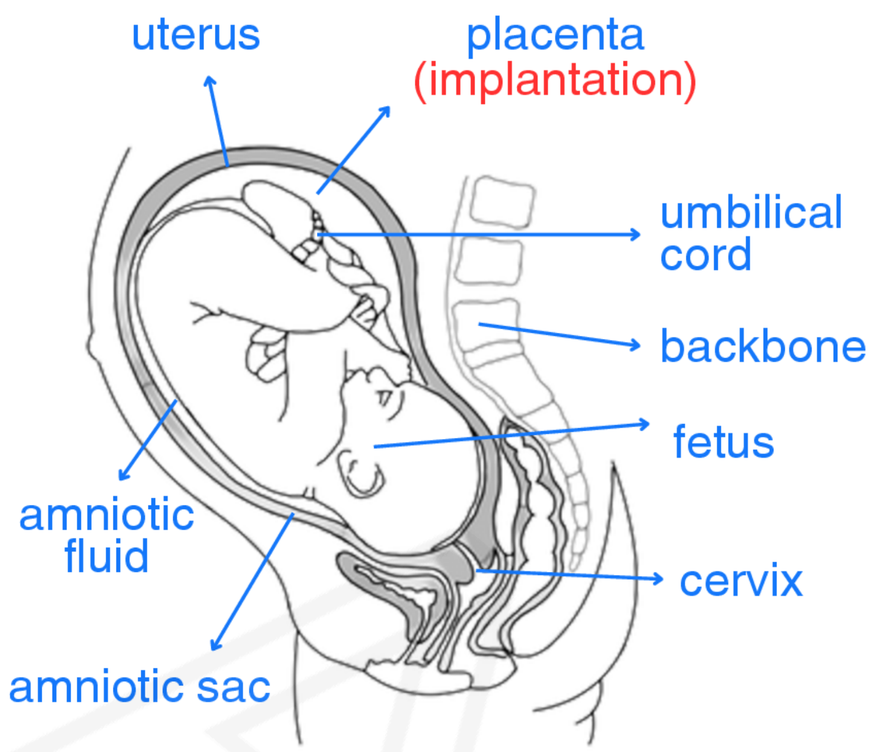
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PREGNANCY

GESTATION PERIOD

9 months for humans

- first 12 weeks: major development of organs
- remaining weeks: grow bigger in size



STAGES OF DEVELOPMENT

- early stages: increase in complexities
- late stages: increase in size
- all stages: growth and development

AMNIOTIC SAC & AMNIOTIC FLUID

(a) amniotic sac:
- membrane encloses amniotic fluid
- broken at birth

(b) amniotic fluid:
- protects fetus against mechanical shock, drying out & temperature Δ

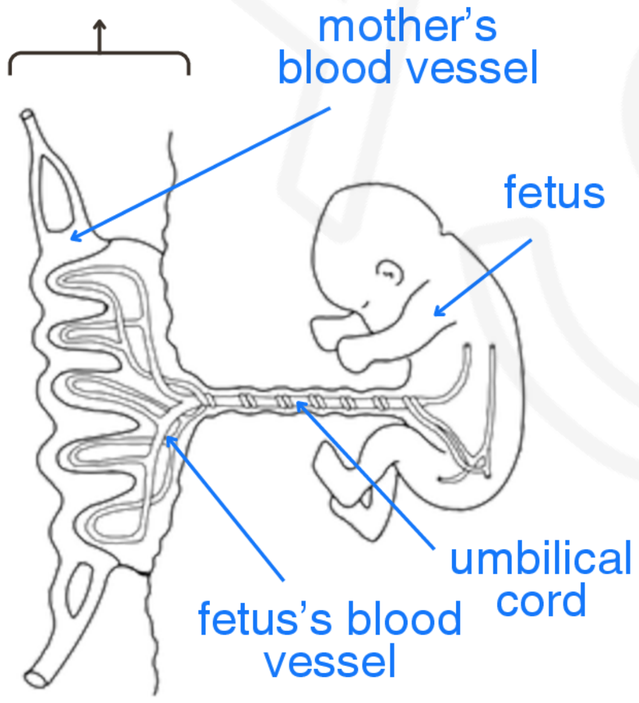
<u>functions</u>

- maintains temperature
- mechanical protection
- provides support
- sterile environment
- allows movement
- lubrication

<u>birth</u>

(a) muscles in the uterus lining contract
(b) amniotic sac breaks
(c) cervix dilates
(d) baby passes out through the vagina
(e) umbilical cord is tied & cut

PLACENTA



<u>placenta:</u>
- contains mother's blood | detaches afterbirth
- umbilical cord connects fetus and placenta
- exchange of dissolved nutrients, gases & excretory products between mother's blood & fetus's blood

<u>umbilical cord:</u>
- contains fetus's blood
- contains umbilical artery & veins to carry oxygenated (to fetus) & deoxygenated blood (away)

<u>fetus requires nutrients:</u>

(a) glucose (d) water
(b) amino acids (e) oxygen
(c) fatty acids & glycerol

<u>fetus removes waste products:</u>

(a) carbon dioxide (b) urea

<u>features of placenta:</u>
- thin wall
- large surface area

(diffusion due to difference in concentration gradients)
- acts as a barrier to prevent toxins and pathogens from entry

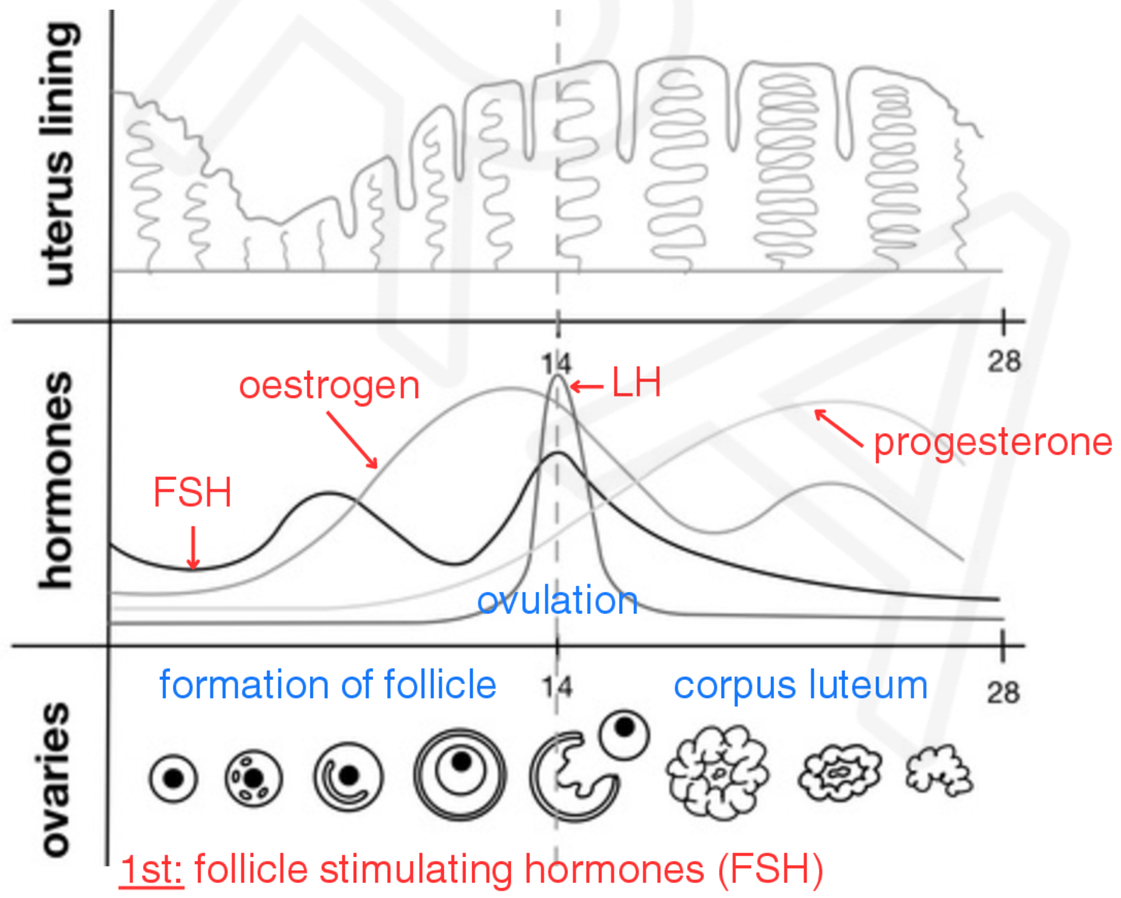
(viruses & nicotine can pass through)

SEXUAL HORMONES IN HUMANS

SECONDARY SEXUAL CHARACTERISTICS

development & regulation of secondary sexual characteristics during puberty

<u>male:</u> testosterone	<u>female:</u> oestrogen
• growth of sexual organs & growth of body hair • emotional changes due to ↑ in hormones	
• growth of penis & testes • growth of facial hair and body hair *(pubic, armpit, chest)* • develops muscles • voice breaks • produce sperm	• growth of breasts • growth of body hair *(pubic, armpit, chest)* • wider hips • menstrual cycle begins



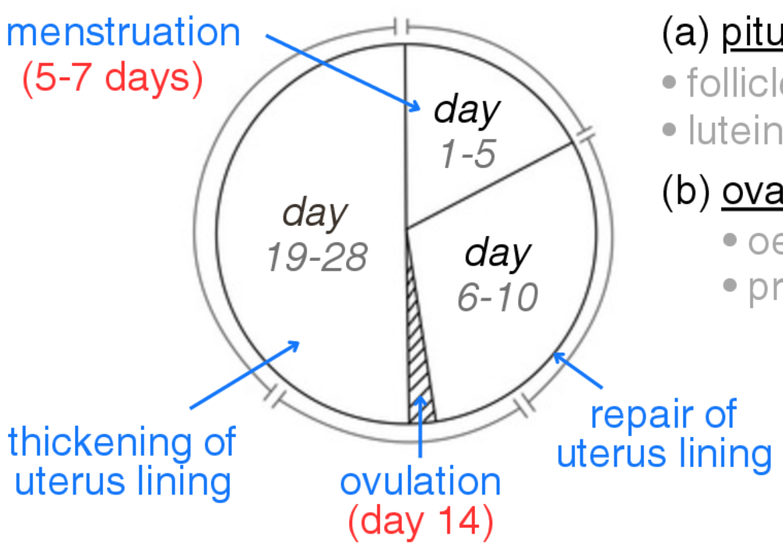
<u>1st:</u> follicle stimulating hormones (FSH)
(a) stimulate egg maturation in the follicles
(b) stimulate the secretion of oestrogen

<u>2nd:</u> oestrogen (oestrogen peaks → secretes LH)
(a) stimulates growth & repair of uterus lining
(b) inhibits FSH & stimulates the release of LH

<u>3rd:</u> luteinising hormones (LH)
(a) ovulation (release of egg into oviduct)
(b) results in formation of corpus luteum

<u>4th:</u> progesterone (level drops if ovum is not fertilised)
(a) maintains thickness of uterus lining
(b) inhibits FSH & LH production

MENSTRUAL CYCLE (28-day period)



(a) <u>pituitary gland secretes:</u>
- follicle stimulating hormone
- luteinising hormone

(b) <u>ovary secretes:</u>
- oestrogen
- progesterone

<u>pregnancy</u> ⟵ placenta secretes progesterone

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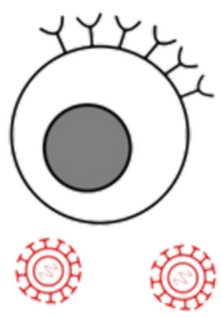
SEXUALLY TRANSMITTED INFECTION

an infection that is transmitted through sexual contact

- first stage: human immunodeficiency virus (HIV)
- final stage: acquired immune deficiency syndrome (AIDS)

how HIV affects immune system

- HIV changes its protein coat to avoid being recognised by lymphocytes
- HIV infects certain types of lymphocytes
- uses lymphocytes as a machinery to multiply
- reduces antibodies production
- leads to AIDS, liable to other infections



METHODS OF TRANSMISSION

(a) sharing needles with infected person
(b) blood transfusion (c) breastfeeding
(d) from mother to fetus through placenta
(e) organ transplant
(f) sexual intercourse / seminal fluid

controlling spread of STIs

(a) limit sexual partners
(b) not having unprotected sex (use condom)
(c) getting tested regularly

UNIT 17: INHERITANCE

ASTRA

CHROMOSOMES, GENES AND PROTEINS

Inheritance: transmission of genetic information from generation to generation

STRUCTURE OF GENES

chromosome → gene → DNA ladder → nucleotide

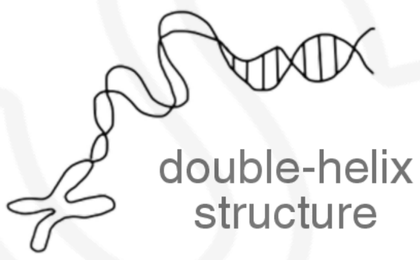
chromosome: thread-like structure of DNA



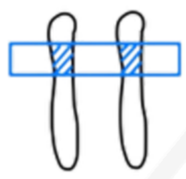
made of DNA & contains genetic information in the form of genes

↑ nucleus

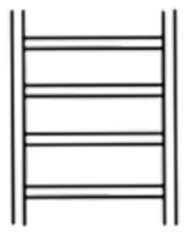
gene: length of DNA that codes for a protein



allele: an alternative form of a gene



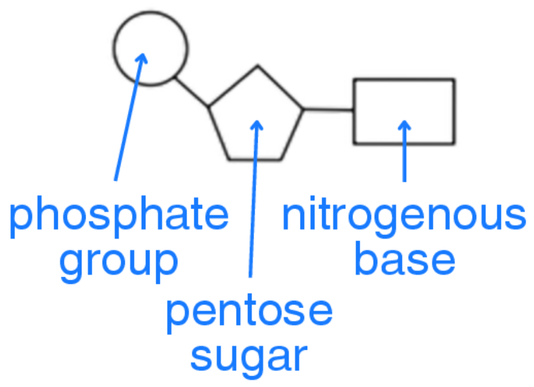
DNA ladder

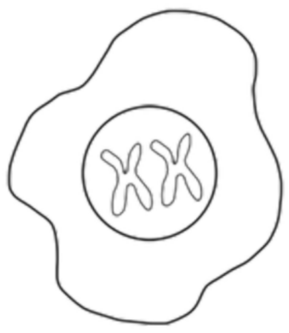


base pairing

- adenine (A)
- thymine (T)
- guanine (G)
- cytosine (C)

nucleotide: simplest functional unit of DNA





haploid nucleus: nucleus containing a single set of chromosomes (sex cells: gametes) 23 chromosomes

diploid nucleus: nucleus containing two set of chromosomes (somatic cells) 46 chromosomes

INHERITANCE OF SEX

sex is determined by an entire chromosome pair

- female: sex chromosomes XX
- male: sex chromosomes XY

male: 50% female: 50%

female \ male	X	Y
X	XX	XY
X	XX	XY

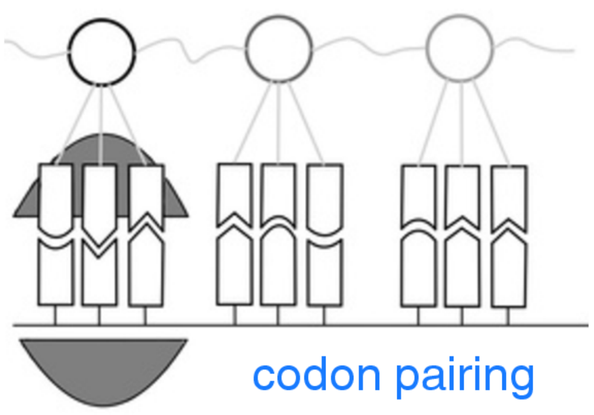
punnett square

DNA BASE SEQUENCE

sequence of bases in a gene determines the sequence of amino acids used to make a specific protein

different sequences of amino acids give different shapes & functions to protein molecules

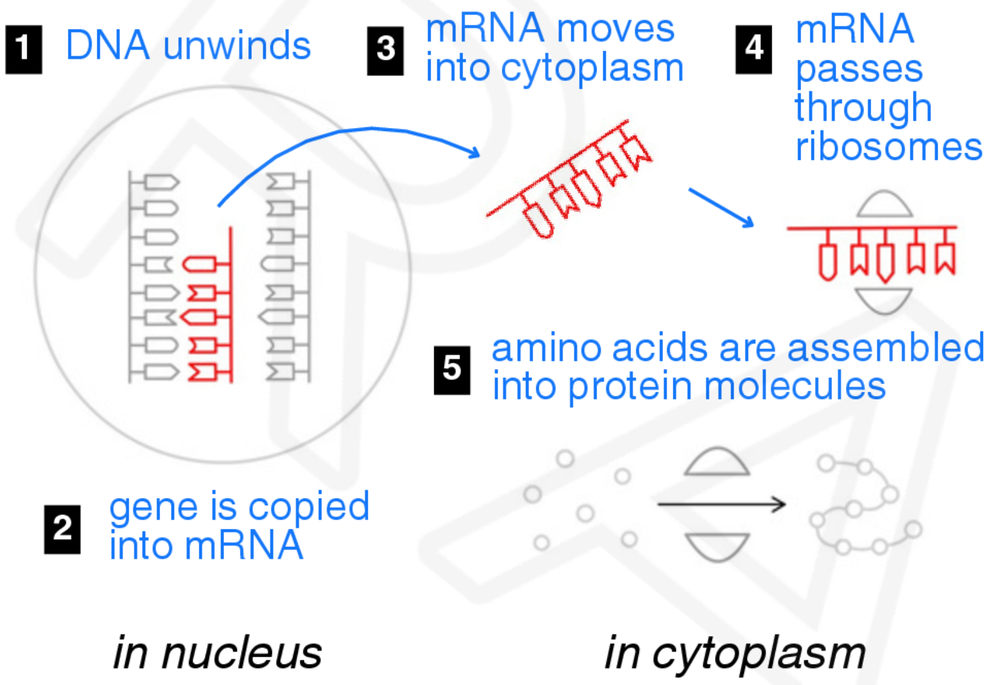
DNA controls cell function by controlling production of proteins (enzymes, membrane carriers, receptors)



transcription: rewriting base code of DNA into bases of RNA

translation: using RNA base sequence to build amino acids into sequence of protein

PROTEIN SYNTHESIS



(a) the gene coding for the protein remains in the nucleus
(b) messenger RNA (mRNA) is a copy of a gene
(c) mRNA molecules are made in the nucleus & move to the cytoplasm
(d) the mRNA passes through ribosomes
(e) the ribosome assembles amino acids into protein molecules
(f) the specific sequence of amino acids is determined by the sequence of bases in the mRNA

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

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MITOSIS

nuclear division giving rise to genetically identical cells

roles of mitosis

- growth of new cells
- replacement of dead cells
- repair of damaged tissues
- asexual reproduction

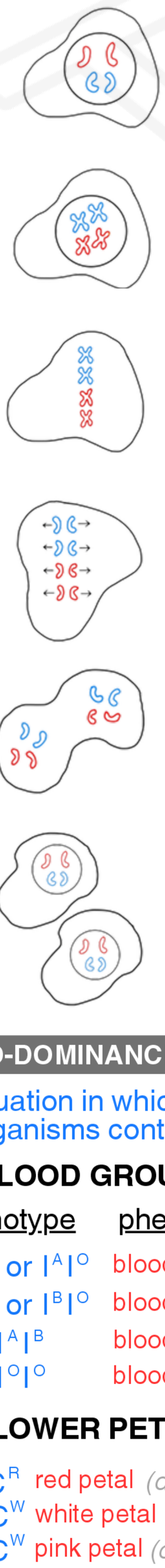
STEM CELLS

unspecialised cells that divide by mitosis to produce daughter cells that can become specialised for specific functions

zygote: embryonic stem cells

MITOTIC DIVISION

- the exact replication of chromosomes occurs before mitosis
- during mitosis, the copies of chromosomes, separate whilst maintaining the chromosome number in each daughter cell



1. each chromosome makes identical copies of itself
   DNA replicates itself
2. chromosomes line up along centre of the cell
   nuclear membrane disintegrates
3. cell fibres shorten & pull chromosomes apart
4. once chromatids are fully separated
   cell divides into 2
5. 2 genetically identical daughter cells are produced
   each cell has 1 copy of chromosomes

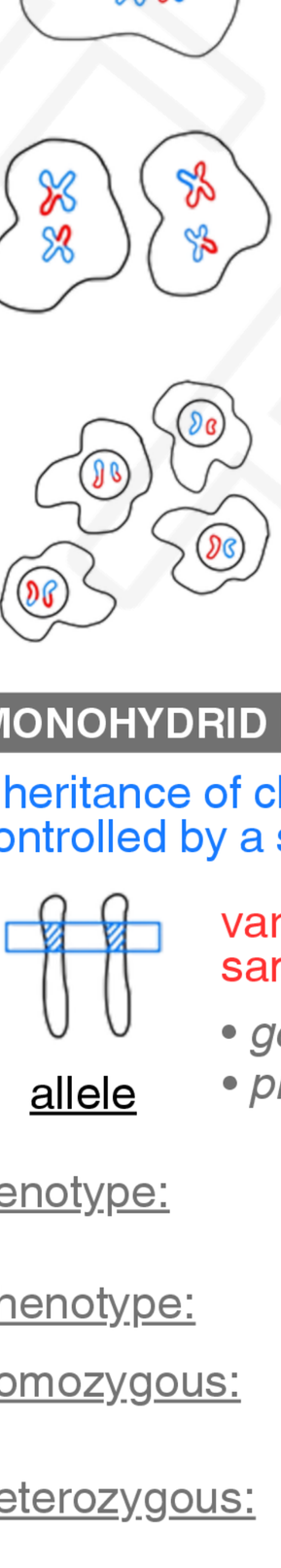
MEIOSIS

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

roles of meiosis

- involved in the production of gametes (sex cells)
- produces 4 haploid daughter cells

produces variation by forming new combinations of maternal and paternal chromosomes every time a gamete is made



1. each chromosome makes identical copies of itself
   DNA replicates itself
2. chromosomes pair up along the centre of cell
   nuclear membrane disintegrates
3. recombination occurs
   crossing over
4. cell fibres pull the pairs apart
   meiosis: reduction in chromosomal number
5. chromosomes will line up along the centre of the cell, cell fibres will pull them apart
   mitotic division
6. 4 haploid daughter cells

CO-DOMINANCE

situation in which both alleles in heterozygous organisms contribute to the phenotype

BLOOD GROUP

both I^A and I^B are dominant to I^O

genotype	phenotype
I^AI^A or I^AI^O	blood group A
I^BI^B or I^BI^O	blood group B
I^AI^B	blood group AB
I^OI^O	blood group O

heterozygous blood group B \ heterozygous blood group A	I^A	I^O
I^B	I^AI^B	I^BI^O
I^O	I^AI^O	I^OI^O

blood group A	25%
blood group B	25%
blood group AB	25%
blood group O	25%

FLOWER PETAL

C^RC^R red petal *(dominant)*
C^WC^W white petal *(dominant)*
C^RC^W pink petal *(co-dominance)*

MONOHYDRID INHERITANCE

inheritance of characteristics controlled by a single gene

allele — variation of the same gene

- *genotype*
- *phenotype*

genotype	phenotype
Bb	black hair
bB	black hair
Bb	black hair
bb	blonde hair

genotype: genetic make-up of an organism and in terms of the alleles present

phenotype: observable features of an organism

homozygous: having two identical alleles of a particular gene (pure breeding)

heterozygous: having two different alleles of a particular gene (not pure breeding)

dominant allele: allele that is expressed if it is present in the genotype

recessive allele: allele that is only expressed when there is no dominant allele of the gene present in the genotype

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PUNNETT SQUARE

- shows the possible combinations of alleles that could be produced in the offspring

MONOHYBRID CROSSES (ratio of these combinations can be worked out)

pure breed	homozygous dominant: B	B
homozygous dominant: B	BB	BB
B	BB	BB

offspring genotype: BB only

offspring phenotype: all black hair (100%)

pure breed	homozygous recessive: b	b
homozygous recessive: b	bb	bb
b	bb	bb

offspring genotype: bb only

offspring phenotype: all blonde hair (100%)

to identify unknown genotype

- *use test cross*
- *involves crossing an unknown individual showing dominant phenotype*
- *look at the ratio of phenotypes in offspring*

	homozygous dominant: B	B
heterozygous: B	BB	BB
b	Bb	Bb

offspring genotype: BB and Bb

offspring phenotype: all black hair (100%)

	heterozygous: B	b
B	BB	Bb
b	Bb	bb

offspring genotype: BB , Bb , bb

offspring phenotype: 75% black hair, 25% blonde hair

	homozygous recessive: b	b
heterozygous: B	Bb	Bb
b	bb	bb

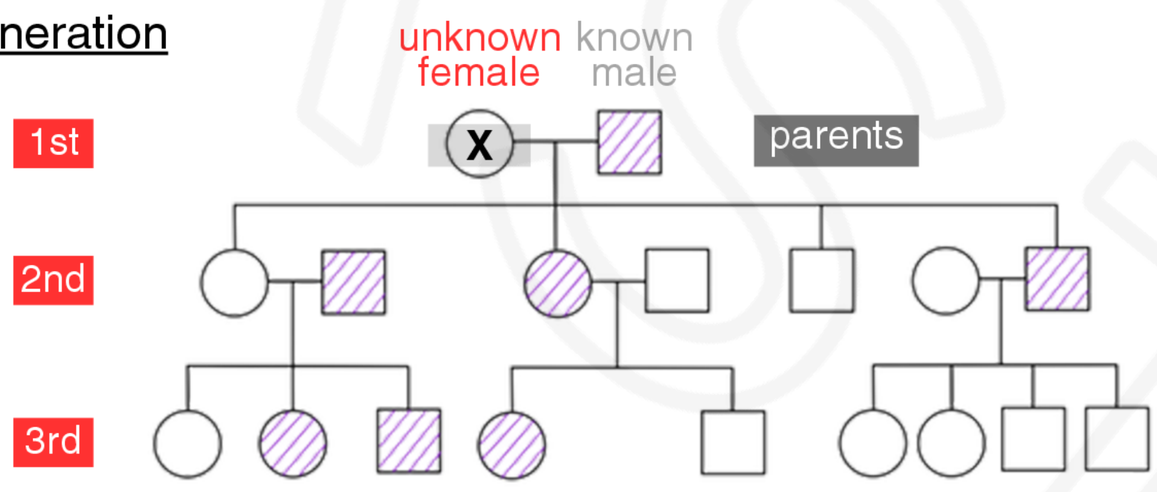
offspring genotype: Bb and bb

offspring phenotype: 50% black hair, 50% blonde hair

PEDIGREE DIAGRAM

- patterns of inheritance through generations of family
- probability of genetic disorder

generation



HEMOPHILIA

- inability to make blood clot
- excessive bleeding

sex-linked conditions

X^H normal

X^h hemophilia

normal female X^HX^H

carrier female X^HX^h

hemophiliac female X^hX^h

normal male X^HY

hemophiliac male X^hY

trial and error

trial 1

unknown female		hemophiliac male: X^h	Y
	X^H	X^HX^h	X^HY
	X^H	X^HX^h	X^HY

trial 2

unknown female		hemophiliac male: X^h	Y
	X^H	X^HX^h	X^HY
	X^h	X^hX^h	X^hY

reject: X^HX^H

homozygous dominant female

(no hemophiliac male offsprings)

carrier female 50%
normal male 50%

accept: X^HX^h

heterozygous female

has possible combinations of normal male & hemophiliac male

SEX-LINKED CHARACTERISTICS

- a feature in which the gene responsible is located on a sex chromosome, this makes the characteristic more common in one sex than in the other (shorter Y-chromosome)
- alleles controlling particular characteristics are found on X-chromosome only

males are more likely to show sex-linked recessive conditions

red-green colour blindness & hemophilia

RED-GREEN COLOUR BLINDNESS

genotype	phenotype
X^RX^R	normal female
X^RX^r	carrier female
X^RY	normal male
X^rY	colourblind male

normal male		carrier female: X^R	X^r
	X^R	X^RX^R	X^RX^r
	Y	X^RY	X^rY

phenotypic ratio:	normal female 25%	normal male 25%
	carrier female 25%	colourblind male 25%

UNIT 18: VARIATIONS

ASTRA

differences between individuals of the same species

PHENOTYPIC VARIATION

- genetic
- environmental

genetic variation

- mutation (DNA)
- meiosis (allele)
- random mating
- random fertilisation

environmental variation

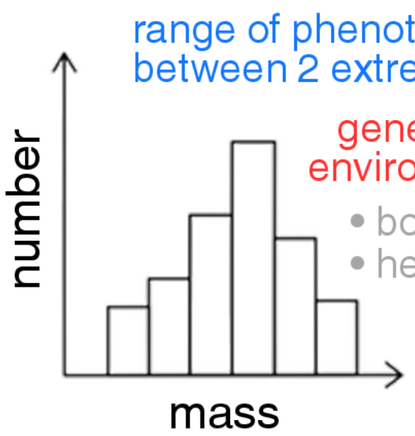
- climate
- diet
- accident
- culture
- lifestyle

(a) continuous variation

range of phenotypes between 2 extremes

genetic + environment

- body mass
- height

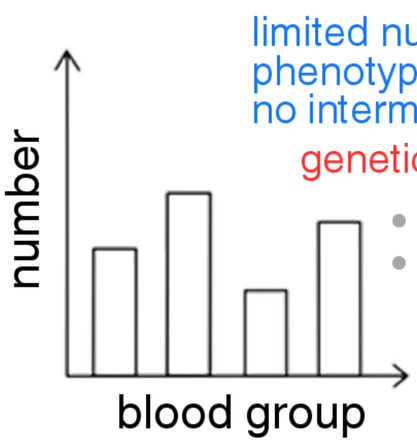


(b) discontinuous variation

limited number of phenotypes with no intermediates

genetic only

- blood group
- seed shape



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MUTATION • random genetic changes to the base sequence of DNA | • mostly no effects on phenotype

mutation
- good
  - *survival advantage*
  - *adaptation*
  - *evolution*
- bad
  - *genetic illnesses*
  - *cancer*

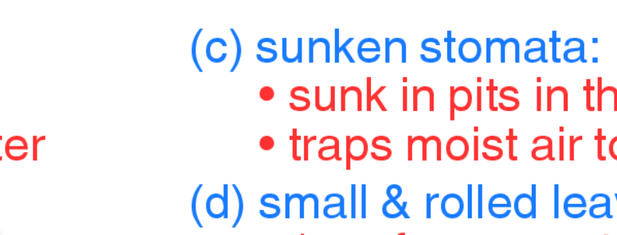
(occurs spontaneously & continuously)

causes that increases rate of mutation:

(a) ionising radiation
- UV ray • X-ray
- gamma ray

(b) chemicals
- tar in tobacco *(carcinogens)*

sickle-cell anaemia



- genetic disease due to mutation
- sickle-shaped red blood cells

(a) blockage of blood flow (stiff)
(b) lead to stroke & heart problems
(c) organs are deprived of oxygen

genotype	phenotype
$Hb^A Hb^A$	normal
$Hb^S Hb^S$	sickle cell anaemia
$Hb^A Hb^S$	sickle cell trait

co-dominance:
mild sickle cell traits – malaria resistant

ADAPTIVE FEATURES

an inherited feature that helps an organism to survive and reproduce in its environment
(probability of an organism surviving and reproducing in the environment in which it is found)

XEROPHYTES • adapted to extremely dry conditions

(a) deep & extensive, shallow roots:
- reach water far underground
- quick absorption of large quantities of water

(b) thick waxy cuticle:
- reduces water loss – barrier to evaporation
- shiny surface reflects heat & lowers temperature

(c) sunken stomata:
- sunk in pits in the epidermis
- traps moist air to reduce rate of evaporation

(d) small & rolled leaves:
- ↓ surface area to ↓ evaporation & transpiration

(e) thickened leaves & stem: • stores water

HYDROPHYTES • adapted to extremely wet conditions

(a) large air spaces in leaves:
- keep leaves closer to surface of water
- large surface area for absorption & photosynthesis

(b) stomata on upper surface & thick wavy layer:
- repel water & keeping stomata open and clear

(c) small roots: • extract nutrients from water

SELECTION

NATURAL SELECTION

(a) genetic variation within populations
(b) production of many offspring
(c) struggle for survival, including competition for resources
(d) greater chance of reproduction by individuals that are better adapted to the environment than others
(e) these individuals pass on their alleles to the next generation

→ adaptation by natural selection:

by which populations become more suited to their environment over many generations

(evolution occurs)

eg. development of strains of antibiotic resistant bacteria

ARTIFICIAL SELECTION

breeding organisms with desirable characteristics together to produce offsprings which share those characteristics (selective breeding)

(a) selection by humans of individuals with desirable features
(b) crossing these individuals to produce the next generation
(c) selection of offspring showing the desirable features

examples:
- to improve crop plants (more yield, sweeter fruits)
- domesticated animals (more milk, better appearance, quality wool, gentle nature)

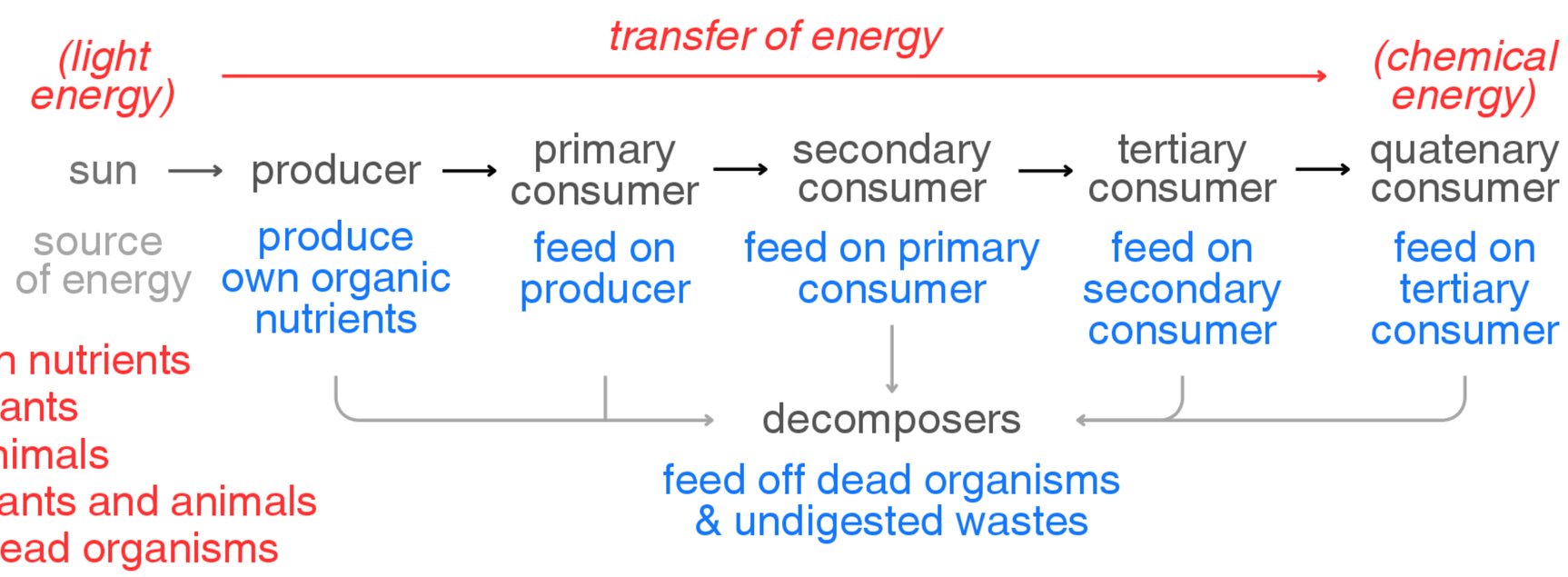
COMPARISON BETWEEN SELECTIONS

natural selection:
- occurs naturally
- development of populations with better adapted features
- takes longer time

artificial selection:
- involves human intervention
- development of populations with features useful to humans
- takes less time

FOOD CHAIN

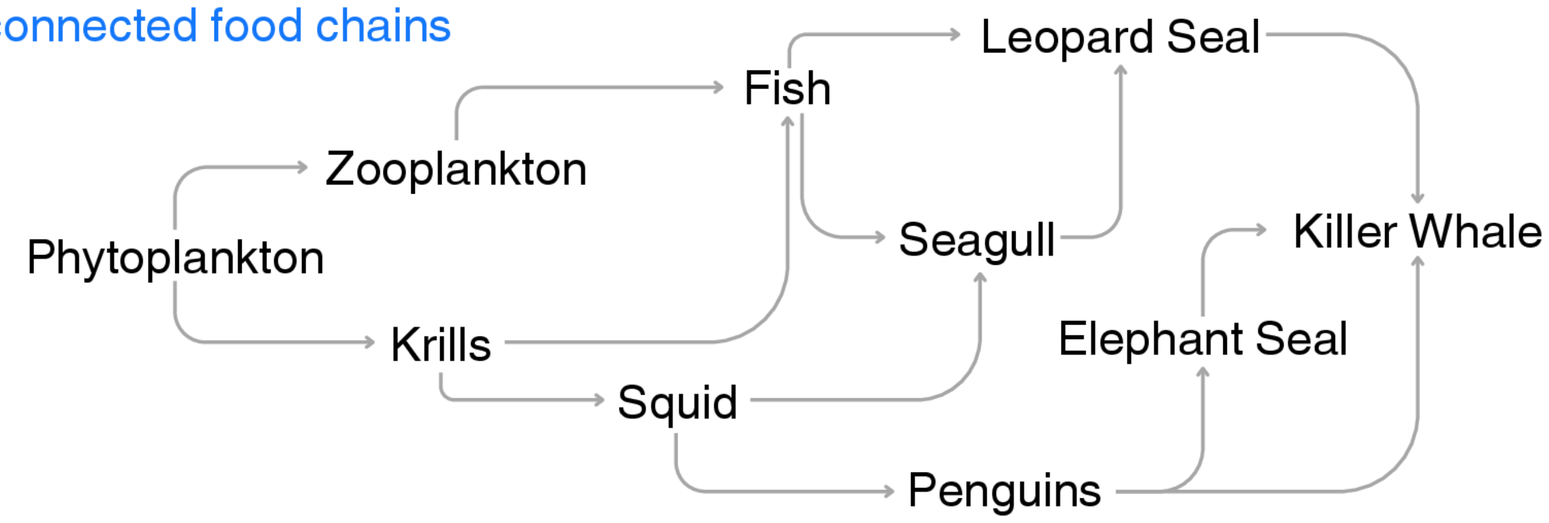
showing the transfer of energy from one organism to the next, beginning with a producer



- producers: produce own nutrients
- herbivores: consume plants
- carnivores: consume animals
- omnivores: consume plants and animals
- detritivores: consume dead organisms

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FOOD WEB • a network of interconnected food chains



interdependence

animals often exist as multiple types of food source

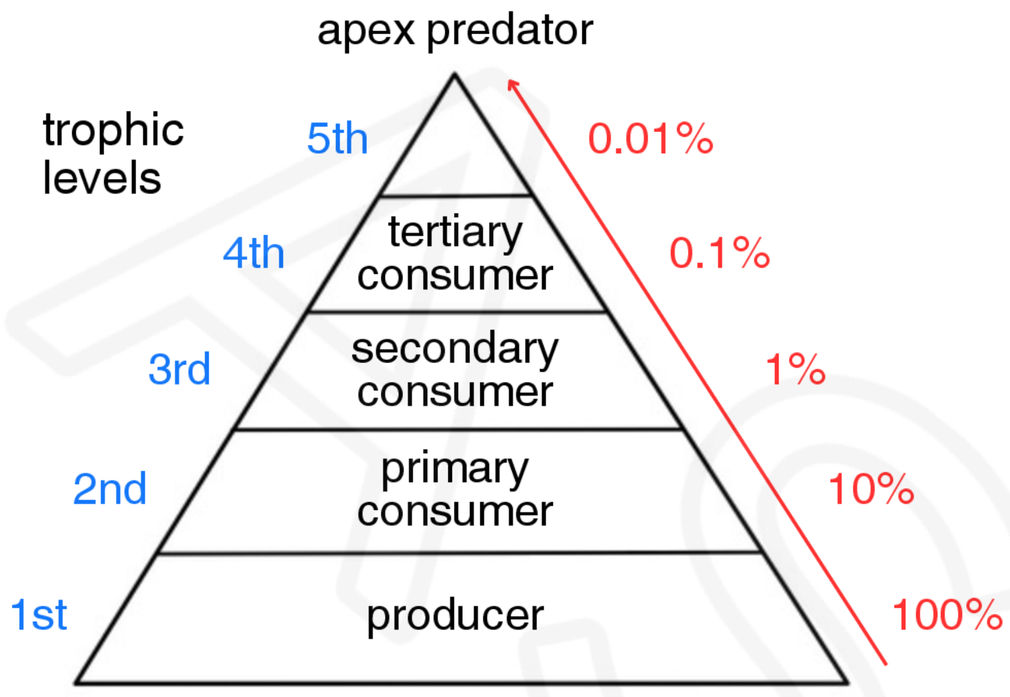
Q – if population of krills ↓:

- population of phytoplankton ↑
- population of squid ↓ drastically
- population of fish ↓ slightly

factors affecting food web: • over-harvesting of food species • introduction/removal of species to habitat

PYRAMID OF NUMBERS I BIOMASS I ENERGY

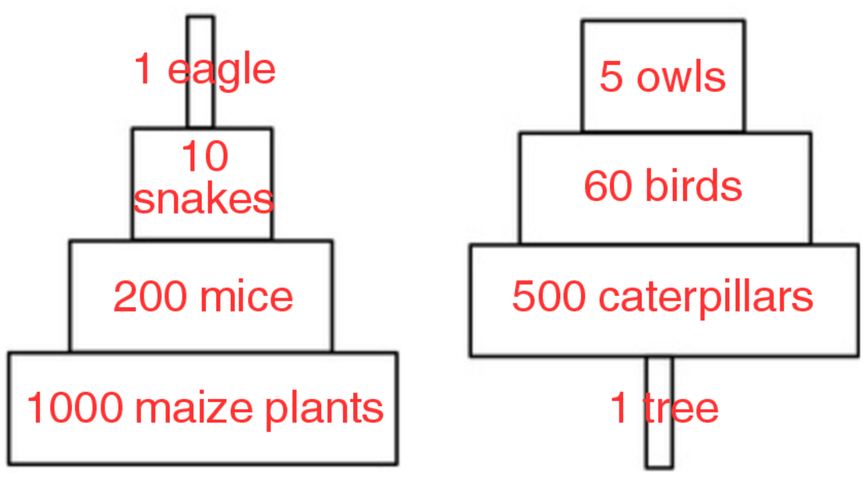
PYRAMID OF ENERGY



- trophic level shows energy transfer, producer has 100% (loss of energy at each trophic level)
- 90% of energy loss, only 10% is passed on or transferred
- insufficient energy to support another trophic level (rarely go beyond 5 trophic levels)
- energy lost: (a) waste products (urine / faeces)
  (a) movement
  (c) heat or respiration
  (d) undigested wastes (decomposers)
- not all animals / part of animal (in one trophic level) are eaten or digested
- more energy efficient for humans to eat crop plants than to eat livestock that have been fed on crop plants

PYRAMID OF NUMBERS

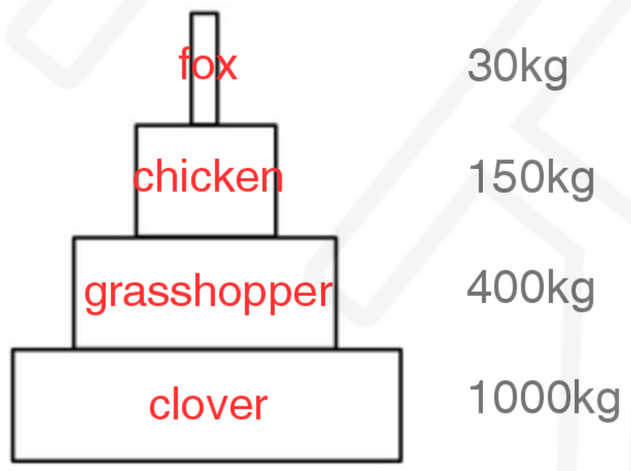
- shows number of organisms
- width represents number



pyramidal-shaped *not pyramid-shaped*

PYRAMID OF BIOMASS

- shows dry mass of organisms
- number of individuals x individual mass
- always pyramid-shaped



advantages of pyramid of biomass vs numbers

(a) in a pyramid of numbers, one large individual is shown in the same way as one very tiny individual

(b) biomass indicates how much food there is, available or left

(c) biomass is an indicator of the energy available

(d) pyramid of biomass is pyramid shaped, pyramid of numbers is not always

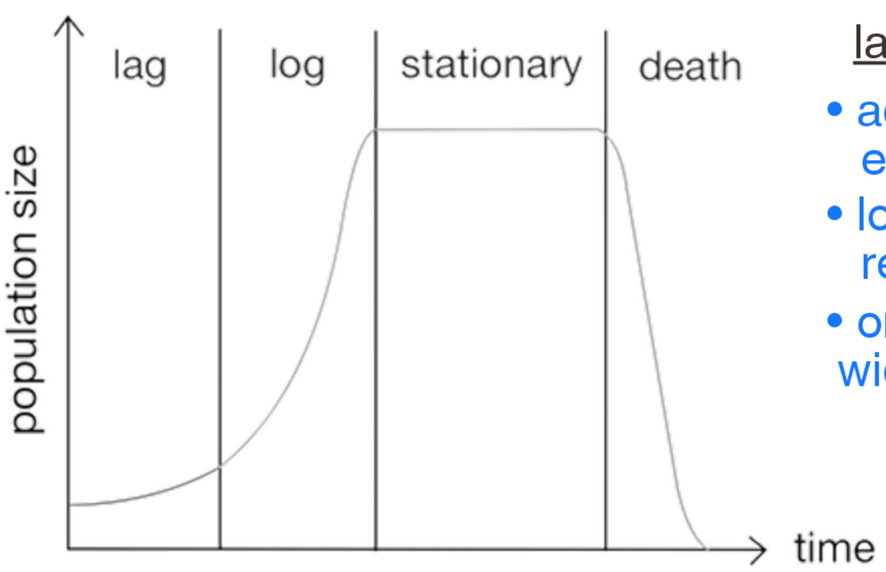
POPULATIONS

(a) population: a group of organisms of one species, living in the same area, at the same time

(b) community: all of the populations of different species in an ecosystem

(c) ecosystem: a unit containing the community of organisms and their environment, interacting together

SIGMOID CURVE



lag phase
- adapting to the environment
- low rate of reproduction
- organisms are widely dispersed

log phase
- exponential
- abundant food supply
- ↑ birth rate > ↓ death rate
- ↓ limiting factors

stationary phase
- curve levels off
- birth rate = death rate
- limiting factor: nutrients slow growth

death phase
- population ↓
- death rate > birth rate
- shortage of food supply & toxic wastes

factors affecting rate of population growth

(a) food supply: amount & quality of nutrition
require for growth, survival & reproduction

(b) competition: intra (same) I inter (different)
competition for resources

(c) predation: ↓ in predator, ↑ number of prey

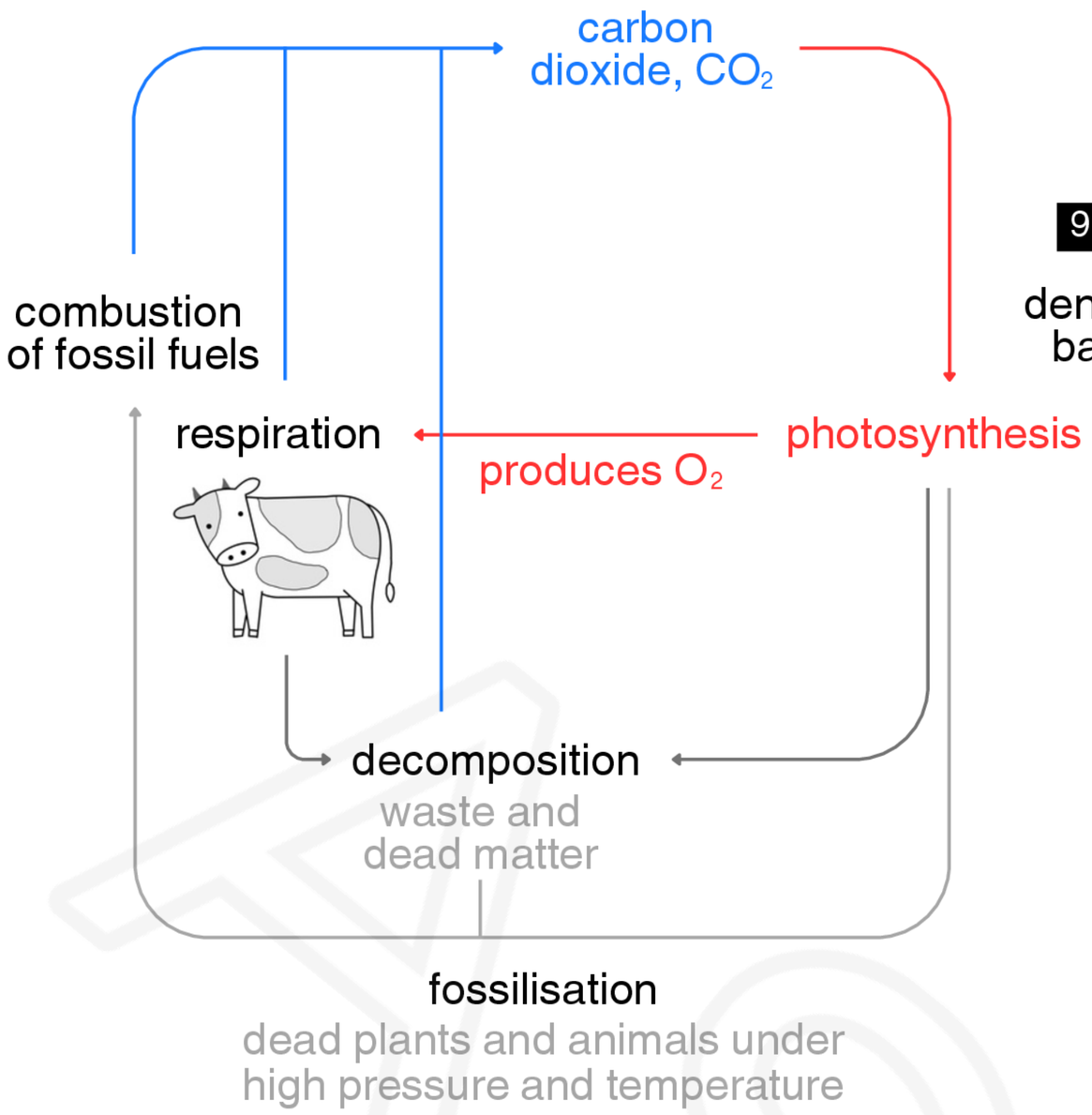
(d) diseases: leads to death of organisms
less population growth, cancels out birth rate

limiting factors:
- predation
- diseases
- Δ in temperature
- Δ in light intensity
- immigration (in)
- emigration (out)

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NUTRIENTS CYCLE

CARBON CYCLE

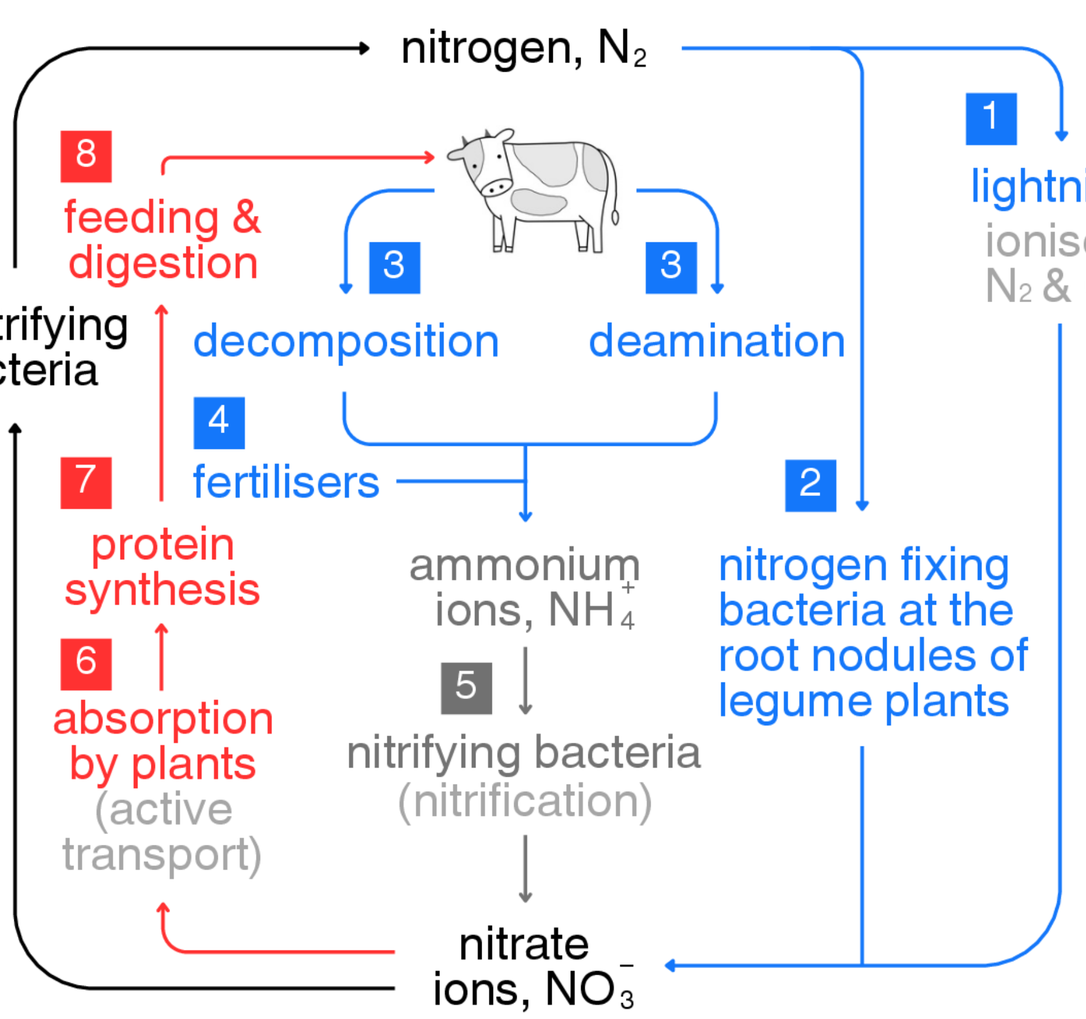


- carbon is taken out from carbon dioxide by plants for photosynthesis (producing oxygen)

ways to increase carbon dioxide in atmosphere

(a) respiration by animals, plants & microorganisms
(b) increase in combustion of fossil fuels
(c) decomposition by microorganisms
(d) mass deforestation (↓ in number of producers)

NITROGEN CYCLE



- nitrogen is required to make proteins & needs to be converted into nitrates to get absorbed

nitrogen fixation: nitrogen fixing bacteria/lightning converting nitrogen to nitrates directly

nitrification: decomposition/wastes/fertilisers converting ammonium compounds into nitrites then nitrates

making nitrate ions			taking in nitrate ions
1	2	nitrogen fixation	6 7 8 converting back to N_2
3	4	ammonification	9 denitrification
5		nitrification	

UNIT 20: HUMAN INFLUENCES ON ECOSYSTEMS

ASTRA

INTENSIVE FOOD PRODUCTION

FOOD SUPPLY

(a) agricultural machinery
to use larger areas of land & improve efficiency

(b) chemical fertilisers
to improve yields

(c) insecticides
to improve quality & yield

(d) herbicides
to reduce competition with weeds

(e) selective breeding
to improve production by crop plants & livestock

MONOCULTURES

continuous production of one type of genetically identical crop

advantages:

- higher yield
- improves efficiency
- easier to manage
- more earnings
- technological advancement

disadvantages:

- loss of biodiversity
- disruption of food chain
- extinction of species
- lost of habitat
- spread of diseases
- disrupts soil fertility / loss in nutrients
- desertification
- soil erosion (landslides)
- deforestation
- pollution by pesticides

INTENSIVE LIVESTOCK PRODUCTION

large number of livestock kept in the same area

advantages:

- food security
- increase yield & efficiency
- reduces cost of farming
- kept in small area of land (increase output)

disadvantages:

- loss of biodiversity
- disruption of food chain
- extinction of species
- lost of habitat
- reduce nutrient recycling
- production of greenhouse gases (methane / carbon dioxide)
- overgrazing
- water pollution (eutrophication)
- spread of diseases

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IMPORTANCE OF BIODIVERSITY

biodiversity: the number of different species that live in a particular area

HABITAT DESTRUCTION

causes:

(a) increased area for housing, crop plant production & livestock production
(b) extraction of natural resources
(c) freshwater & marine pollution

altering food webs & disrupting biodiversity

POLLUTION

3 types of pollution: • land • water • air

(a) water pollution
- untreated sewage (lack treatment)
- discarded rubbish (non-biodegradable)
- excess fertilisers (agricultural land)

(b) air pollution • greenhouse gases

sources: • carbon dioxide – combustion
• methane – keeping livestock

greenhouse effect:
- short wave radiation from sun enters
- long-wave radiation given off by earth
- heat is absorbed by greenhouse gases

enhanced greenhouse effect:
- less long-wave radiation escapes atmosphere
- more heat is absorbed by greenhouse gases

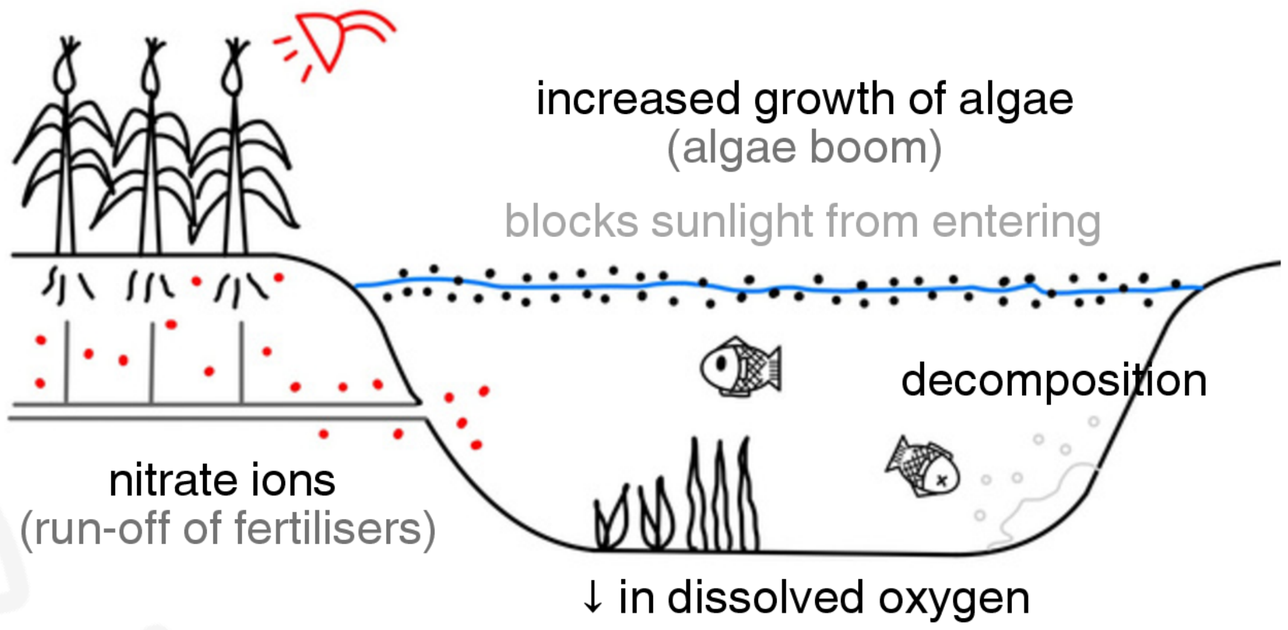
(c) plastic pollution
- releases toxins (bioaccumulation)
- aquatic animal: (choke, strangle, get caught in it, fill up stomach)
- on-land: (burying landfills, toxic)

DEFORESTATION clearing of trees on a large scale

unsustainable use of land:
• building • grazing for cattle • monoculture & plantation

undesirable effects:
- habitat destruction
- reducing biodiversity
- extinction of species
- loss of soil / soil erosion
- flooding (landslides)
- ↑ CO_2 in atmosphere
- global warming
- leaching of nutrients

EUTHROPHICATION



(a) increased availability of nitrate and other ions
(b) increased growth of producers
(c) increased decomposition after death of producers
(d) increased aerobic respiration by decomposers
(e) reduction in dissolved oxygen
(f) death of organisms requiring dissolved oxygen in water

CONSERVATION

SUSTAINABILITY

sustainable resources

one which is produced as rapidly as it is removed from the environment so that it does not run out

non-renewable:
• fossil fuels • coal • natural gas • crude oil

(a) reduce the amount of resources used
(b) sustainable resources to replace

FISH STOCK

conservation methods:

(a) legal quotas
(b) control size of fish
(c) closed seasons
(d) educate fishermen
(e) fines / treaties
(f) restocking
(g) fish farms
(h) reduced demand
(i) alternative sources
(j) monitoring population
(k) captive breeding & release
(l) no-catch zones / protected areas
(m) minimum mesh size & net types

FORREST

conservation methods:

(a) replantation of trees
(b) education & awareness
(c) monitoring & tracking
(d) quotas for logging
(e) protected areas

ENDANGERED SPECIES

risks of becoming endangered
- climate change
- habitat destruction
- hunting / poaching
- starvation
- overharvesting
- pollution / poisoning
- introduced species
- slow reproduction rate

conservation methods:

(a) monitoring & protecting species & habitats
(b) education (c) captive breeding programmes
(d) seed banks : small, easy to collect, dormant

reasons to conserve:
- maintaining / increasing biodiversity
- ↓ extinction • protecting vulnerable ecosystem
- maintain ecosystem functions:
  (a) nutrients recycling (b) resource provision:
  - *food, drugs, fuel & genes (selective breeding)*

CONSERVATION TECHNIQUES

(a) artificial insemination
- collect, identify sperm / semen
- freeze sperm / use sperm bank
- selecting / screening of sperm
- use hormones for ovulation
- determine when female is ovulating
- insert semen / sperm into female (vagina / uterus)

(b) in-vitro fertilisation (IVF)
- use fertility drugs
- gametes (sperm/egg) collected from both parents
- egg cells are inseminated (fertilisation outside of body)
- forms embryo and insert into uterus for implantation

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UNIT 21: BIOTECHNOLOGY AND GENETIC MODIFICATION

ASTRA

BIOTECHNOLOGY

USE OF BACTERIA

- rapid reproduction rate
- ability to make complex molecules
- do not take up much space
- presence of plasmid
- cheap to grow
- few ethical concerns over their manipulation and growth

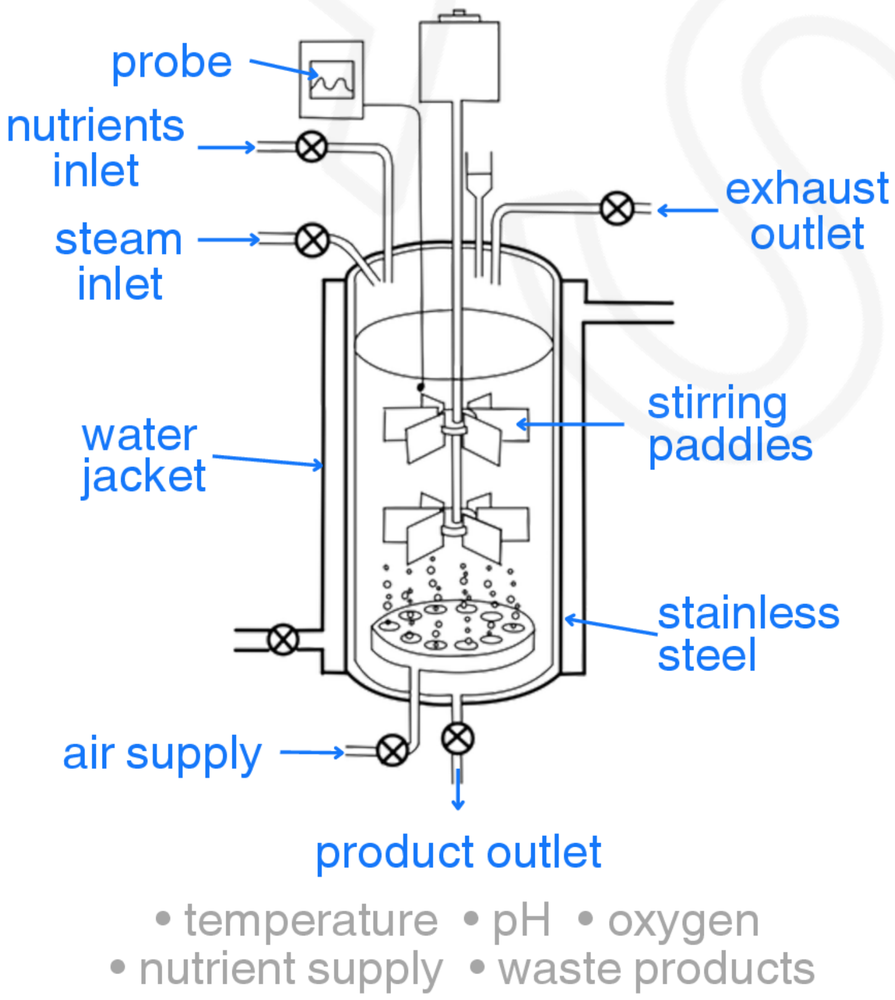
FERMENTER

large scale production of useful products by bacteria & fungi

(a) insulin: produce human insulin to treat diabetic patients

(b) penicillin: produce antibiotics to inhibit growth of bacteria (from penicillium mould)

(c) mycoprotein: a protein-rich food suitable for vegetarians (from fungus fusarium)



- temperature • pH • oxygen
- nutrient supply • waste products

ENZYMES

(a) biofuels: fuels from living organisms

anaerobic respiration in yeast produces ethanol

glucose ⟶ ethanol + carbon dioxide

- ethanol is extracted by distillation
- used to replace gasoline in cars

(b) bread-making: fermentation

- anaerobic respiration in yeast produces carbon dioxide, causes the bread to rise

GENETICALLY MODIFIED CROPS

advantages:

- increases yield
- appealing
- faster growth
- cheaper
- drought resistance
- solve famine

disadvantages:

- reduce in biodiversity (death of other plants)
- develop super breed (stronger than GM)
- ↑ costs (R&D) & dependency (chemical)
- long-term side effects (affects consumers)

APPLICATION OF BIOTECHNOLOGY

(a) fruit juice production: use of pectinase

- pectinase breaks down cell wall made of pectin
- easier to squeeze juice from fruit (more juice)
- adding pectinase produces clearer fruit juice

(b) biological washing powder: use of enzymes

- *quickly breaking down large, insoluble molecules into small, soluble molecules: dissolves in water*
- *effective at ↓ temperatures, ↓ energy & ↓ cost*
- *to clean delicate fabrics*
  - protease: breaks down protein (blood, vomit)
  - lipase: breaks down fat-containing stains
  - amylase: breaks down starch-containing stains

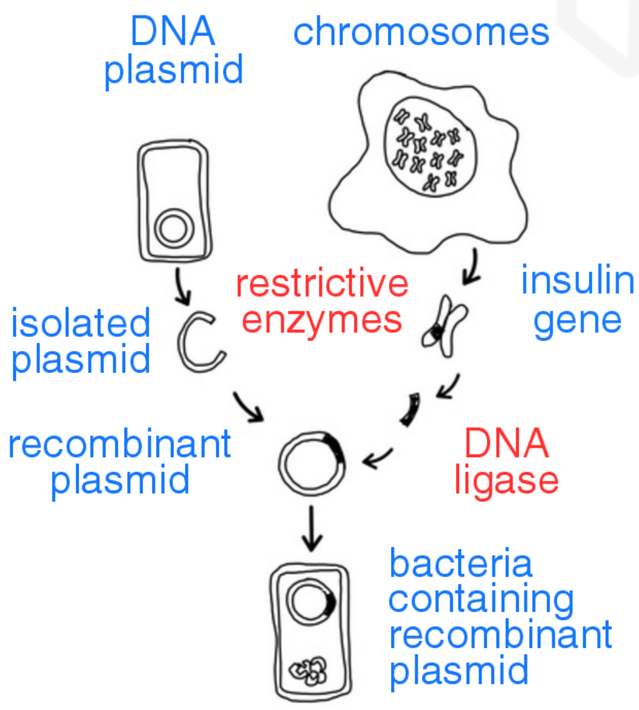
(c) lactose-free milk: use of lactose

- lactose intolerant individuals lost the ability to produce lactase (lactose is broken by lactase)
- prevents diarrhoea and nausea

CONTROLLED CONDITIONS IN FERMENTER

• probe:	monitor temperature & pH in the fermenter
• exhaust outlet:	releases carbon dioxide from aerobic respiration
• stirring paddles:	agitation to ensure uniform distribution of nutrients, oxygen & temperature
• stainless steel:	does not corrode & affect product of fermentation
• product outlet:	allow collection of products after fermentation
• air supply:	supplies oxygen for aerobic respiration
• water jacket:	maintain & control temperature (optimum temperature for enzymes)
• steam inlet:	aseptic precautions to sterilise (kill microorganisms)
• nutrients inlet:	supply nutrients for growth, energy & reproduction

GENETIC MODIFICATION



- changing the genetic material of organism by removing, changing or inserting individual genes
- transgenic organism is genetically modified

examples:

1. produce insulin
2. resistance to herbicides
3. confer resistance to insect pests
4. produce additional vitamins

(a) isolation of the DNA making up a human gene using restriction enzymes, forming sticky ends

(b) cutting of bacterial plasmid DNA with the same restriction enzymes, forming complementary sticky ends

(c) insertion of human DNA into bacterial plasmid DNA using DNA ligase to form a recombinant plasmid

(d) insertion of recombinant plasmids into bacteria

(e) multiplication of bacteria containing recombinant plasmids

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