Module 1: Cells as the Basics of life

CELL STRUCTURE

19th C Cell theory:

- All things are made up of cells and cell products
- New cells formed from reproduction
- Smallest unit of life

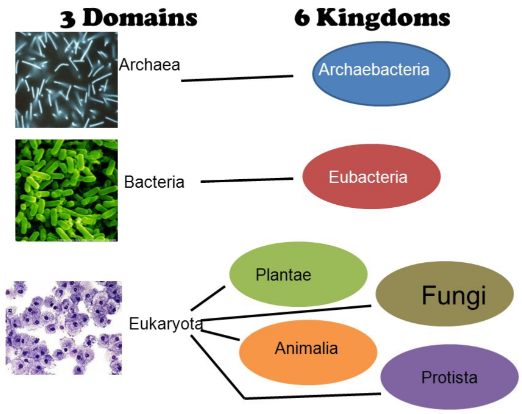
Modern additions to cell theory:

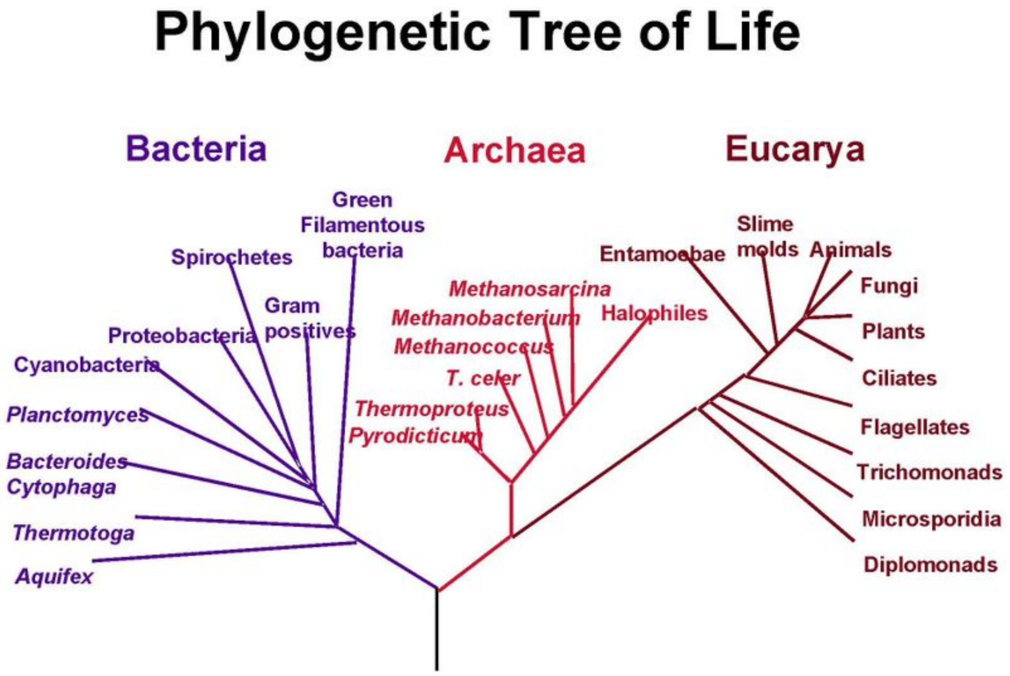
- Contains genes/DNA →growth, function, development
- Chemical reactions of life take place

Human bodies have 220 types

Specialisation and differentiation

TYPES OF CELLS





Eukaryotes: Have membrane bound organelles, linear chromosomal DNA in the nucleus – Plantae, Fungi, Animalia, Protista

Prokaryotes: no membrane bound organelles, one circular chromosome in the nucleoid – Bacteria and Archaea.

Bacterial Arrangements:

- **Bacillus = short rod / sausage**
- **Coccus = round**
- **Spirillum = twisted rod**
- **Spirochaete = long spirls / coils**

Prefix:

- **Exists in pairs = diplo**
- **Chains = strepto**
- **Bunches = staphylo**

MICROSCOPES

Light microscope	SEM	TEM
Magnification 1000x	Magnification 100,000x	Magnification 5,000,000x
Resolution >200 nm	Resolution 10nm	Resolution 0.2nm
Colour – colour	Colour – black and white	Colour – black and white
Specimen preparation - simple	Specimen preparation - easy	Specimen preparation - difficult
Live specimen - Yes	Live specimen - No	Live specimen - No
Cost $150 - $3000	Cost $1,000,000	Cost $100,000

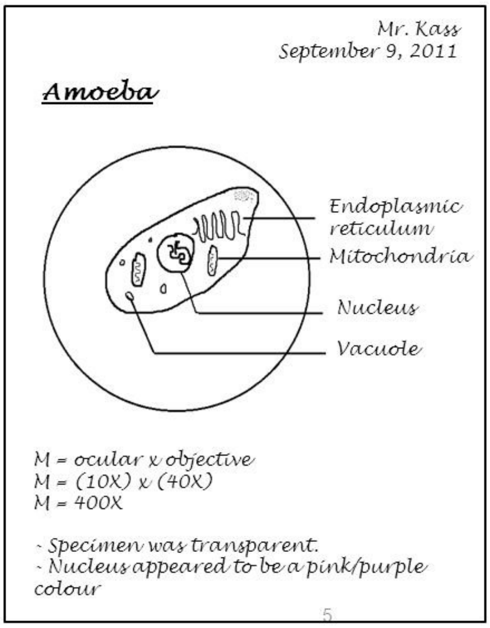
Light Microscopes: Pass light through specimen (cannot see any details finer than wavelength of light waves)

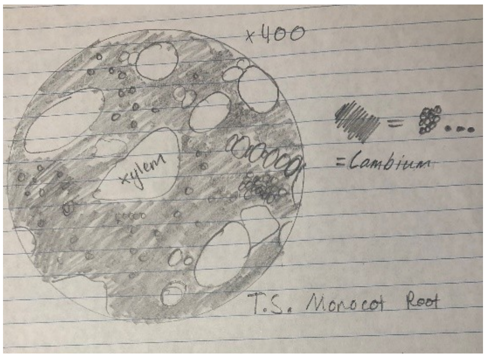
Scanning Electron Microscope: bounce electrons off specimen (3d image – topographical view)

Transmission electron microscope: pass electrons through specimen (2d image – cross section, shows organelles and ultrastructures)

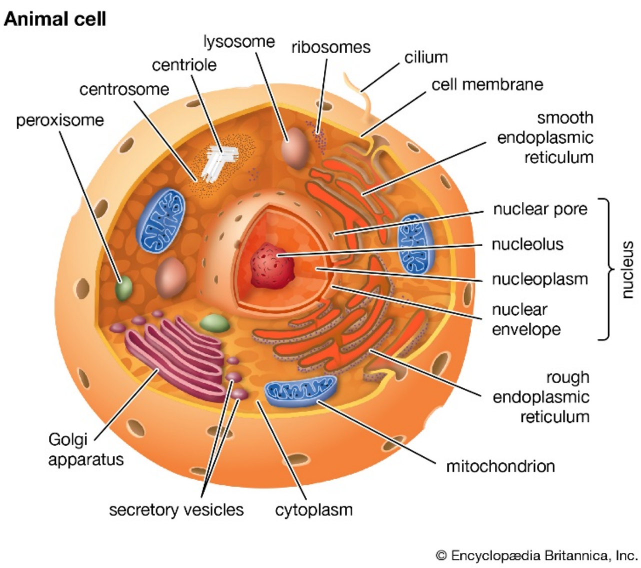
Biological Drawing Rules

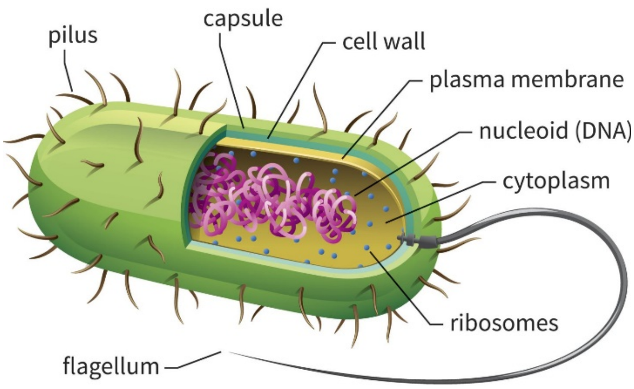
- ❑ Drawing is neat and LARGE. Must take up most of the paper
- ❑ Diagram is drawn in pencil and "coloured" using stipples (little dots)
- ❑ All diagram labels are printed to the <u>right</u> of the drawing and are lined up in a straight line
- ❑ Name and date are written in the upper right hand corner of the diagram
- ❑ An appropriate title is given to the diagram
- ❑ Lines between label and feature are drawn using a ruler
- ❑ Lines do not cross
- ❑ Calculations and qualitative observations are included at the bottom of the diagram





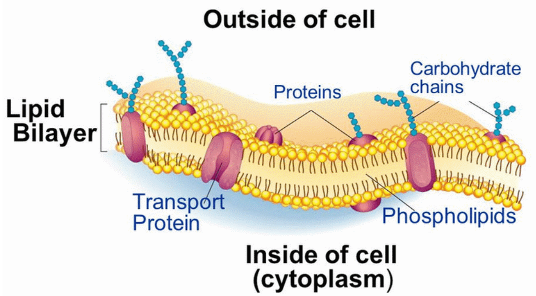
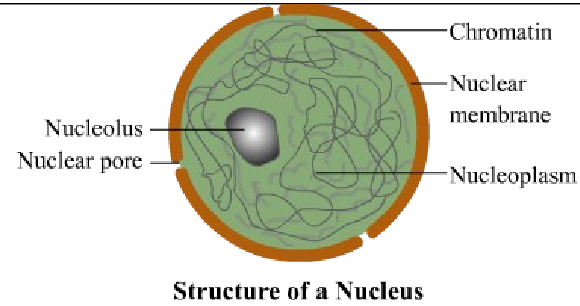
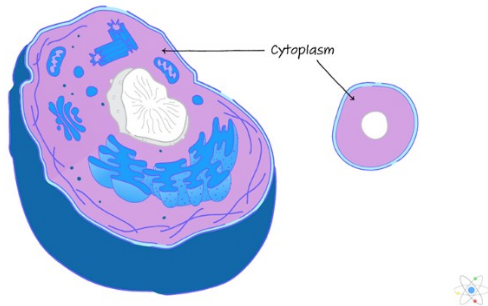
ORGANELLES





Prokaryotic cell size: 1-5 μm Apprx.

Eukaryotic cell size: 10-50 μm Apprx.

Organelle / Feature	Structure	Function	Diagram
Cell membrane – not technically organelle	- Fluid mosaic model - Semi-porous plasma membrane - Phospholipid bilayers (with suspended proteins and molecules)	- Encloses the organelle / cell - Establishes cell boundaries - Allow certain substances in - Allow different conditions on either side	
Nucleus	- 2 membranes forming nuclear envelope - Outer membrane is continuous with ER - Nuclear pores - Nucleolus (where ribosomal DNA is built)	- carries chromosomes (DNA) - site of DNA transcription - nuclear pores let in and out stuff (e.g. mRNA) - determines proteins synthesised by ribosomes	
Cytoplasm (the entire contents of the cell minus nucleus)	- cytosol fluid+ organelles - all cells contents (excluding nucleus) - contains cytoskeleton made of microtubules and microfilaments	- ATP production occur here - synthesises proteins - cytoskeleton provides shape, ability to move and divide	

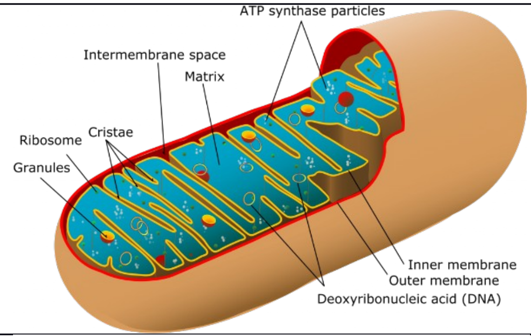
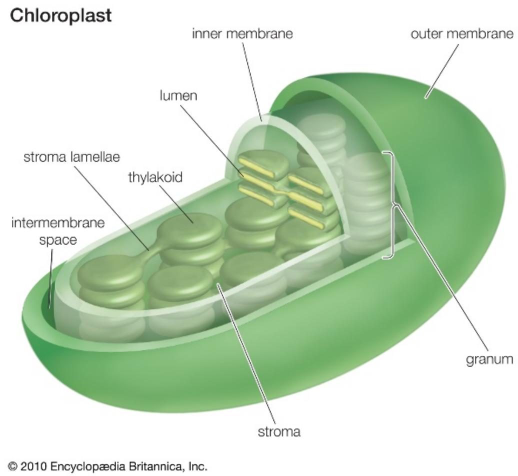
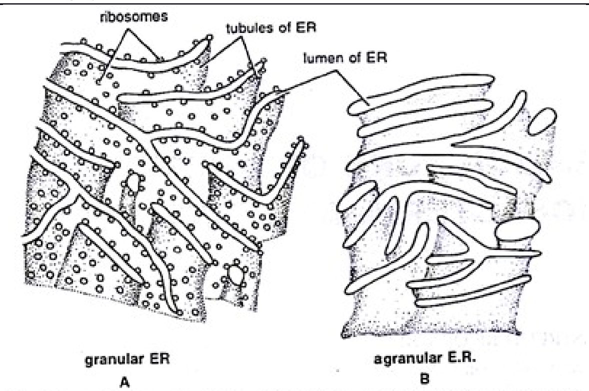
<table>
<tr><th></th><th></th><th></th><th></th></tr>
<tr><td>Mitochondria</td><td>- double membrane
- inner has folds called cristae
- inside inner is the matrix which contains mitochondrial DNA (one circular chromosome – supports idea of endosymbiosis)</td><td>- Cellular Respiration
- Provides energy to the cell</td><td>
</td></tr>
<tr><td>Chloroplasts</td><td>- Double membrane
- Inside both are thylajoid sacs
- Thylakoid sacs stacked in granum
- Fluid inbetween – stroma
- Granum interconnected by lamella
- Inside thylakoid sacs is lumen
- In between membranes is intermembrane space
- Have own circular DNA – supports idea of endosymbiosis
- Have chlorophyll which absorbs red and blue light and makes plants green.</td><td>- Photosynthesis
- Creates glucose, food source for cellular reproduction
-</td><td>
</td></tr>
<tr><td>Endoplasmic reticulum</td><td>- Networks of membrane bound sacs called cisternae
- Continuous outer membrane
- Rough is dotted with ribosomes</td><td>Smooth
- Forms and transports lipids, fats, steroids, hormones
- Detoxifies
Rough
- Synthesises and transports proteins</td><td>

Fig. 298. Structure of endoplasmic reticulum. A, Rough ER; B, Smooth ER.</td></tr>
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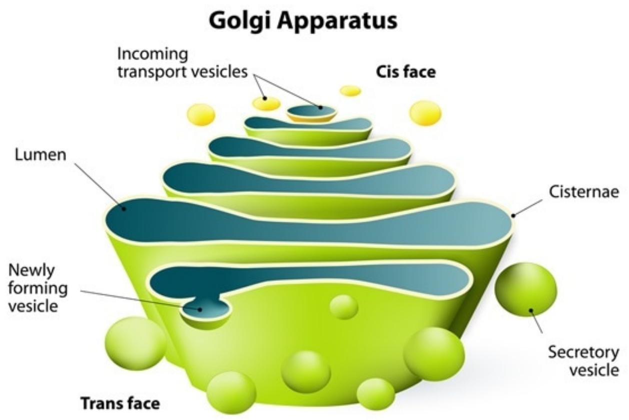
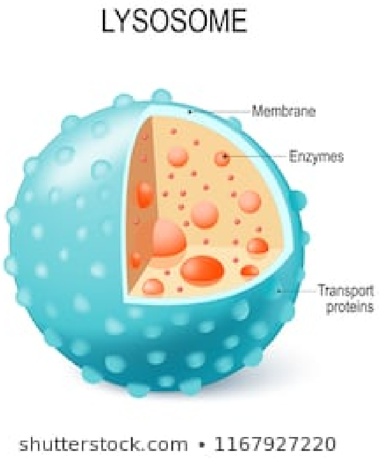
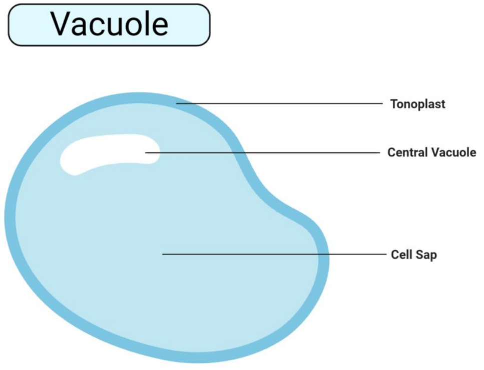
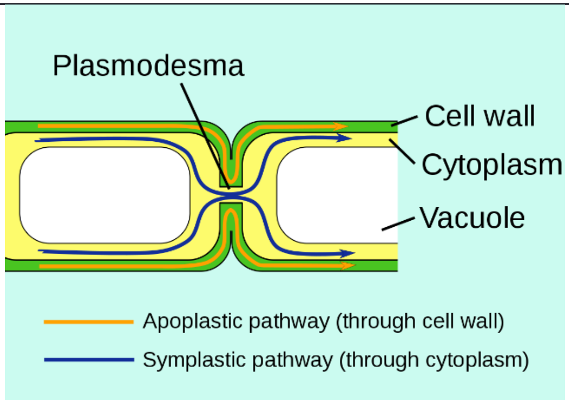
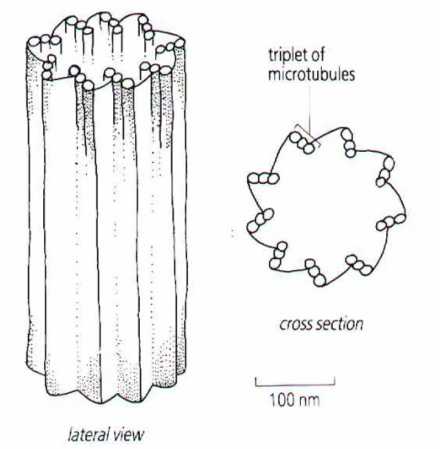
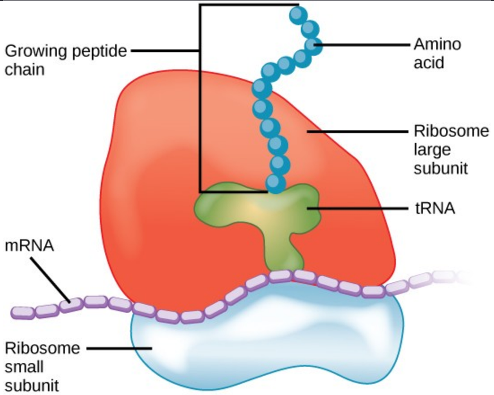
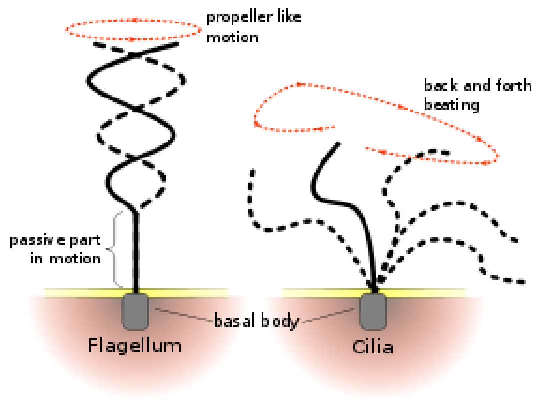
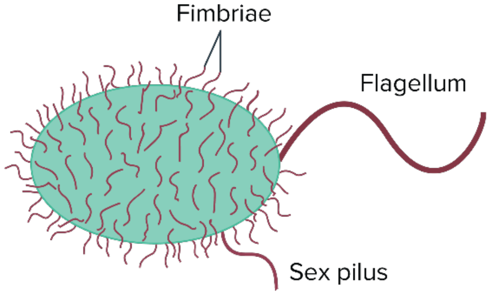
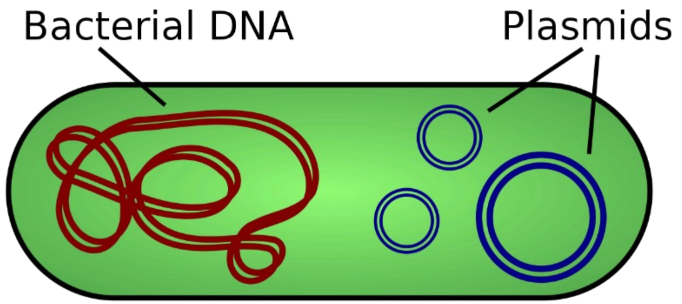
Golgi Body	- 'stack of pancakes' - Stack of flattened sacs similar to ER - Pinches off to form vesicles - Made of phospholipid bilayer	- Substances created by ERs are modified and packaged for transport (exocytosis) - Receives vesicles as well (endocytosis) - 'post office' of the cell - Makes vesicles of phospholipids	
Lysosomes	- Type of vesicle - Single membrane	- 'Digests' complex compounds to simpler ones - Eats dead/broken organelles - Causes cell death	
Vacuole	- Fluid filled space - Single semi-permeable membrane	- Storage (of water or food) and digestion - Maintains turgor pressure (pressure that pushes cell membrane against cell wall and therefore maintains shape	

Plasmodesma	- Extension of ER outside cell. - Connects with plasmodesma of other cells	- Transports without the need of vesicles or endo/exocytosis	
Centriole – non membrane bound	- stacked at right angles like a + - Rod shaped - No membrane	- Organise spindle fibres in prophase of cell division (of animal and fungal cells)	
Ribosomes – non membrane bound	- Made of rRNA and proteins - Small ribosomal subunits – read RNA - Large ribosomal subunits – join amino acids to form a polypeptide chain	- Sites of protein production	

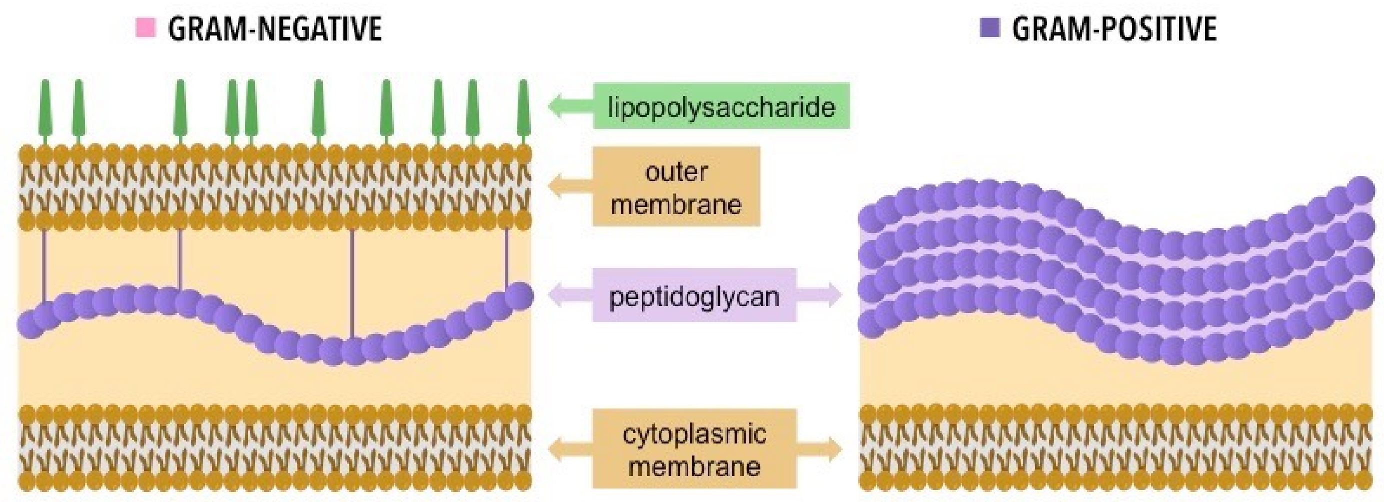
Flagellum – not membrane bound **/ Cilia**	- Longer hair protrusion - Looks like a tail - Eukaryotes: built of pair of microtubles) - Prokaryotes – one filament that is bent and spins around.	- Swimming - Eukaryotes – swim by whipping tail - Prokaryotes – swim with propeller Prokaryotes flagellum →-→ Eurkaryotes moves like snake	
Pili / fimbriae – not membrane bound	- Hair like structure	- Pilli: Allows for conjugation and sharing of plasmid DNA - Fimbriae: adheres to surfaces	
Plasmids – not membrane bound (not an organelle)	- Extrachromosomal DNA in small loops	- Allows for traits to be transferred across bacteria (e.g. antibiotic resistance)	

TYPES OF EUKARYOTIC:

	Fungal Cell	Plant Cell	Animal Cell
Centrioles	YES		YES
Cell wall*	YES – CHITON	YESN – CELLULOSE	
Vacuole		LARGE CENTRAL VACULOE	
Chloroplast		YES	

*bacterial prokaryotic cells have peptidoglycan cell wall

GRAM NEGATIVE VS GRAM POSITIVE BACTERIA:



Antibiotics work better on gram positive (purple when stained) because they destabilise cell wall.

CELL MEMBRANE

Cell membrane:

- Encloses the organelle / cell
- Establishes cell boundaries
- Allow certain substances in

Allow different conditions on either side

Fluid Mosaic name justification: mosaic – composed of heaps of little parts . fluid – parts can moves around and rearrange, not fixed.

Semi-Permeable: to let in the right concentrations of what is needed. Controls what goes in and out

- ➔ *Muscle cells' membranes let in more glucose for ATP production because they need more energy*
- ➔ *Liver cells' membranes let out more waste*

Structure: phospholipid bilayer

:a phospholipid is a biomacromolecule formed of: contains omega-3

2 Hydrophobic fatty acid tails (non-polar)

Hydrophilic phosphate containing heads (polar)

Proteins: suspended in the membrane. Regulate what come in and goes out .

Integral proteins: go through both layers and allow for the transport of substances (transmembrane)

Receptor proteins: are on one side and receive signals

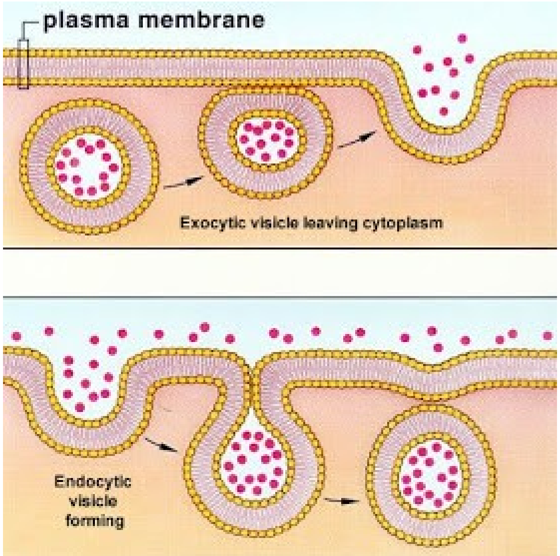
Peripheral proteins: anchor cell to inner scaffolding of cell.

Cholesterol: keeps it at the right fluidity. Makes it less fluid as temps rise and more fluid as temps fall

Communication: via the emitting and receiving of proteins/hormones and chemicals.

Releasing vesicle = **exocytosis**

Receiving vesicle = **endocytosis**



Polarity: non-polar molecules pass through easily (e.g. O2)

Polar or charged molecules don't.

Fusing Bilayers: some proteins can help to fuse bilayers. This can be good or bad

→***Good:*** *sperm and egg fertilisation*

→***Bad:*** *Virus infiltrating cell*

Working together: Sometimes proteins come together (fluid) → *to trigger an immune response*

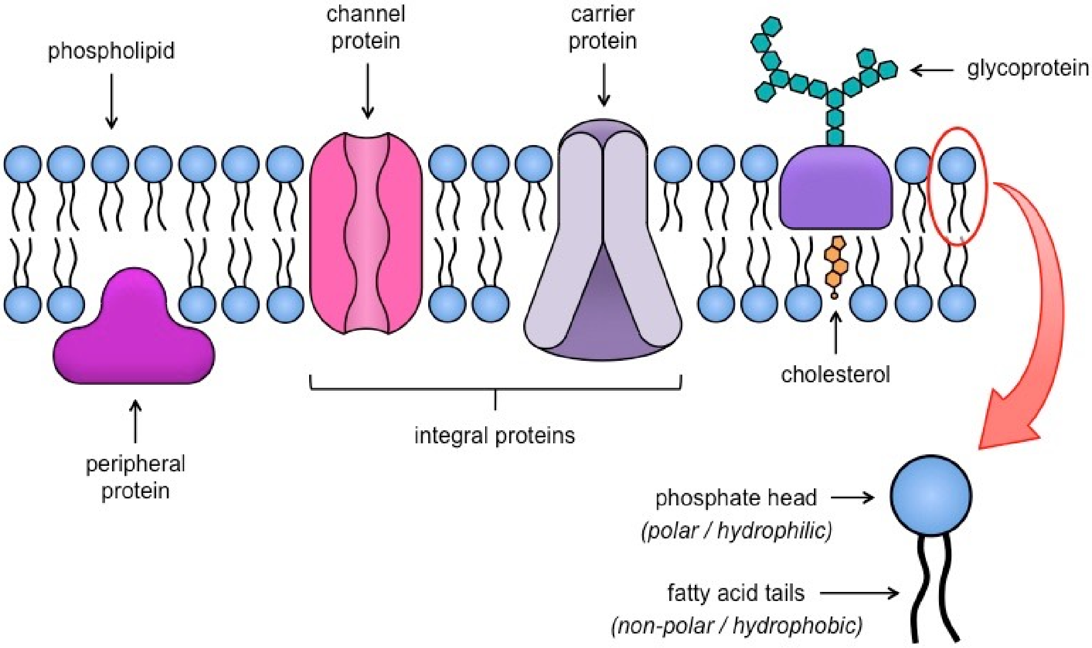
Transporting Substances:

Passive: (90% - 10% →50% - 50%) **Chanel Protein**

- Diffusion / osmosis: High concentration to low concentration through membrane
- Facilitated: diffusion with a protein 'doorway'

Active: (90% - 10% → 0% - 100%) **Carrier Protein**

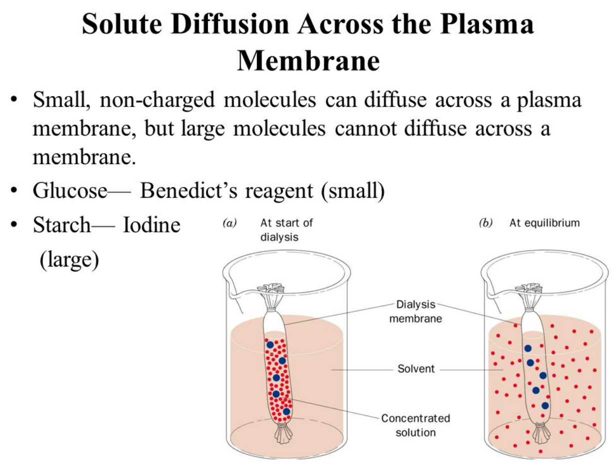
- Assisted with protein pum
- →*e.g. muscle cells need 100% glucose*



CELL FUNCTION

DIFFUSION AND OSMOSIS PRAC:

- 3 beakers set up
    1. (<u>control</u>) – distilled water dialysis bag in distilled water
        - shows no change
    2. (<u>osmosis</u>) starch solution dialysis bag in iodine solution
        - bag turns black/purple if iodine enters, water stays clear as no starch leaves
        - water (and with it iodine) enters bag to approach starch concentration equillibrium
    3. (<u>diffusion</u> and osmosis)glucose solution dialysis bag in distilled water
        - test beaker water with benadicts solution to check for glucose diffusing out of bag
        - glucose diffuses out of bag



CELLULAR TRANSPORT

Passive transport	Active Transport
Osmosis	Ion pumps
Facilitated diffusion	Exocytosis
Simple diffusion	Endocytosis

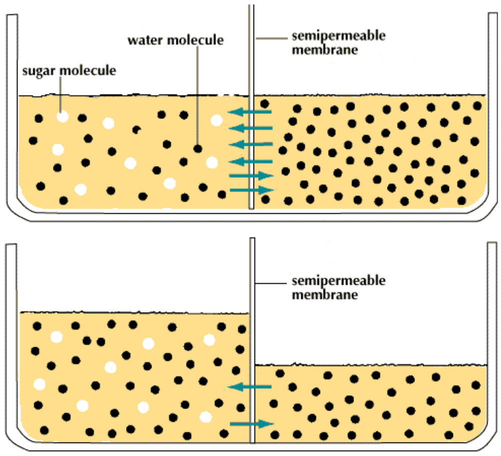
- Cells have size limitations to effectively allow movement of substances across cell membranes
- Diffusion approaches equilibrium
- SA:V ratio is given by 3:r (r=radius of cell)
- When a cell nears its maximum efficient size it divides
- Max distance of any human cell from blood supply (and therefor supply of oxygen and nutrients etc) of 100-200 μm
- Brownian motion – movement of molecules in a fluid

Examples in the body:

- Our body's have adapted to have better diffusion
- Digestion / nutrients absorbtion
    - villi and microvilli in small intestine (increases SA)
    - Blood vessels and peristalysis maintains concentration gradient
    - Remains constantly moist and warm
- Alveolus gas exchange:
    - Lungs are divided into alveoli (increases SA)
    - Breathing (ventilation) and blood maintain concentration gradient
    - Moist and warm

PASSIVE TRANSPORT

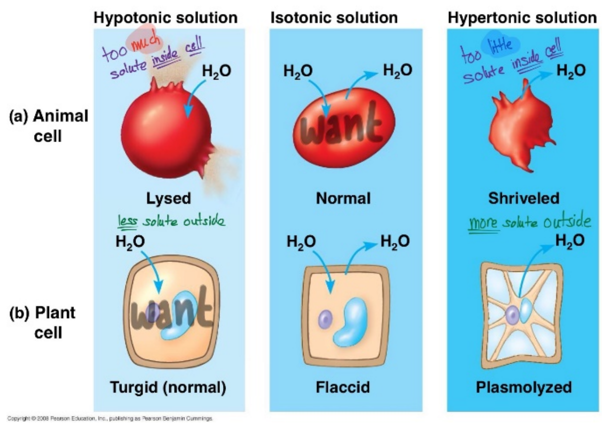
Osmosis:



- Definition: Net movement of (free) water molecules from a region of low solute concentration to an area of high solute concentration across a semi-permeable membrane
- Water flows with osmotic pressure / gradient
- Type of passive transport/diffusion where water moves down a concentration gradient across a semi permeable membrane.
- Smaller = bigger SA:V ration = more efficient diffusion.
- Bigger means less efficient diffusion + more needs to come in and out
- Cells must have right amount of water to function properly
- Osmosis acts to equalise concentration on both sides of a semi-perm. membrane

Tonicity:

- Relevant solute ocncentratuon of 2 environments separated by semi-perm membrane
- Water moves towards hypertonic environment
- **Hypertonic**
  - A hypertonic solution has a higher concentration than inside cell
  - Cells lose water and shrink – become flaccid (called crenation)
  - In the cell can plasmolyse – the membrane is pulled away from cell wall (only in plants – causes wilting)
- **Hypotonic**
  - A hypotonic solution has a lower concentration than inside the cell
  - Cells gain water and grow – become turgid
  - Cells may lyse (pop cell membrane – called haemolysis in blood cells)
    - Cell wall stops this in plants and creates turgor pressure.
- **Isotonic**
  - Concentration in and out of cell is the same
  - No osmosis / change
  - Become flaccid



Speed of passive transport (diffusion, osmosis, facilitated diffusion) and active transport is determined by:

- Concentration gradient (bigger difference = quicker)
- Size and type of molecule
  - Bigger = more distance between membrane and parts of cell – if oxygen and nutrients take to long to reach the necessary parts of the cell it can die/run out of energy.
- Temperature (warmer = quicker)
- Moisture (more = quicker)
- Energy supply

Passive transport:

- No energy used
- As size of organism increases they cant simply rely on diffusion →use transport systems (blood vessels, excretory system etc.)

Simple Diffusion:

- Occurs with non-charged, non-polar small molecules. (e.g. O_2 CO_2)
- Gasses, hydrophobic molecules, small molecules and some small polar molecules (Co_2)
- Approaches equilibrium

Facilitated transport (too big or polar): - big can't fit through – polar attract molecules to form group that can't fit, repels from phospholipid bilayer.

- Integral proteins are used when the proteins are:
  - Too big
  - Charged / polar

Integral Proteins: (2 types)

- **Protein channel**
  - 'open doorway'
  - Water soluble molecules and ions
  - Regulates flow of small polar molecules or ions (e.g. Na^{2+})
- **Carrier Protein**
  - One at a time – 'air lock'
  - Binds to molecules and pushes / carries it through by changing shape
  - Regulates flow of large molecules (e.g. amino acids, glucose)

ACTIVE TRANSPORT, ENDOCYTOSIS & EXOCYTOSIS

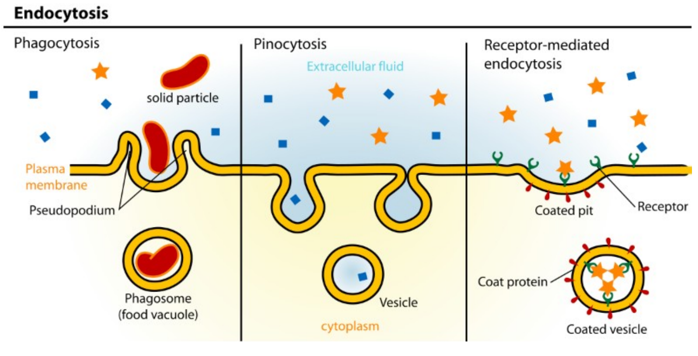
Active Diffusion:

- Uses energy (ATP) (or electrochemical gradient)
- Moves against concentration / electrochemical gradient
- Transport proteins / intergral proteins move large/hydrophilic/charged molecules (e.g. Glucose, Ca^{2+})
  - Transport proteins have a specific molecule they move
  - Called Protein pumps
- Occurs with molecules constantly moving into / out of cell (e.g. glucose, ammonia, CO_2)

  E.g. in body
  - uptake of iodine into thyroid gland
  - ion uptake into hair root cells in plants
- maintains homeostasis
- used when cells need more than equilibrium e.g. glucose uptake into muscle cells.
- Primary transport uses energy from ATP
- Secondary uses energy from electrochemical gradients caused by ion pumps

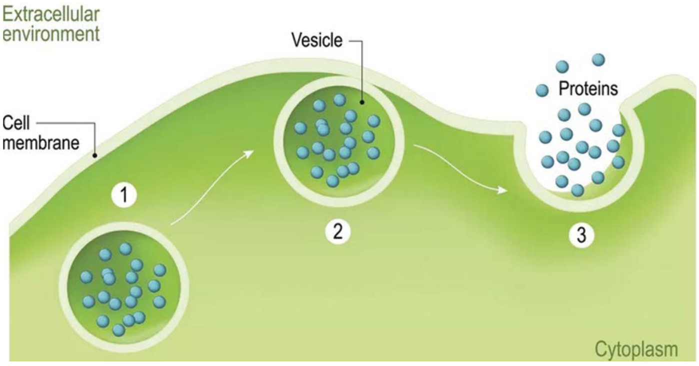
Endocytosis

- Taking in
- Occurs when molecule is too large of polar to cross membrane or integrated proteins e.g. single celled organism used to ingest food particles
- Plasma membrane extends outwards and surrounds it.
- Types of endocytosis:
  - Phagocytosis:



- Cell takes in a particulate (relatively large particles)
- Engulfed and enclosed in cells into a vesicle
- Binds with lysosome to form endosome/phagosome
- Materials inside are broken down
- E.g. white blood cells 'eating' bacteria – innate immunity (types of white blood cells include monocytes or neutrophyls

- Pinocytosis:
  - Cell takes in liquid including water from extracellular fluid -"cell drinking"
- Receptor mediated endocytosis
  - Some molecules (such as low density lipoproteins) bind to receptors in a 'pit'. When full the pit deepens and forms vesicle.



Exocytosis:

- Opposite – intracellular vesicle fuses with membrane and expels contents
- E.g. secretions of hormones, enzymes, and antibodies
- Placements of integral proteins

CELL REQUIREMENTS - ORGANIC

ATP

Comes mostly from glucose

energy sources for metabolic activity (atp):

prokaryotic cells – made in cytoplasm

eukaryotes – made in mitochondria

Glucose

Autotrophs: photosynthesis

Have pigment (chlorophyll) in organelle (chloroplast)

Autotrophs store glucose as insoluble starch so its not lost with water

Heterotrophs: glucose derived from autotrophs

CELL REQUIREMENTS - INORGANIC

water

- Function relies on water
- Organisms and cells are 70-90% water
- Cytoplasm is primarily water
- Considered universal solvent
- Used to remove waste

Gasses

O2

- Used for aerobic cellular respiration to produce atp
- Product of photosynthesis
- Used to make organic compounds

CO_2

- Used in photosynthesis
- Waste and potentially harmful to animals

Ions – e.g. Ca, K, O, Mg, Na, etc

- Used on lagre scale (macronutrients) or small scale (micro/trace nutrients)
- Essential for structure and function (into cells via diffusion)
- E.g. ca is used for bones

ORGANIC COMPOUNDS

- CHOs and CHONs
- Synthesised in cells

Carbohydrates – CHO

- Produced by photosynthesis or eaten
- Essential for life → broken into ATP

Monosaccharides

- Single monomer units
- Taste sweet
- E.g. glucose, ribose, fructose, galactose
- Soluble in water

Disaccharides

- Two monosaccharides bonded together
- Sweet taste
- Soluble in water

Polysaccharides

- Polymers know as complex carbohydrates
- Plants → starch, lignin, cellulose
- Animals →glycogen (in liver), chitin
- insoluble

Lipids - CHO

- Fats, waxes, oils
- Cells manufacture for many functions (e.g. phospholipid bilayer)
- Cell membrane, hormones, energy storage
- Made of monomers called triglycerides (3 fatty acids + 1 glycerol)

Proteins - CHON

- Largest organic molecules
- Hormones, enzymes, antibodies, structural proteins
- Protein monomer is an amino acid
- Amino acids joined by peptides into chains

Nucleic acid – CHON

- DNA and RNA

- Produced in nucleus
- Monomer is nucleotide
- Hold genetic information
- Recipe for proteins

Vitamins – CHO or CHON

- Manufactured or eaten
- Water or lipid soluble
- Essential for all metabolism
- Vitamin deficiency is non-infectious desease

Ions

- Phosphorus: in phospholipids and nucleotides including ATP
- Sulphur: forms bridges between parts of proteins
- Na, Cl, K: nerve cell function
- Ca: nerve cell and bones
- Mg: Cofactors for some enzymes (e.g. DNA polymerase)
- Fe: carries oxygen in Haemoglobin
- Iodine: needs to make hormones (e.g. thyroid hormos)

REMOVAL OF

- Waste products may hinder cell function or damage cells/enzymes
- E.g. CO_2 build up causes build up of carbonic acid and therefore blood acidity (bad for enzyme function)
- Cellular removal = diffusion, lysosomes, exocytosis

Waste product	Origin	Removal organ
Ammonia	Breakdown of amino acids in liver (deamination)	Kidneys
Urea	Ammonia gets converted to urea in liver	Kidneys
CO_2	Cell respiration	Lungs
Water	Cell respiration	Kidneys
Lactic acid	Anaerobic respiration	liver

Waste	By-product of	Eliminated by
carbon dioxide	cellular respiration	respiratory system
urea	digestion of proteins	excretory system
lactic acid	anaerobic respiration (lactic acid fermentation)	liver
hydrogen peroxide	many metabolic processes	peroxisomes
old organelles	over-use	lysosomes
ethanol (alcohol)	fermentation (in yeast and plants)	simple diffusion
hydrogen sulfide	anaerobic cellular respiration (in prokaryotes)	simple diffusion

PHOTOSYNTHESIS

- Occurs in chloroplast-chlorophyll i.e. all places green
- Occurs constantly in two types

Light dependent

- Water gets split up
- Makes ATP and NADPH

Light independent (calvin cycle) (uses CO_2, ATP and $NADH_2$ – from light dependent)

- CO_2, ATP, $NADPH_2$
- Makes glucose and water

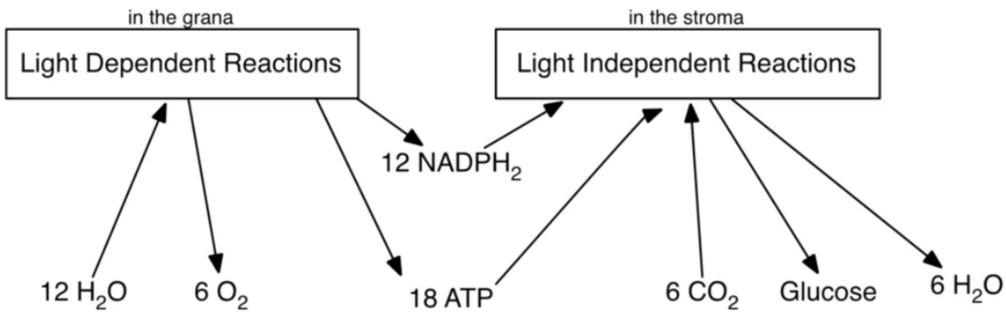
$$6CO_2 + 12H_2O \rightarrow C_6H_{12}O_6 + 6O_2 + 6H_2O$$

$6CO_2$: used in light independent reaction

12H2O: used in light dependent (yields 6O2, Hydrogens used in 12NADPH2)
ATP + NADPH2:

Overall process:

1. Absorbs light (photexcitation excites electrons) (Light dependent)
2. Electron transport (Light dependent)
3. Generation of ATP (Light dependent)
4. Carbon fixation into carbohydrates (Light independent)



CELLULAR RESPIRATION

Stages of Cellular Respiration

- The systematic breakdown of glucose.
- Occurs in stages:
  1. **Glycolysis** (without oxygen)
  2. **Krebs Cycle** (aerobic in mitochondria)
  3. **Electron transport chain** (aerobic in mitochondria)

The process results in **38 ATP**
Anaerobic makes lactic acid and occurs in cytosol
The energy is released when ATP → ADP

Glycolysis:

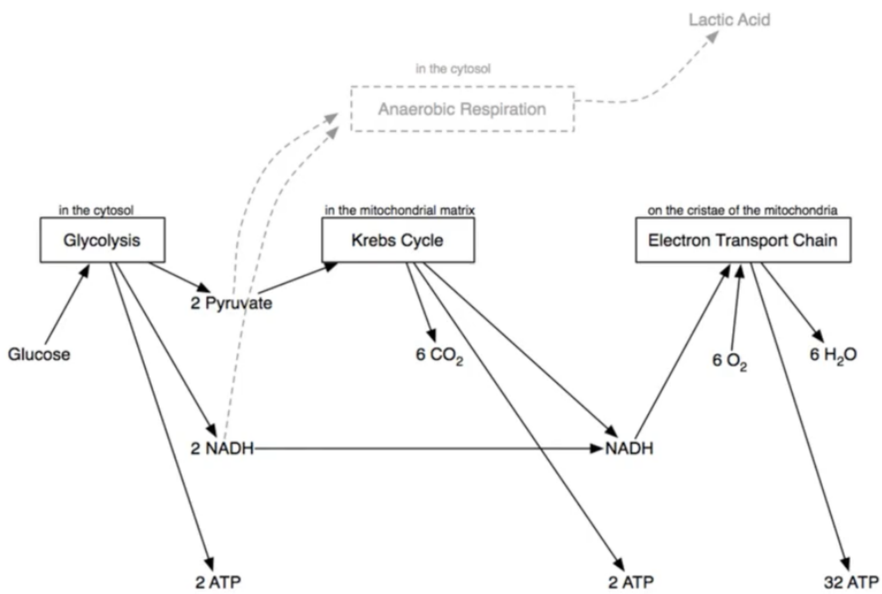
- Occurs in cytoplasm
- Makes lactic acid or ethyl in plants
- Forms carbon rich pyruvate molecules
- Occurs in cytosol/cytoplasm
- Pyruvate is formed from Glucose to transport carbon

Krebs Cycle: (or citric acid cycle)

- Uses pyruvate to make NADH and FADH2
- ‘throws away’ carbon and oxygen (waste products – CO2)
- Leaves hydrogen (held in NADH)
- Occurs in matrix of mitochondria

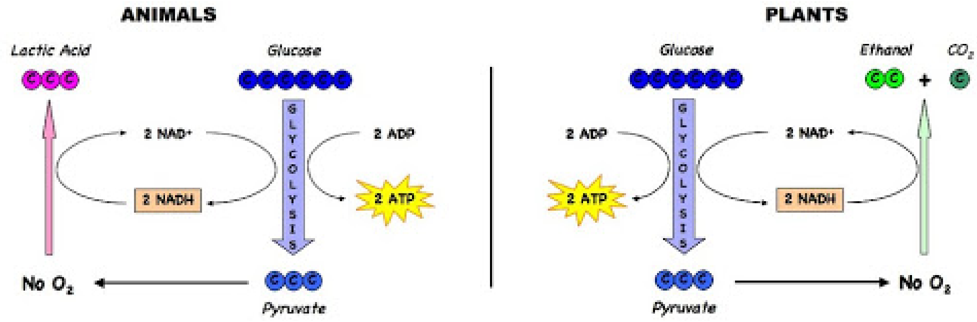
Electron Transport Chain:

- Makes 34 ATP using NADH and FADH2
- A hydrogen ion is passed from enzyme to enzyme along the cristae
- Each move makes 1 ATP



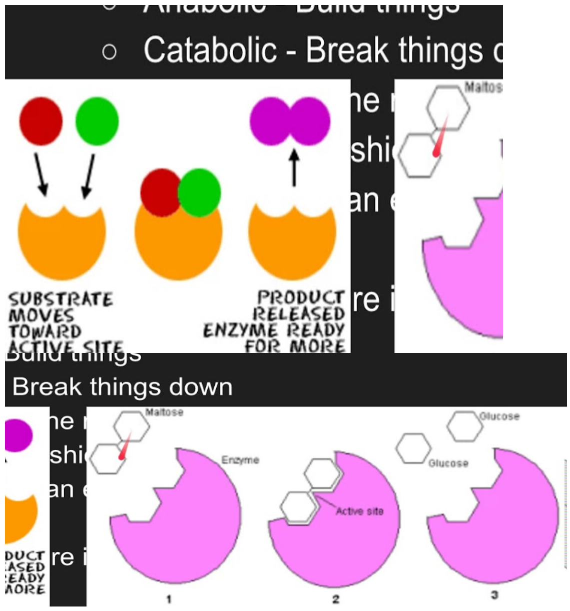
Fermentation in Yeast or Anaerobic Respiration in Animals:

- Creates ATP when O2 is not present (anaerobic)
- Produces ethanol or lactic acid as a by-product
- Makes 2 ATP (therefor MUCH less efficient)



ENZYMES

– **Metabolism –** a chemical process to maintain life. Each cell does thousands of metabolic processes

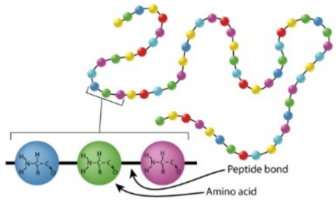


2 Types of enzyme reactions:

Catabolic: Breaking things down
Anabolic: building things up/joining together
→both are controlled by enzymes: **Biological catalysts**

Properties of enzymes:

- Globular and 3 dimensional
- Organic proteins
  - 1 or more polypeptide chain folded and coiled into specific shape (resulting in active site)
  - Held in shape by weak bonds so that heat can denature
  - Composite shapes are attracted to each other (active site vs substrate)

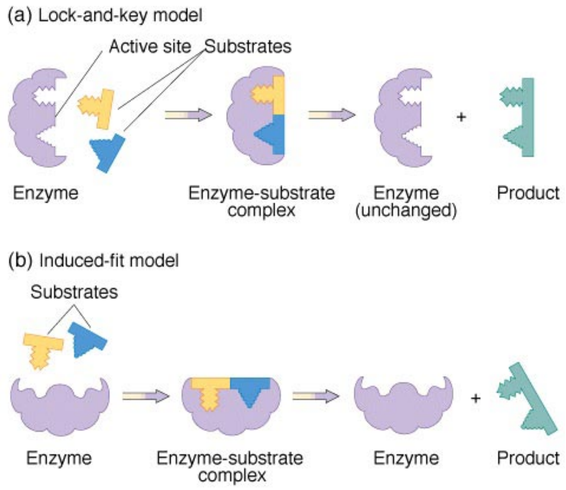


Lock and Key model:

- E.g. puzzle pieces or a lock and key
- Certain enzymes can only fit certain substrates (or a range of similar ones)
- Enzyme and substrate make exact fit
- Explains enzyme specificity

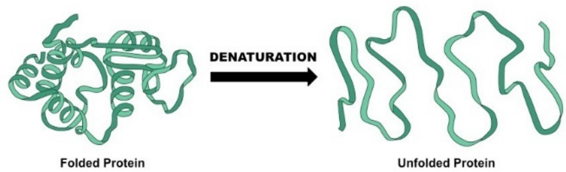
Induced Fit model:

- Substrate can subtly change the shape of the enzyme to fulfil function



Denaturation of Enzymes:

- Enzymes have a range of optimum conditions – Temperature, pH, Substrate concentration
- Denaturation (e.g. caused by heat) is usually permanent.

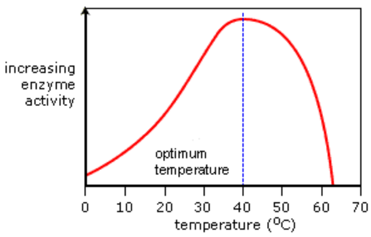


- Temperature: as temp rises above denaturation point individual amino acids in protein (in enzyme) vibrate. → causes break in hydrogen bonds. At extremely high temperatures peptide acid bonds in individual amino acids can break --> causing **protein fragmentation**
- pH: too low pH (too acidic) means too many H^+ ions (or OH^- in basic) are floating around, these can interact with amino acids and change enzyme/active site shape.
- Optimum conditions can vary: e.g. Pepsin in stomach works in acidic environment

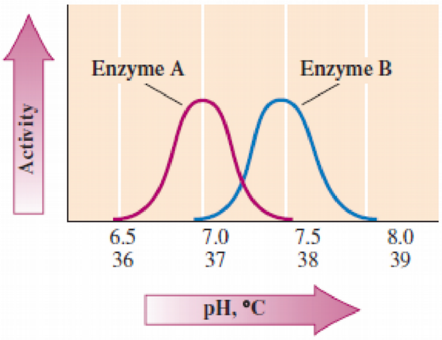
  Consequences of Denaturation:
- Disturbance of homeostasis (e.g. too much heat, pH or substrate concentration negatively effects protease's protein digestion)
- Shape changes (active site change stops enzyme function)

Optimum conditions:

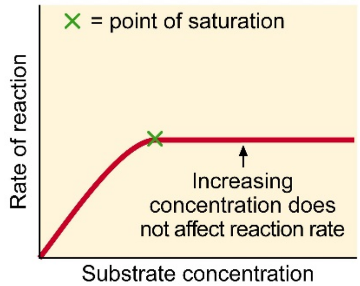
- Temperature:



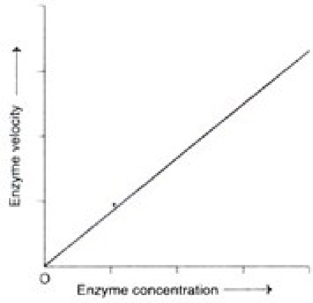
- pH:



- Substrate concentration:



- Enzyme concentration:



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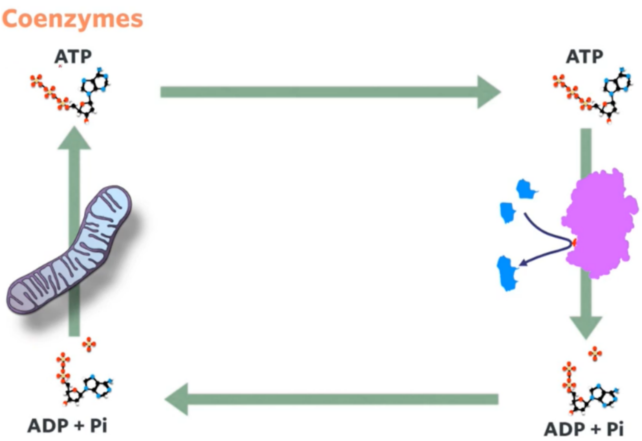
- **Enzyme Cofactors and Inhibiters:**

- Cofactors: Fits into the active site and encourages a better fit
  - Coenzyme: is a biological cofactor.
- Inhibiters: fits into active site or on enzyme and hinders substrate fit
  - Competitive Inhibition model: binds to active site and blocks substrate from binding
  - Non-competitive Inhibition: binds somewhere else on enzyme and changes its shape (including active site shape)

ATP as a Coenzyme:

- ATP→ADP gives the energy the reaction needs



Module 2: Organisation of Living Things

ORGANISATION OF CELLS

UNICELLULAR, MULTICELLULAR AND COLONAIL

- Organism: exists as a separate entity and has some functions of life, including:
  - Growth

- Obtaining nutrients
- Respiration
- Excrete waste
- Reproduction
- Respond to stimuli

TABLE 4.1.1 Features of unicellular, colonial and multicellular organisms

Unicellular	Colonial	Multicellular
single cell	many cells	many cells
mostly prokaryotes (and some eukaryotes)	eukaryotes	eukaryotes
one cell carries out all the functions to sustain life	individual animals (e.g. zooids) work together to perform functions to sustain the colony	cells are specialised to perform specific functions required by the organism
functions are carried out within the cell	functions are carried out by individuals (zooids) with specific roles within the colony	functions are carried out at cellular, tissue, organ and system level (some simple multicellular organisms function only at the cell or tissue level)
microscopic size—surface area to volume ratio limits size	usually macroscopic	macroscopic size—increasing the number of cells allows increased body size
short lifespan due to energetically expensive workload for one cell	long lifespan, as work and energy costs are shared by cells within the colony	long lifespan, as work is efficiently divided between specialised cells
mostly asexual, clonal reproduction	mostly asexual, clonal reproduction; sexual reproduction is present in some species	mostly sexual reproduction
whole organism is involved in reproduction	usually specific zooids are responsible for reproduction	only cells specialised for reproduction will reproduce (gametes)

	Unicellular	**Multicellular**	**Colonial**
Cell Type	Mostly prokaryotic	Eukaryotic	Euakaryotic
Cell size (um)	0.1-5	10-100	10-100
Cell membrane structure	Peptidoglycan with no sterols or carbohydrates	Lipid bilayer	Lipid bilayer
Organelles	n/a – no membrane bound organelles	Membrane bound	Membrane bound

Multicellular:

- Complex, many cell types
- Eukaryotic
- E.g. plants, animals, fungi

Colonial:

- Special form of life (unicellular or multicellular)
- Many organisms living together
- Generally same form of organisation
- Unicellular colonial – e.g. volvox

Unicellular:

- E.g. diatom or E. Coli

CELL SPECIALISATION

Example: embryonic development

Zygote→(mitosis) blastula/blastocyst (differentiation) → (once specialisation begins) embryo

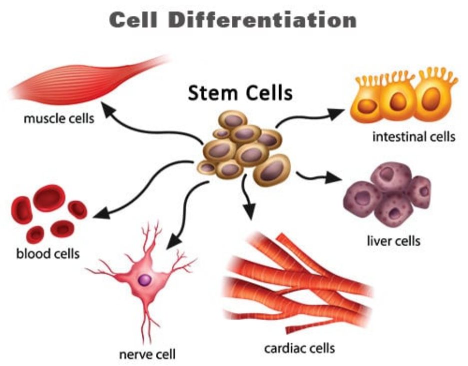
Embryonic stem cells differentiate into mesoderm cells, endoderm cells, ectoderm cells

Further differentiation:

- mesoderm cells – cardiac cells, smooth muscle cells, red blood cells, skeletal muscle cells, kidney tubules
- endoderm cells – lung cells, thyroid cells, pancreatic cells,
- ectoderm cells – epidermis, neuron cells, pigment cells.

- Stem cells are undifferentiated (meristem cells in plants)
- Therefore, are in abundance during early life (developing)

- **Differentiation**: during organism development, stem cells are instructed by specific gene expression. This causes them to differentiate into a particular type of cell (e.g. skin, bone, liver cells etc.)
- **Specialisation**: when the cell developed a specific function
- Differentiation drastically changes the shape, size, response to signals etc.
- Plant cells don't lose ability to differentiate after specialisation.
- Example of Differentiation:
    - Nerve cell: develop layer of fat for insulation, long branches – for fast signalling and conductivity
    - Muscle cells: long with lots of mitochondria to contract
- There are 220 types of human cells



HIERARCHY OF LIFE

Organelles >> cells >> tissue >> organ >> organ system >> organism

Examples:

- Multiple mitochondria >> cardiac muscle >> ventricular muscle >> heart >> circulatory system >> human
- Axon >> motor neuron >> motor nerve >> sympathetic nervous system >> nervous system >> frog
- Chloroplast >> spongy cell >> spongy mesophyll >> leaf >> foliage >> tree
- Beta Cell >> pancreatic tissue >> pancreas >> endocrine system >> organsim

AUTOTROPHS/PLANTS

There are two types of autotrophs:

- Photoautotrops – convert solar energy into chemical energy. E.g. plants, algae, some Protista, cyanobacteria
- Chemoautotrophs – use chemical energy from environment.

PLANTS

Divided into two groups:

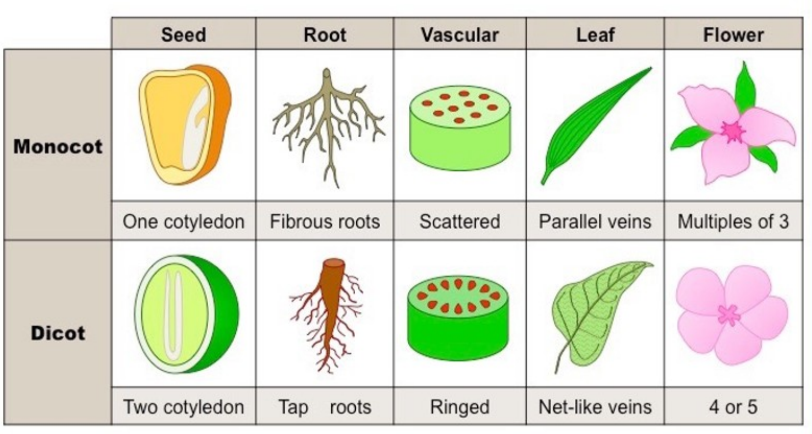
- **Vascular:** e.g. ferns, cycads, conifers, flowering plants (angiosperms).
    - has transport vessels – i.e. xylem and phloem
    - 3 types of tissue: vascular tissue, ground cells, dermal cells
- **Non vascular plants:** e.g. moss, algae

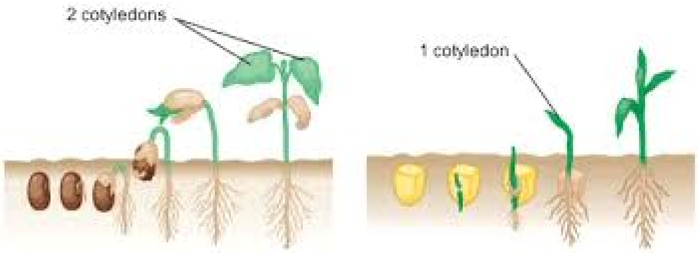
Plant Organs + Purpose:

- <u>Leaves</u>: photosynthesis
- <u>Roots</u>: anchorage, storage, absorption, conduction
- <u>Stem</u>: support, transport

Angiosperm Types:

- Monocotyledons (all grasses)
- Dicotyledons (broader leafed plants)

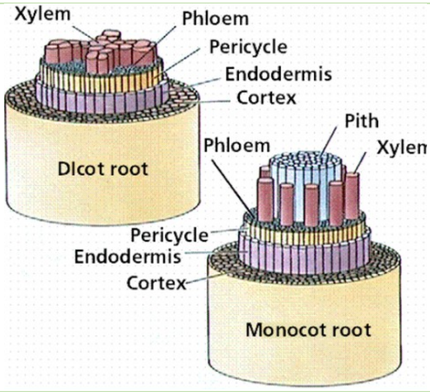
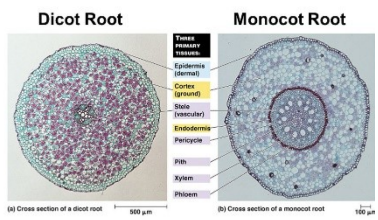




PLANT ROOT SYSTEMS

Function:

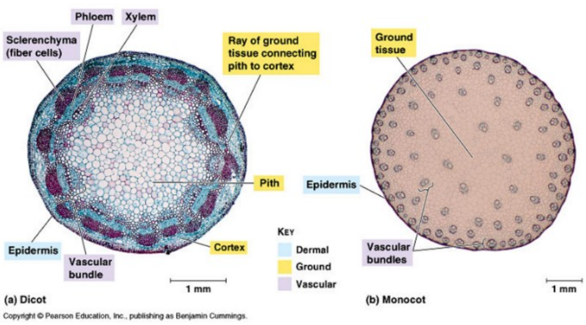
1. Anchorage:
2. Water and mineral absorption
3. Water and mineral conduction (transport
4. Carbohydrate storage

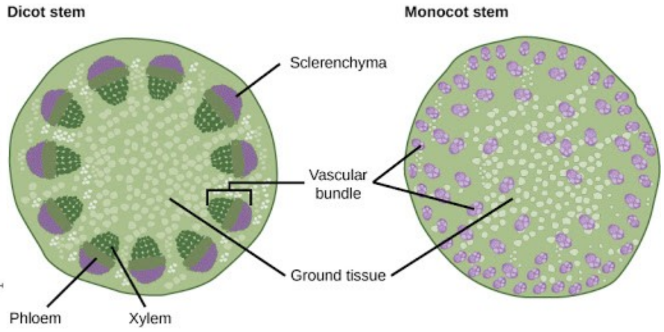
Monocots	Dicots
• **Have fibrous root system** • **Have xylem distributed in the 4 corners:**	• Have taproot system • Xylem distributed like a + with phloem in spaces
	

PLANT STEMS

Function:

1. Transport
2. Support





LEAVES

Function:

1. Photosynthesis

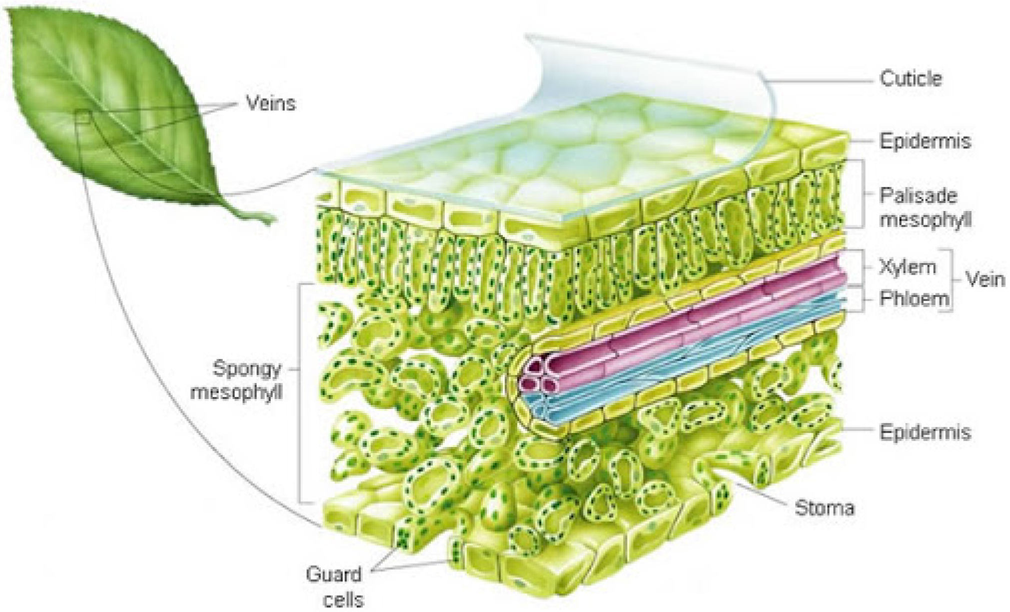
Paths into leaves:

Carbon Dioxide:

Enters through stomata >> through epidermis into mesophyll >> across cell membranes into cells

Water:

Through roots (osmosis) >> osmosis into xylem >> water up stem >> enters leaf (and leaves via stomates) >> into mesophyll >> into chloroplasts



Stomates:

- Usually in lower leaf epidermis
- Sometimes on young stems
- Composed of 2 guard cells and a pore
- Control intake and output of gases and closes to minimise water loss (transpiration)
- Guard Cells:
  - Open and close pores
  - Becomes turgid (open) at accumulation of Potassium
    - Higher concentration causes osmotic gradient and water flow in
  - Can photosynthesise – needs energy for active transport of potassium

OTHER STRUCTURES

Lenticels:

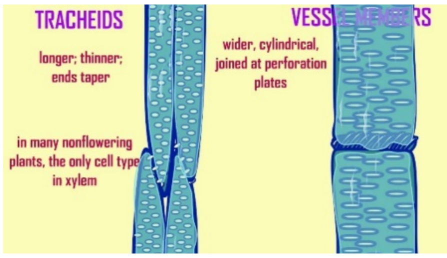
- Opening that allows O2 in and CO2 out in stems' cells
- Found predominantly on stems/trunks of fruit trees (i.e. cherries)

Pneumatophores:

- Areal roots found in swamps and estuaries
- Have pores for gaseous exchange
- Occur in very saline or anaerobic areas
- E.g. mangrove trees

XYLEM

- Uses **transpiration** to transport water and dissolved minerals/ions
- Transpiration – goes up, one way
- Water enters root by osmosis → into xylem →up to leaves



Structure:

- Xylem tubes are dead cells that form tubes
- Supported by lignin (which provides stability and support)

Transpiration: **TRANSPIRATIONAL FLOW THEORY**

- Passive flow of water due to pressure, osmosis, evapotranspiration (water lost through leaves) and properties of water
- USES TACT:
    - T – transpiration
    - A – adhesion
    - C – cohesion
    - T – tension (surface tension)

PHLOEM

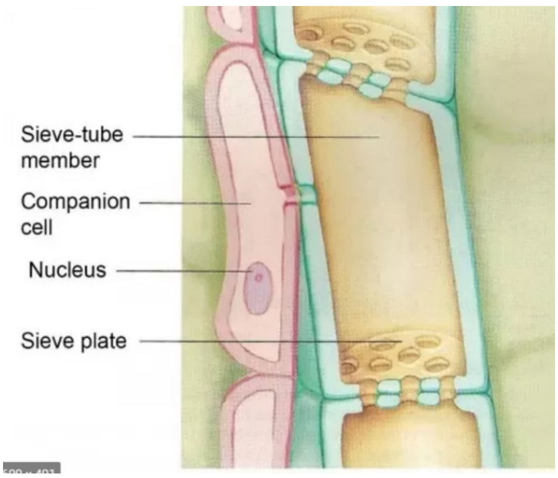
- Uses **translocation** to transport glucose, amino acids, hormones (in water)
- Translocation – goes to where its needed in any direction
- Relies on water from xylem to transport sugar (packaged in sucrose – i.e. 2 glucose molecules – for transport in vessels)

Translocation: **Pressure Flow Theory**

- Source to sink
- Glucose being used creates a pressure/concentration difference that causes flow in that direction from source (leaves – manufacturing OR roots – storage)

Structure:

- 2 types of phloem cells
    - Sieve tubes-
        - essentially a straw / pipe
        - highly specialised with no nucleus or organelles
        - this is to maximise translocation in lumen (hollow pipe)
        - have perforated walls
    - companion cells
        - contain mitochondria and ribosomes make the energy for active transport
        - connected to sieve tubes by plasmodesmata
        - undergo metabolic reactions to fuel sieve tubes



ANIMALS/HETEROTROPHS

Type	**Energy Source**	**Carbon Source**
Photoautotrophs	Solar	CO2

Chemoautotrops	Inorganic molecules	CO_2
Photoheterotrophs	Solar	Organic compounds
Chemohetertrophs	Organic compounds	Organic compounds

General respiration:

- thin membranes, large surface area, moist
- some small aquatics (e.g. sea sponges or flatworms) require no specialised respiratory organ, just diffusion.
- Larger animals need more efficient and complex gas exchange systems due to greater gas requirements

AMPHIBIANS

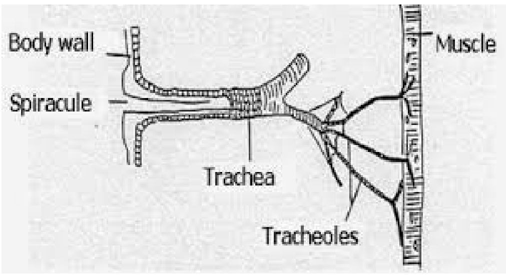
Respiratory system/gas exchange

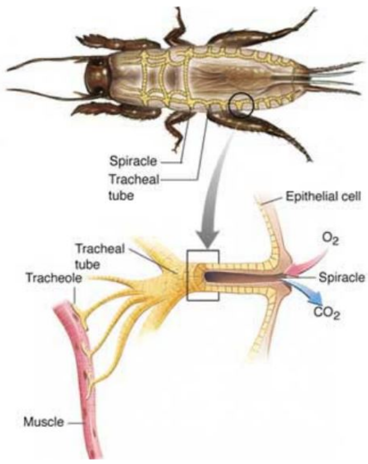
- surface gas exchange (although may have primitive lungs)
- pores in the skin increase surface area for gas exchange, moistened by mucosal glands

INSECTS

Respiratory system/gas exchange

- via a system of branching tubes called tracheal tubes
- the end of each tube contains a small amount of fluid, which the animal controls to regulate gas exchange by changing surface area in contact with cells
- directly into cells by fluid at the end of the tracheoles
- muscles contract to draw in oxygenated fluid and relax to release
- ventilation by constant rhythmic body movement
- spiracles are valves (no more than 8 abdominal and 2 thorassic pairs)

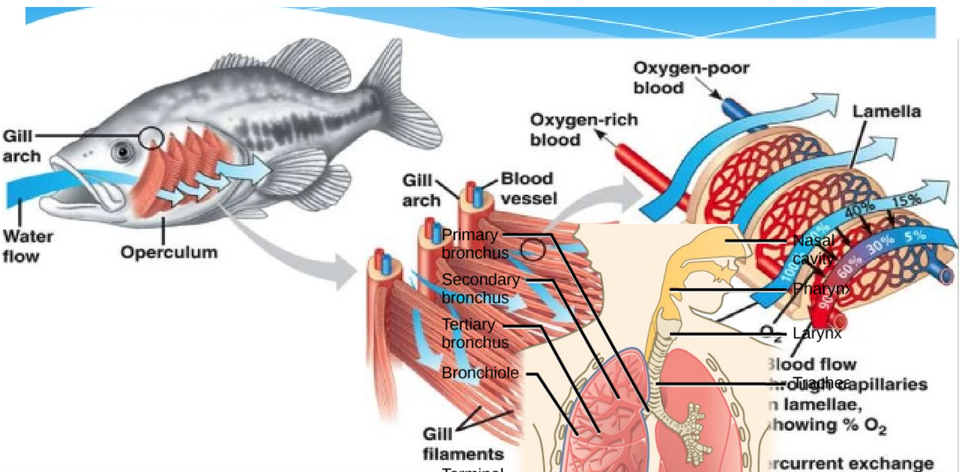




FISH

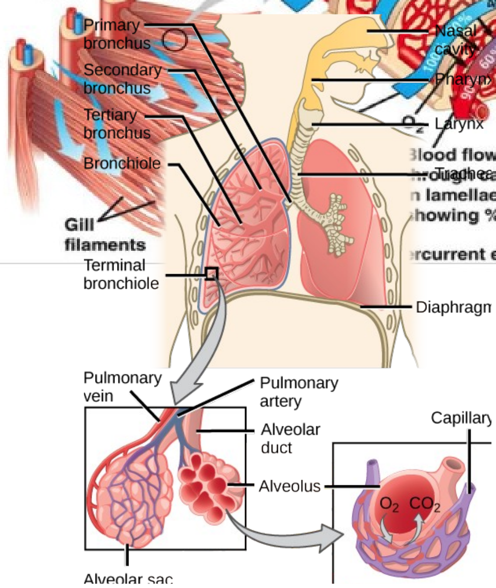
Respiratory system/gas exchange

- breathe oxygen dissolved in water using gills
- extract 80% O_2
- gills which are covered by operculum
- gill filaments made up of lamellae which hold capillaries
- large surface area and countercurrent blood flow (i.e. water and blood in opposite direction)



MAMMALS

Respiratory system/gas exchange



Digestive system

Diets in order of gastro. Complexity:

herbivores (high cellulose content) >> omnivores >> carnivores >> nectofeeders

Omnivore – e.g. human

- complex but not for cellulose breakdown
- monogastric
- medium length small intenstine
- underdeveloped cecum (region for microbial fermentation)
- relatively long large intestine/colon (some gut fermentation)

Carnivore – e.g. dog

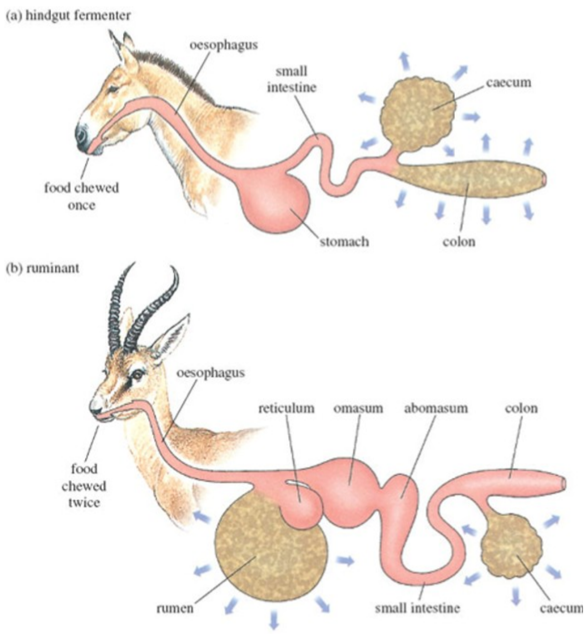
- guts for processing animal flesh
- underdeveloped cecum (region for microbial fermentation)
- very short and not very complex (short small intestine, short, simple, smooth large intestine/colon)

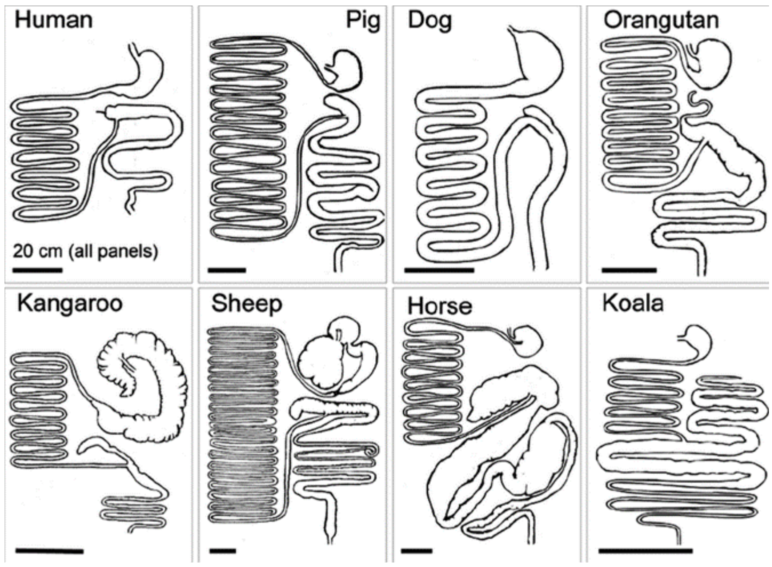
Herbivore: foregut digestion – e.g. cow

- **ruminant**: i.e. stomach is divided into large chambers
    - → including rumen for lots of microbial fermentation / digestion of plant materials-cellulose
    - Separation into chambers means longer time and therefor better digestion
- Short to medium cecum (most fermentation in rumen)
- Medium colon (no fermentation required)

Herbivore: hindgut digestion – e.g. rabbit

- Cecum is very large chamber for digestion of cellulose
- Shorter small intestine
- Very long large intestine





CIRCULATORY SYSTEMS

Open Circulatory System:

- E.g. molluscs, most arthropods (insects)
    1. Haemolymph fluid pumped by tubular or sac-like heart and by muscle movement
    2. Through short vessels into large spaces called sinuses
    3. Bathes cells (gas exchange via diffusion)
    4. Returns into heart through ostium holes

Closed Circulatory System, Single circuit:

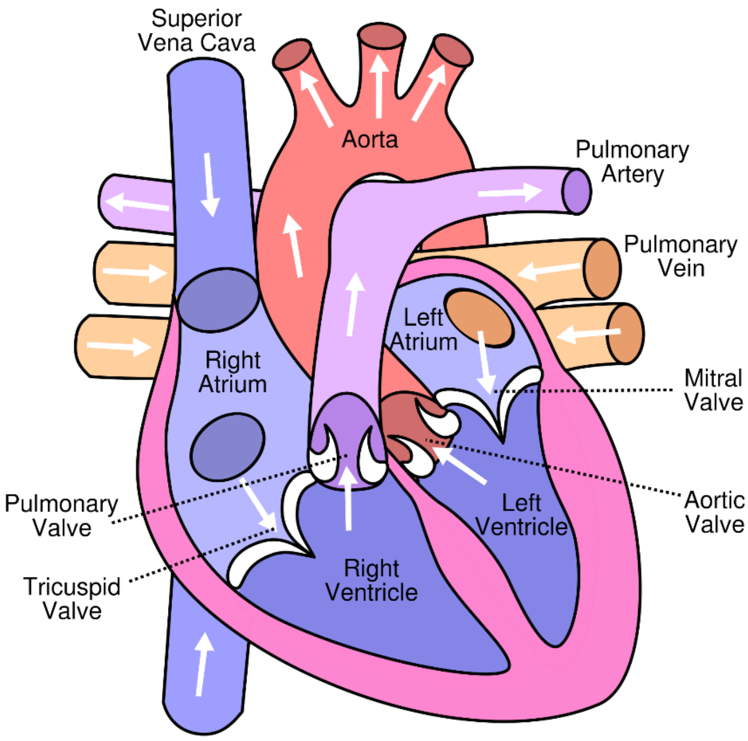
- E.g. fish, sharks
- Blood contained within vessels
- Relatively low pressure
- Does gills and rest of body in one circuit

Closed Circulatory System, Double Circuit:

- E.g. all vertebrates other than fish
- Blood pumped through a pulmonary circuit to lungs, oxygenated, and back to heart
- Then to rest of body

Path of blood through a human heart:

BODY > inferior and superior vena cava > right atrium > tricuspid valve > right ventricle > semilunar pump > pulmonary artery > LUNGS > pulmonary vein > left atrium > mitral valve > left ventricle > aorta > BODY



COMPONENTS OF BLOOD:

Erythrocytes (red blood cells) 45%

- Carry gasses
- 7 days for stem cell (from bone marrow) to specialise to red blood cell
- Biconcave disc with no nucleus (maximise haemoglobin-oxygen carrying capacity)
- Diameter: 7-8 um, thickness: 2um
- Last 100-120 days before broken down by liver and spleen

Leucocytes (white blood cells) >1%

- 5 specialised types involved in immune defence
- Have nucleus
- Diameter: 10-20 um
- Low numbers in healthy people

Platelets >1%

- Manufactured in bone marrow
- Smallest component of blood
- No nucleus
- Makes blood clot
- 7-14-day lifespan until broken down by spleen

Plasma 55%

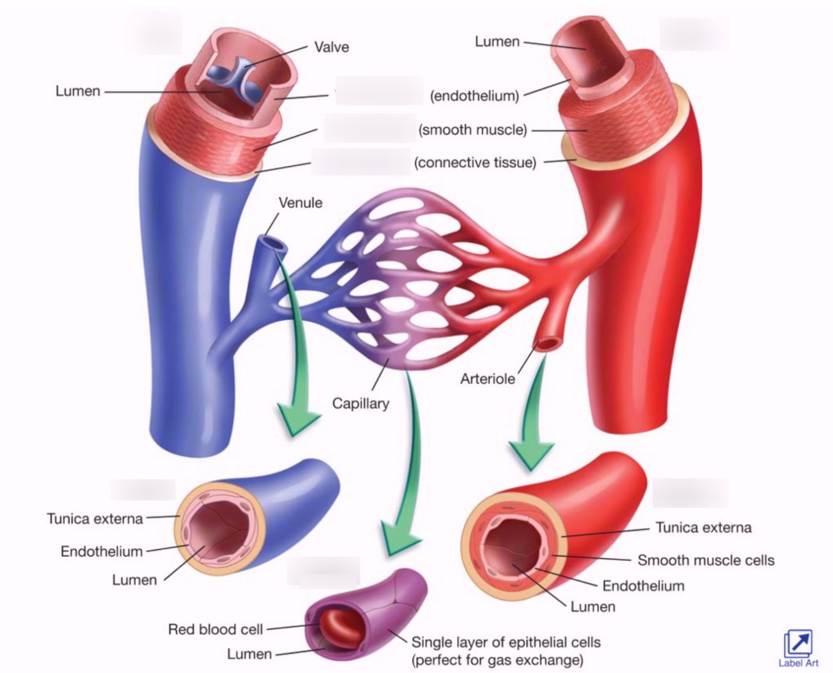
- Fluid to transport other components
- 90% water, 10% protein, antibodies, enzymes, salts, products of cell metabolism

Blood composition through the organs:

Organ | Waste	O2	CO2	Glucose	Urea (nitrog.waste)
Brain	Decrease	Increases	Decrease	Increases
Lungs	Increases	Decrease	Decrease	Increases
Liver (makes urea from ammonia)	Decrease	Increases	Decrease	Increases
Small intestine	Decrease	Increases	Increases	Increases
Kidney	Decrease	Increases	Decrease	Decrease
Muscles	Decrease	Increases	Decrease	Increases

BLOOD VESSELS:

	Arteries	Veins	Capillaries
Structure	• Epithelial layer • Elastic muscle wall • Same as veins but thicker	• Epithelial layer • Elastic muscle wall • Thinner than arteries • valves	• Single cell epithelial layer • 1 cell wide
Function	• Moves blood away from heart at higher blood pressure	• Blood towards heart	• Connects A. and V. • Direct site of diffusion



Module 3: Biological Diversity

SELECTION PRESSURES

Biotic Selection Pressures	
Competition	**Predation**
Disease	**Parasitism**
Land Clearance (anthropogenic change)	**Pollutants (Anthropogenic)**

abiotic factors

Abiotic Selection Pressures	
Physical	**Chemical**
Light availability	**Water supply**

Sunlight changes and affects climate (warmer at equator) **Effects growth of plants, colouration, migration, reproduction, metabolism, circadian rhythms (cycle of night and day behaviour -e.g. sleep at night)**	
Temperature **Hotter = higher transpiration, water deficiency, more evaporation (e.g. deserts, droughts)**	**Availability of gasses** Effect respiration and photosynthesis (e.g. mountains have less O_2)
physical forces (e.g. wind,waves) **Physically effect organism:** **Rain – could cause flooding or over watering. Cause excess water** **Tides – causes intertidal zones, differing levels of exposure.** **Wind – soil erosion**	**Ion supply**
Geological Structure/Topography **Influences climactic conditions** **(e.g. mountain tops are colder, more winds, less oxygen** **Can cause geographic isolation**	
Shelter/Space	

Selection Pressure: the effect of an environmental factor that differentially influences the mortality and fertility of members of a population with a certain phenotype. Selecting agent is cause of selection pressure.

e.g. cheetahs are selecting agent, predation by cheetahs are selection pressure.

CANE TOADS

- Introduced from Hawaii to North Qld (although native to central/south America) in 1935
- Introduced to combat cane beetle and frenchie beetle
- Cane toad (or Bufo Marinus)
- Very hardy, predator to insects and small prey
- Spread throughout northern aus. (move west 40-60 km/year)
- Forage at night
- Ground dwelling
- Eats terrestrial and aquatic insects and snails (and forages for things like uneaten pet food)
- Very successful at adapting and surviving aus conditions due to :
  - Rapid dispersal
  - Rapid reproduction
  - Highly adaptable
  - Lack of predators

Impact in Australia:

- Didn't control beetles
- Poisonous to any other animals (excrete bufotoxin from paratoid glands on back of neck)
- Caused a decline in predatory birds and reptiles (e.g. goannas and toad eating snakes – death adder, black snake)
- Competed with native animals
- Kills dung beetles (→ more sick cattle)

Selection Pressure on Cane Toads:

- very few selection pressures
- need water source to live and reproduce (→ found in high rainfall areas)

- prefer warm temps, but are adapting to tropical/subtropical

Evidence for Evolution in Cane Toads (frontier Species):

- accelerated rate of movement / 100m per day linear – rather than 10m directionless
- approx. 10% has evolved to have longer legs and spine
- →more successful reproduction
- Higher metabolism
- Negative: causes spinal arthritis in old age (limits movement)

- →frontier species breads with frontier species = **Olympic Village Effect** (are diverging rapidly from core population)

Native Wildlife Adaptations examples:

- Indirect: Black Headed Python species increased as cane toads killed predators
- Direct: some red belly black snakes diverged from main pop. To have smaller heads and mouths →eats none or small cane toads (which are less poisonous) (some become better at digestively neutralising poison)
- Behavioural: tree snakes and frogs avoid c.t.
- Behavioural: some crows and black kites kill c.t. by flipping them and attacking underside
- Behavioural: some dwarf crocodiles only eat hind legs

PRICKLY PEAR

- Native to South America – came to Australia in 1788 (first fleet)
- Introduced as food for cochineal beetle (which provided red dye)
- By 1925 was out of control in Qld and NSW
- Spread by birds by distributing indigestible seeds or cuttings from parent plant
- By 1912: 10 million hectares infested
- By 1920: 60 million hectares
- By 1924: Successfully combatted by cactoblastis moth's caterpillar which eats it
- →successful because once cactus died control species died

ADAPTATIONS

Adaptations: caused by DNA mutation + natural selection (anything that helps survival and therefore reproduction)

Structural: anatomical/morphological

Physiological: metabolic function

Behavioural: actions in response to the environment

Plant Adaptations:

- Temp, water availability, salinity are main selection pressures
- Halophytes are plants in extreme saline conditions
- Plants in cold conditions are deciduous or have anti-freeze proteins/mechanisms
- Xerophytes live in extreme dry

STRUCTURAL ADAPTATIONS

PLANT STRUCTURAL ADAPTATIONS:

Dry	Forests	Cold
Reduced leaf SA	Reduced SA (e.g. pine needles)	Thin bark
Fewer stomata	Leaf abscission (deciduous – leaf dropping)	Thick waxy leaves (prevent fungal growth)

Stomatal hairs create humid microclimate	Waxy cuticle	Drip tip
Sunken or protected stomata		Buttress (allow more nutrients absorbsion)
Rolled leaves		Epiphytes (grow on another plant)
Leaves orientated away from sun		

Leaves	Stems/Trunks	Root systems
Leaf shape (flat blade with a large surface area)	Thick bark	Extensive root systems
Thick waxy cuticle	lenticels	Deep root systems
Stomates on the underside of the leaf		Root hair cells
Sunken stomates (desert plants)		
Hairy leaves		
Needle like leaves/reduced leaves		

ANIMAL STRUCTURAL ADAPTATIONS:

- Body size and shape (inc. SA:V ratio)
- Body coverings (e.g. feathers, fur)
- Colouring (camouflage)
- Tails, flippers, flukes, fins
- Ear size
- Spines
- Dentition (teeth and beaks)
- Skeletal framework/exoskeleton
- Sensory receptors

PHYSIOLOGICAL ADPATATIONS

PLANT PHYSICOLOGICAL ADAPTATIONS:

adaptation to drought:

- Crassulacean acid (CAM) in photosynthesis:
- Adaptation to periodic drought
- Allows gaseous exchange to occur at night (cooler temps and less water vapour pressure deficit)

Adaptation to cold

- Antifreeze proteins / accumulation of solute →lower freeze point

Deciduous plants:

- Losing leaves – pauses photosynthesis to save water

Vertical orientation:

- Leaf and limb drop in dry climates →minimises direct sunlight →less water loss

Dark colouring and Horizontal orientation:

- Absorbs sun and heat

Stoma closure during day

- Prevents water loss

Vernalisation requirements for flowering

- Needs certain number of days at certain temp

Dormancy

- Part or whole of plant →little or no growth or metabolic function

Salt regulation (secretion and exclusion)

- Exclusion: filtered away at roots
- Secretion: from salt glands

TROPISM:

Caused by hormones, the orientation or response of plant (or lower animal) to a stimulus that acts with greater intensity from one direction

- Phototropism (light)
- Geotropism (gravity)
- Chemotropism (particular substance)
- Hydrotropism (water)
- Thigmotropism (mechanical stimulation)
- Traumatropism (wound or lesion)
- Galvano/electrotropism

Orthotropic = towards, diatropic = right angle to, plagiotropic = oblique

ANIMAL PHYSIOLOGICAL ADAPTATIONS:

Vasodilation/constriction

- Allows for thermoregulation
- Animal can survive wider range of temperature conditions

Camouflage/colour change: (physiological = pigmentation)

- Hide from predation

Disease resistance

Toxin Tolernece

Reproductive mechanisms

Osmoregulation

Enantiostasis (salt regulation e.g. estuarine organisms)

Counter current heat exchange

- Arterial blood heats venous blood
- Prevents heat loss
- E.g. birds feet in water

Oxygen storage

Bioilluminescence

Pheromone release

Torpor (hibernation, brumation, aestivation)

Nocturnal activity

BEHAVIOURAL ADAPTATIONS

ANIMAL BEHAVIOURAL ADAPTATIONS:

Migration

Reproductive behaviour

Territorial behaviour

Communication

Defence displays

Burrowing

Hive construction

Seeking shade

Evaporative cooling (e.g. red kangaroos lick paws – also causes vasodilation)

Huddling

Birds lifting one foot out of water

EVOLUTION

Evolution requirements:

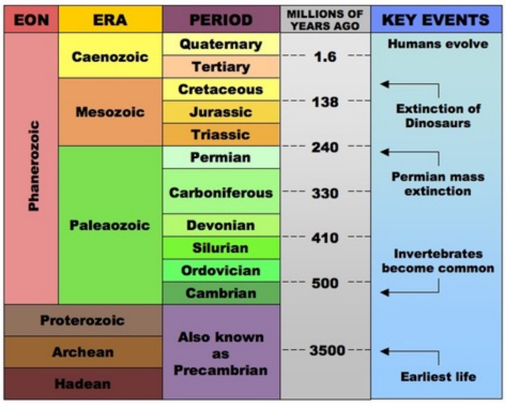
- Variation
- Selection Pressure

6 Steps to evolution:

1. Have variation caused by a random genetic mutation

2. A selection pressure is introduced - environment change(favours some with a specific allele)
3. Survival of the fittest (those suited reproduce and thrive)
4. Genetic frequency increases – reproduction causes those with desirable trait to become majority
5. Species continues to evolve (steps repeated)
6. Speciation

Geological Time Scale:



Hadean (hell like) – 4.5-3.8 b.y.a

Archaean – 3.8-2.5 bya

Cells started forming around ocean vents – chemosynthesis

Proterozoic – 2.5b-544 mya

Cells moved to shallower waters – photosynthesis started

Phanerozoic – 544 mya – now

Photosynthesis and atmosphere development → to current life

General early evolutionary changes:

- Prokaryotic →Eukaryotic
- Single cell →multicell
- Simple→complex
- Aquatic → terrestrial

Major Stages in Evolution:

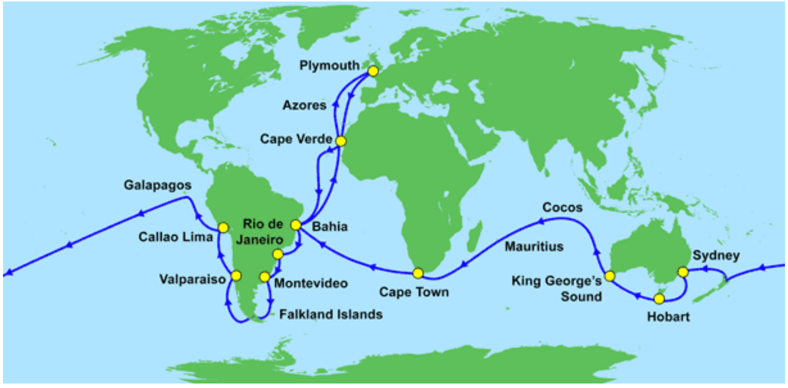
Formation of organic molecules	**4 bya**
Biological membrane formation	**4-3.5mbya**
Prokaryotic heterotrophic cell development	**3.5-2.5mbya**
Prokaryotic autotrophs (stromatolites)	**2.5-2 bya**
Eukaryotic cells	**2-1.5 bya**
Colonial organisms	**1.5-1 bya**
Multicellular	**1-0.5 bya**

THEORY OF EVOLUTION - DARWIN

Charles Darwin and Alfred Wallace proposed idea of natural selection

- Survival of the fittest
- Not all species were created in their current form but evolved from ancestral beings

Formed the theories on the **HMS BEAGLE** from 1831-1836



OBSERVATIONS:

- All species exhibited phenotypic variation between indiviuals (caused by spontaneous genetic mutation)
- All species produced more offspring than environment could support (only strongest survive and pass on their traits – traits become more prominent) e.g. turtles can lay up to 28,000 eggs
- The animals that struggled died
- Noticed regional variation (finches)

On travels Darwin noticed animals that had many differences despite fitting the same or similar ecological niches.

Australia (King Georges Sound WA, Hobart TAS, Sydney NSW, Bay of Islands NORTH ISLAND NZ):

- noticed the similaries between the Australian Platypus and English Water Rat – why they looked so different despite similar function and environment?
- Same with red kangaroo vs rabbit
- some birds were very different but crows and magpies were almost identical → Why?
- "Surely two distinct creators must have been at work"

Galapagos Islands (South American islands) FINCHES:

- Evolved from a single species on the mainland (called Blue-Black Grassquit finch)
- Specialisation: Once the finches settled on islands they adapted to differences in environment and diet (size, shape of beaks)
- Adaptive radiation: the diversification of a group of organisms

-

THEORY OF NATURAL SELECTION / BIOLOGICAL DIVERSITY

microevolution: change in a genome, or gene pool, for a given species in a relatively short time.

Reasons:

- **Mutation:** random genetic mutation
- **Migration:** can cause a higher concentration of mutation in geographic region → higher presentation in species → **Reproductive and Geographic isolation:**
- **Genetic drift:** by chance, more of the mutated gene is passed down than original
- **Natural selection:** favours mutated gene
- **Speciation:** forms new species

EVOLUTION OF THE HORSE

- Came from north America
- Disproven from orthogenesis (evolution in one direct goal by an internal driving mechanism)
- Change in dentition: indicative of carnivours → modern herbivorous)
- Legs became more specialised (still pentadactyl limb) and longer to run faster
- Toes fused and number of hoof parts decreased to adapt to hard ground
- Skull shape changed
- Have a transitional series (group of fossils showing microevolution)
- Related to tapirs and rhinos
- Got bigger with evolution as number of natural predators decreased and food sources increased

EVOLUTION OF THE PLATYPUS

- Geographic isolation causes them to get smaller as you go north
- Venomous mammals
- Have 5 X and 5 Y chromosomes
- Earliest offshoot of mammalian family tree
- Have reptile like features
- Platypus (and 4 echidna species) are last monotremes
- Diverged from main mammal lineage around 165-180 mya
- Soft leathery eggs
- Lactate pores in skin
- Vernoumous spores (in males as females don't hunt)
- Bill can detect electrical impules
- Evolved when Australia, South America, and Antarctica were connected
- Egg yolk proteins are shared with reptiles and fish
- Reptile like cloaca (multipurpose excretory and sexual hole)
- Give birth to eggs: non placental
- Snake venom vs. platypus venon = convergent evolution
- Teeth replaced with horny pads (diet change)

CONVERGENT EVOLUTION

two species within a similar ecological niche conditions evolving similar features (e.g. sharks and dolphins – colouration, fluke and fin, streamline shape)

analogous structures: same purpose but difference structure, e.g. insects vs birds wings

DIVERGENT EVOLUTION

one species experiencing different environmental pressures (migration, geographical isolation) developing differences (e.g. darwins finches – beak shape, size, etc)

homologous structures: same shape and structure but difference purpose, e.g. pentadactyl limb, e.g. vestigial pelvis and leg bones of whale

PUNCTUATED EQUILLIBRIUM

Punctuated equilibrium: rapid change followed by long change of consistency – replace ancestoral species

e.g. crocodiles evolved and then remained largely unchanged

Opposite of Darwin's gradualism

P.E. can explain some evolutionary pathways when fossil records are incomplete (missing links)

Catastrophism: a mechanism for/sub-component of P.E. – natural disasters cause sudden change as new species fill the ecosystem

EVIDENCE FOR EVOLUTION

TRANSITIONAL FORMS

e.g. archaeopteryx (reptile to bird)

e.g. lobe fin fish (fish to amphibian)

DATING

Relative dating – lower layers are older (based of stratigraphy and law of superposition)

Absolute dating – based off isotope decay. Ration of parent to daughter isotopes

Indicator fossils – define geological time period. E.g. tryolobytes across all pangean continents

PALAEONTOLOGY

Fossilisation: any elements of the past

- Hard body parts more likely to fossilise
- Often in sediment

Types of fossilisation:

- Petrification
- Moulds – impressions
- Casts – sediment filled mould
- Mummification
- Ice/amber preservations
- Hard original parts (e.g. bones)
- Imprints (footprints, burrows, droppings)

Requirements for Fossilisation:

- Rapid burial – not subject to scavengers
- Little decay
- Little or no disturbance of sediment
- Erosion in order to find fossils

Whale: whales fossils have been used to identify vestigial leg and pelvis – ankle similar to that of bison, indicates common ancestry

BIOGEOGRAPHY

- Geological distribution of species (past and present)
- Evidence for continental drift
- Past: Gondwana fossils found across continents
- Present: ratites (i.e. flightless birds) in the southern Gondwanan countries (Aus. – Emu, cassowary; N.Z. – kiwi, rhea; South Africa – ostriches

COMPARATIVE ANATOMY

- Similarities between different species

Homologous structures indicate shared ancestor (convergent and divergent evolution): structures that have been modified for different environments. E.g.:

- Pentadactyl limb
- Seed structure
- Vestigial structures
- Vertebrate heart and brains

COMPARATIVE EMBROLOGY

All vertebrates look very similar in embryo

All have gills and tail at some point

Some genes have been switched on/off at some point

Gene cascading = order in which stuff develops (e.g. head to toes) (gene cascading happens in same order)

BIOCHEMISTRY

All organism have similar cell structure and function

Similar organic compounds, method of heredity, cell function, enzyme production, DNA

Amino acid analysis = More similar the amino acid sequences the later they diverged

DNA analysis = specific nucleotide not just amino acid (group of 3)

DNA hybridisation = heat DNA to unzip its helix structure, then combined with single strand of other organism and see how closely they rezip together

Chromosomal comparison = gene position / gene loci →compare location of certain genes

Molecular clocks = genetic mutation occurs at a relatively constant rate. Therefore number of genetic differences is proportional to time since evolutionary divergence. (used to make **phylogenetic trees)**

MICROEVOLUTION

since 1940 antibiotics have been used lots in medication, animal feed, plastic

overuse and overperscription causes antiobiotic resistant super bugs

Rapid Evolution

- Quick genetic selection of favourable traits
- Occurs in rapid reproductive species
- Often anthropogenic

Peppered moth:

- Colour change caused by industrial revolution (it changed colour of tree lichen)

Insecticide resistance

- Some DDT resistant mosquitos live and reproduce

Rabbits in Australia

- Resistance to myxamatosis (control agent) grew

Module 4: Ecosystem Dynamics

- **Ecosystems-** All the organisms in a particular environment and how they interact with other living and non-living components.
- **Ecology:** the study of relationships living things have with their environment and each other
- Ecosystems can range in **size** and **locality** and can sometimes be distinguished by boarders, for example the pond ecosystem at school, or where a rainforest meets the sea.
- The difference between ecosystems lies in biotic and abiotic factors found there → *e.g. species and conditions of rainforest are dramatically different to desert ones.*

Types of Terrestrial Ecosystems in Australia:

Terrestrial ecosystem	Appearance	Description
Desert		■ Annual rainfall is low, <250 mm ■ High temperatures through the day (approx. 40°C) and cold temperatures through the night (approx. 0°C) ■ Often sandy soil, sometimes rocky ■ Typical organisms include sparse grasses and saltbushes; the spinifex hopping mouse; insects, lizards and snakes
Grassland		■ Annual rainfall 250–750 mm ■ Temperature can be hot or mild ■ Typical organisms include grasses (e.g. spinifex), kangaroos, rabbits and snakes
Shrubland		■ Annual rainfall 200–400 mm ■ Temperatures are hot ■ Typical organisms include mallee trees, mulga; kangaroos, rabbits and snakes
Woodland		■ Annual rainfall 400–750 mm ■ Temperature can be mild, and sometimes hot ■ Canopy cover 10–30% ■ Typical organisms include grasses, shrubs, eucalypt trees, mice, birds, insects, spiders and wallabies
Temperate forest		■ Annual rainfall >750 mm ■ Temperature is mild ■ Canopy cover 30–70% ■ Typical organisms include eucalypt trees of various types
Rainforest		■ Annual rainfall >1500 mm ■ Air is humid and temperature can be hot or mild ■ Canopy cover is dense (70–100%) and layers (strata) develop (i.e. canopy, understorey, forest floor) ■ Typical organisms include a diverse number of habitats and species (e.g. birds nest ferns, palms, lianas, bracken ferns, leaf litter organisms)

Ecological Hierarchy: population > community > ecosystem > biome > biosphere

Main Distinguishers: the main abiotic factors that influence the types of species are **Heat** and **Water Availability**

Glossary:

Term	Definition
Abiotic	Non-living features—physical and chemical factors (e.g. temperature, rainfall, salinity)
Aquatic environment	An environment existing mainly in water: freshwater, saltwater or both
Biome	Large regional system characterised by major vegetation type (e.g. desert); region of earth with similar ecosystems grouped together
Biosphere	The part of the earth and atmosphere in which living organisms are found
Biotic	Living features—all living things (e.g. numbers, distribution, interactions)
Community	Groups of different populations in an area or habitat
Ecology	Study of the relationships living organisms have with each other and their environment
Ecosystem	A community together with its environment: any environment containing organisms interacting with each other and the non-living parts of the environment (e.g. rainforest, freshwater pond)
Environment	Both living (biotic) and non-living (abiotic) surroundings of an organism
Habitat	Place where an organism lives
Niche	Place of a species within a community involving relationships with other species
Organism	Living thing (e.g. plant, animal)
Population	Group of organisms of the same species living in the same area at a particular time
Species	Groups of similar individuals that can reproduce fertile offspring (e.g. kookaburra, snow gum)
Terrestrial environment	An environment existing mainly on land

POPULATION DYNAMICS

ABIOTIC FACTORS

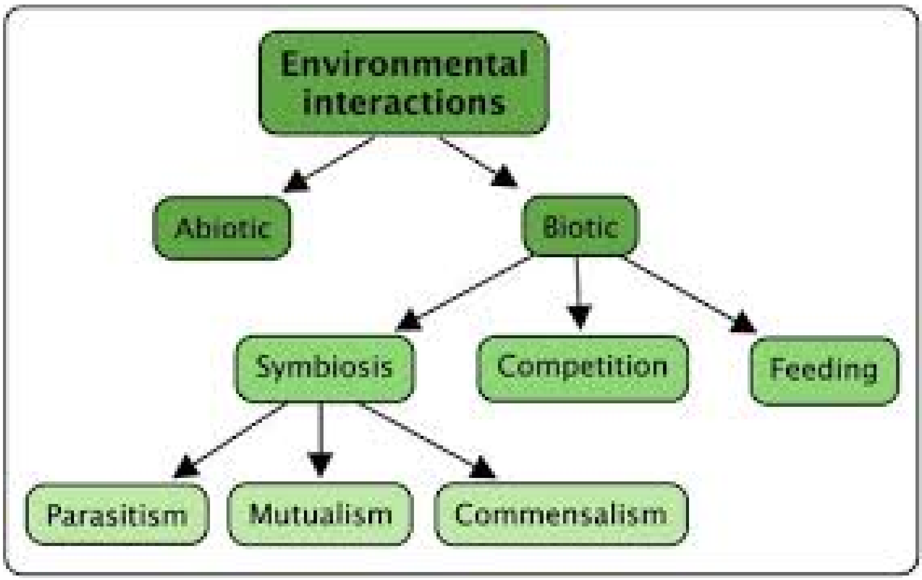
- Abiotic factors can be divided into **chemical** and **physical**

	Green = Effect on / relationship with Biotic	*= best 4 examples
Abiotic Factor	***Aquatic Environment***	***Terrestrial Environment***
Temperature*	- Small, more gradual changes only - Depends on size (large bodies of water = constant, small = variable) - Much easier for animals to adapt to constant temp than variable temp on land. - Aquatic animals lose heat more quickly - Water organisms with higher body temp. than water temp must have insulating adaptations	- Highly variable, up to 20°C in 24 hours (or 40°C in deserts) - Experiences seasonal variation - Experience lapse rate (1000m ↑ = 1 degree lower) - Adaptations to cope with significant changes.
Pressure*	- As depth increases pressure does too. - Deep sea organisms need adaptations to survive the crushing water pressure.	- Small variations due to altitude or weather.
Light Availability*	- Surface reflects up to 55% of light up to 1m. - 1% of light reaches 100m - Position of sun affects it, sun directly above = more light, vs large angle (sunset or certain time of year) = less - Wavelengths are separated - Cloud cover and increased turbidity affect amount of light that penetrates. - Aquatic organisms must adapt.	- Abundant - Only slightly hindered by cloud cover
Landscape position	- Slop and aspect of surrounding landscape may affect light availability and temp. - May effect tides, currents, waves.	- Slope and aspect temp., light, and water, and soil quality. - Run off and erosion causes dramatic environmental changes
Gases (O_2 and CO_2)	- O_2 and CO_2 dissolve into water with contact. Movement = more air, river rapids has more than pond. - As temp ↑ amount of gas ↓ - Aquatic organisms need adaptations to gas availability	- Found in abundance
Rainfall and	- Water constantly available	- Water must be sourced from soil

water availability	- Organisms must have adaptations to type (fresh or salt water) to keep water balance	or consumed - Adapt to amount of water e.g. cactus
Salinity and Ions	- Ions in abundance, distributed by current to different depths. - Freshwater – water moves freely into organisms, must be removed (osmosis) - Saltwater – water moves out freely, must be replaced (osmosis)	- Different soils have different salinities (amounts of ions dissolved in the soil moisture) - Plants must adapt
pH	- pH varies due to organic material and dissolved gasses. - CO_2 dissolved lowers pH – acidic	- Can vary greatly - Largely determined by dissolved salts - Plants must have adaptations to soil pH
Buoyancy*	- Water is much more buoyant and supportive than air. - Hold up organisms and maintain its shape	- Almost no buoyancy. - Animals need supportive structures i.e. skeletons
Viscosity	- Water is much more viscous - Animals adapt move easily - streamlined	- Air provides less resistance
Exposure to natural forces	- Marine ecosystems cope with strength of tide, currents and waves. - Freshwater ecosystems cope with strength or water flow after rain.	- Different terrestrial environments are exposed to different levels of wind and rain depending on weather/climactic patterns and seasonal changes. - Can be extreme, e.g. floods, droughts, cyclones.

*90% of aquatic life lives in the first 300 m called the **epipelagic zone**

BIOTIC FACTORS



Biotic interactions:

- **Interspecific** → between different species within an ecosystem
- **Intraspecific** → between the same species

<not all of these are trophic encounters (animals competing for food) but can be regarding light, space, etc>

Symbiosis → Biotic influences and interactions that have close species contact

Occasional Relationship → is not a constant activity but only happens rarely → *e.g. predation/competition, a lion chasing its prey, can live together when the lion isn't hungry.*

Types of species interaction:

Mutualism: both species benefit from the association → *e.g. Tick bird on Zebra removes parasites and alerts the zebra to danger, tick bird gains food. → bees and flowers, pollination and food. → bacteria in our gut, help us digest and we feed them. → animals eating fruit, gain food and disperse seeds.*

Commensalism: one species' presences benefits the other but it remains neither harmed nor benefited → *e.g. perching plants (epiphytes) gain access to better light without harming the host tree. →remoras riding on sharks and gaining food, shark unaffected*

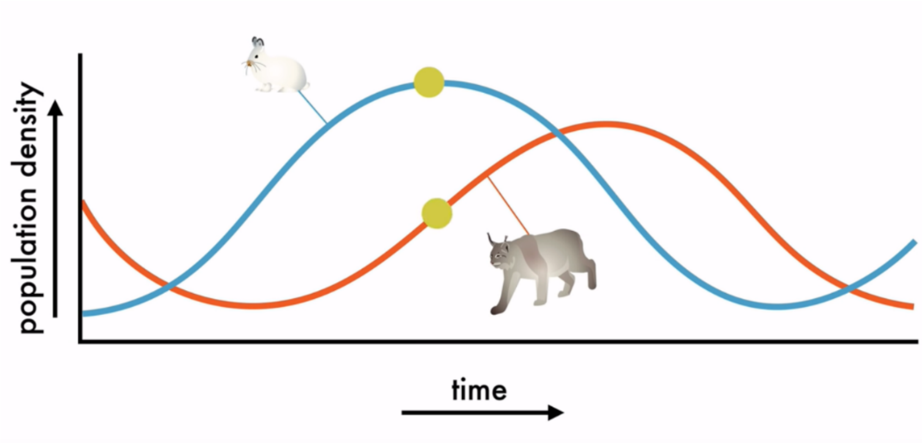
Amensalism: The presence of one species harms the other, but it remains unaffected →*e.g. grazing mammals trample plants around watering holes, plants die, animals unaffected.*

Exploitation:

Predation: predators kill prey

Herbivory: usually does not kill the plant

Parasitism: parasite usually does not kill its host, uses it. →*e.g. parasitic wasp lays eggs in caterpillar. → Tapeworm inside an animal stealing its food source and making it sick. →*



Antibiosis: one species benefits by producing a compound (alkaloid, phenol, antibiotic) which inhibits the growth of another organism. →*e.g. **allelopathy:** a plant releases a toxic compound into the ground that prevents nearby growth, less competition.*

Competition: species or individuals compete for the same resources, both suffer. Competition occurs when animals inhabit the same niche. Competition is most intense in intraspecific relations because they share the exact same requirements→*e.g. plants growing close to each other compete for light and soil nutrients.*

It results in either:

Resource Partition: the mutual, trust-based agreement to share.

Exclusion: one species 'wins' and the other species is derived from resources until it dies out. "no two species can sustain coexistence if they occupy the same niche" – Gause Principle

Type of Interaction	Effects	Examples
Mutualism	+ Species A benefits ⟷ Species B Benefits +	→ *e.g. Tick bird on Zebra removes parasites and alerts the zebra to danger, tick bird gains food.* → *bees and flowers, pollination and food.* → *bacteria in our gut, help us digest and we feed them.* → *animals eating fruit, gain food and disperse seeds.*
Commensalism	O Species A Not Affected ⟶ Species B Benefits +	→*e.g. remoras riding on sharks and gaining food, shark unaffected* →*epiphytes climbing trees*

Amensalism	**O** Species A Not Affected → Species B Harmed **-**	*→e.g. grazing mammals trample plants around watering holes, plants die, animals unaffected.*
Exploitation	**-** Species A Harmed ↔ Species B Benefits **+**	*→e.g. parasitic wasp lays eggs in caterpillar.* *→ Tapeworm inside an animal stealing its food source and making it sick.*
Antibiosis	**+** Species A benefits → Species B Harmed **-**	*→e.g. **allelopathy:** a plant releases a toxic compound into the ground that prevents nearby growth, less competition.*
Competition	**-** Species A Harmed → Species B Harmed **-**	*→e.g. plants growing close to each other compete for light and soil nutrients.*

Feeders:

Autotrophs/producers: all species that do not rely on others as a source of energy, they rely on photosynthesis and chemosynthesis

Heterotrophs/consumers: all animals that must obtain energy and nutrients from living sources.

Detrivores: eat organic waste such as dead leaves or carcasses, eat detritus (dead organic material)

Omnivores: eat both meat and plants

Herbivores: eat plants

Carnivores: eat meat

ECOLOGICAL NICHES

A **niche** is the place of a species within a community involving relationships with other species. It is the role and position a species has in its environment.

Competition occurs more **frequently and intensely in intraspecific relationships** as they share the same requirements and niche. Interspecific competition is less intense and common as different species adapt to have **slightly different requirements**.

Species with similar ecological requirements may reduce competition by **exploiting microhabitats** within the ecosystem or exploiting the same resources at **different times**.

A niche contains multiple components:

- Habitat
- Activity patterns
- Resources
- Interactions that occur with other species
- Interactions with abiotic factors

Resource Partition: the mutual, trust-based ‘agreement’ to share.

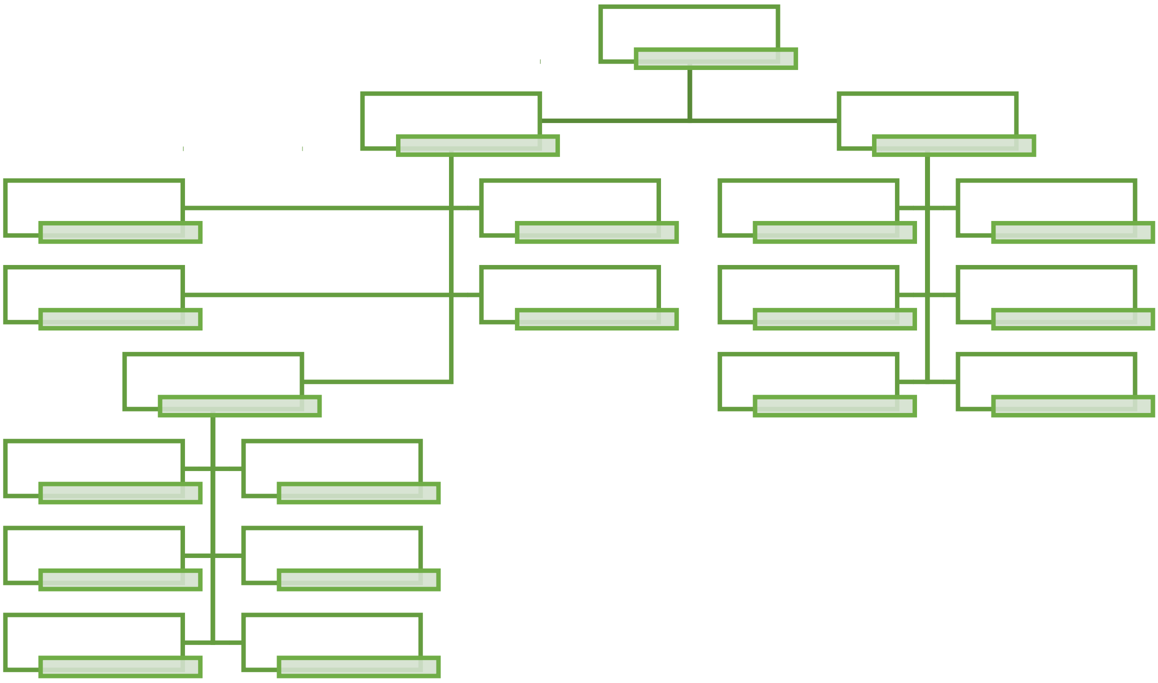
Exclusion: one species 'wins' and the other species is deprived from resources until it dies out. "no two species can sustain coexistence if they occupy the same niche" – Gause Principle

Inter/intra specific competition effects:

- Reduced growth
- Inability to reproduce
- Death
- Emigration

CONSEQUENCES

Population Dynamics: How and why populations change in size and age over time.



Density Dependant Factors:

- Effect of factor will increase as population density increases
- Carrying capacity is influenced
- Influence births and deaths in population

Density Independent Factors:

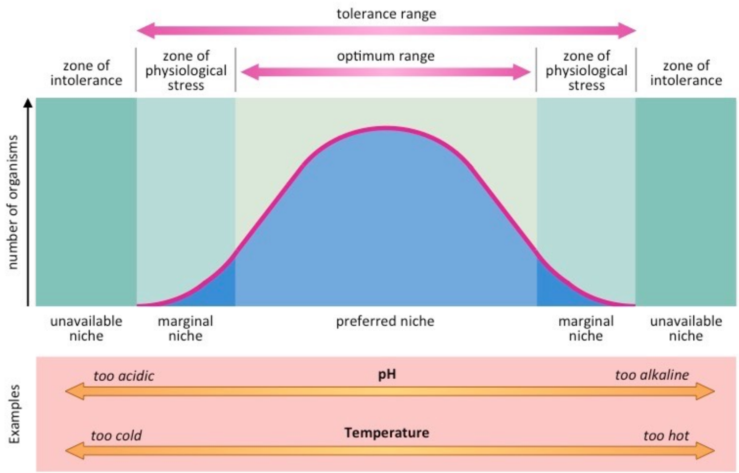
- Impact population regardless of density

Tolerance Range: the range of each abiotic factor that a species can endure. (for example a species can survive a 1°C temp change as it lies in its tolerance range

Optimum Range: lies within the tolerance range, the best possible conditions for the consistent growth of a population

Suboptimum Range: Not ideal but survivable. Population size often decreases.

Limiting factor: The scarcest of the necessary resources

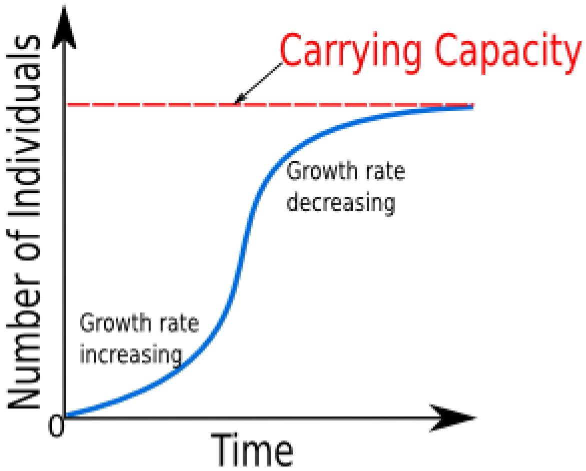


Carrying Capacity: is the maximum population size that ecosystems can sustain indefinitely for a certain species while the species is in equilibrium (not growing or declining)

The carrying capacity is dynamic and is influenced by :

ABIOTIC	- Soil - Water - Space - Shelter
BIOTIC	- Fluctuations of prey species - Fluctuations of predator species - Fluctuations of competitors

Logistic Growth: the initial exponential growth of a population → flattens out as it begins to be affected by density dependant factors (→population may decline to equilibrium and the population remains at the carrying capacity)



MEASURING POPULATIONS

Population: Group of organisms within the same species

Population change: is a combination of Birth, Death, Immigration (in), Emigration (out)

Population Growth = Births – Deaths + Immigration – Emigration

Distribution: the area that a species occupies

Abundance: the number of individuals in that species

Types of Sampling:

Method	Procedure	Uses	Considerations
Point Sampling (distribution) **Used in terrestrial or reef / floor aquatic**	Individual points on a map are chosen (randomly or regularly) and the organisms at those points are counted	Determining the range of organisms that live in an area and how common	- Time efficient - Little disturbance to environment - Rare organisms may be missed
Transect Sampling (distribution and abundance) **Used for vegetation, stationary slow moving organisms(land and sea)**	**Line transect (Distribution)**- Lines are drawn on map, vegetation on line sampled **Belt transects (abundance and distribution) –** Counted aswell either side of line for set distance	Determines how the community changes in an area and how common organisms are	- Time efficient - Little disturbance to environment - Rare organisms may be missed - Only suitable for slow moving or stationary organisms
Quadrat Sampling (Abundance) **Slow moving or stationary organisms - land and sea**	Sampling squares(usually), rectangles or circles (quadrants) are placed in a grid pater on the sample area and the occurrence of organisms in each quadrant is noted - More quadrants = more precise - Size of quad. relates to size and abundance Based of assumption that there is even distribution of species	Determines range of organisms living in an area and how common Good for large areas	- Time consuming - Only suitable for slow moving or stationary organisms - Little disturbance to environment
Mark-recapture (tag-recapture) (Abundance) **Fast moving mobile animals**	Animals are captured > marked > released. After time period population is resampled using same method	Determining population of highly mobile species →*e.g. birds or possums.* Movement of individual can be tracked	- Time consuming - Not suitable for slow moving / stationary organisms - Marking of animals should not affect their behaviour or movement

Mark Recapture technique FORMULA/METHOD:

1. Capture and tag certain amount. Initial amount tagged = **T**
2. Release and recapture. Calc: **T** × **C** / **M** **= result 1** When **C** = amount captured second time. **M** = amount marked
3. Release and recapture. Calc: **T** × **C** / **M** **= result 2**
4. Repeat as many times as necessary and average results. →average = number of that population.

Terrestrial: transects, quadrants, point sampling

Aquatic:

floating / swimming – mark recapture

Reef or floor – Terrestrial techniques

Limitations when:

- Region is inaccessible
- Migratory/mobile animals
- Seasonal population
- Nocturnal population
- Underground population

Therefore results are only estimates.

EXTINCTION EVENTS

Small extinctions	Mass Extinctions
Only affect local ecosystems &/or niches	Entire ecosystem collapse. Affects whole or most of globe
Localised species affected become extinct	Many entire orders and classes become extinct 65-95%
Caused by a small ecological disturbance →*e.g. introduced species or local climate change*	Caused by natural catastrophe → *e.g. meteor strike, sea level change or global climate change*
→*Australian megafauna*	5 know mass extinctions → *K/T Ext (dinosaurs- end of cretaceous)*

Small Extinction – Australian Megafauna:

40 species of megafauna became extinct between 50,000 and 20,000 years ago

Hypothesises:

Hypothesis	Positive evidence	Negative evidence
Blitzkrieg Hypothesis- They had no natural fear of humans and were easy to hunt for food- were hunted to extinction	- Hunting of megafauna has been found in north America, Madagascar and NZ - Dates strongly coincide	- Dates are not accurately known. - No evidence or hunting itself (cut on bones etc) - No megafauna bones have been found in aboriginal camp sites - Clear evidence found in other countries
Climate change hypothesis- Died out as a result of climate change	- Aus. became warmer after ice age ended - Aus. became drier (evidence of drought and fire) - With aboriginal arrival fire became common for clearing - Analysis of pollen in lake sediments show changes in distribution of plant species – disrupted food chain	- Uncertainty of dating of climate changes and whether corresponds with ext.

PAST ECOSYSTMS

Palaeontology: study of life of the geological past.

Geology: Study of the earth and materials its made of, its structure, processes

ABORIGINAL ROCK PAINTINGS

Aboriginal Rock Paintings go back up to 28 000 years.

They inform us about: what animals were present at what time trophic relationships

To properly interpret aboriginal rock paintings we must know:

i) What is depicted in rock art
ii) Age of rocks – radiometric dating

- *E.g. rock paintings in Arnhem Land revealed*
    - *Tas Devil*
    - *Thylacine*
    - *Numbat*

Middens: a historic sight of human occupation where people left debris and food – indicates food source and diet

Palaeontological evidence given:

- show species of flora and fauna present at time
- habitat and human activity
- culture and food source

Geological evidence given:

- context/time
- paint contains abundant minerals from time

ROCK STRUCTURE AND FORMATIOSN

Rock type	origin	Relation to evidence
Igneous	Cooled lava / magma	Preservation in ash or stone Shows volcanism
Metamorphic	Heat and pressure	Can help stratification
Sedimentary	Layered sediment and pressure	Sandwiches most fossils Uses law of superposition

Law of Superposition: lower rock layer (strata) = older, layer on top = younger. (relative dating)

ICE CORE DRILLING

What are ice cores?

- Large long cylinders of ice.
- Analysed to show climate
- Data from up to 800 000 years ago

Where do they come from?

- Antarctic (and polar) glaciers – further back in time
- Greenland ice – more precise in recent past

How are they collected?

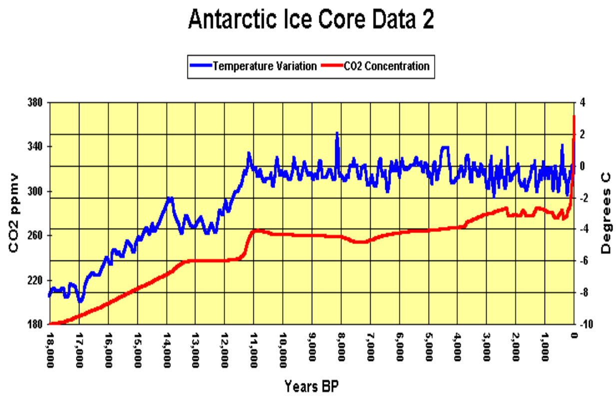
- Drilling and pulling up 1.5 m poles

What evidence do they show?

Identified factor	meaning
Stable isotope ratios or hydrogen and oxygen ratio	Air temp
Analysis of bubbles	Concentration of greenhouse gasses
Thickness of layers	Quality of snowfall annually
Concentration of dust and particulates	Wind erosion on land (wind speed)
Tephra shards (volcanic ash) and acidity	Volcanic activity

What have scientists concluded about climate change based on ^?

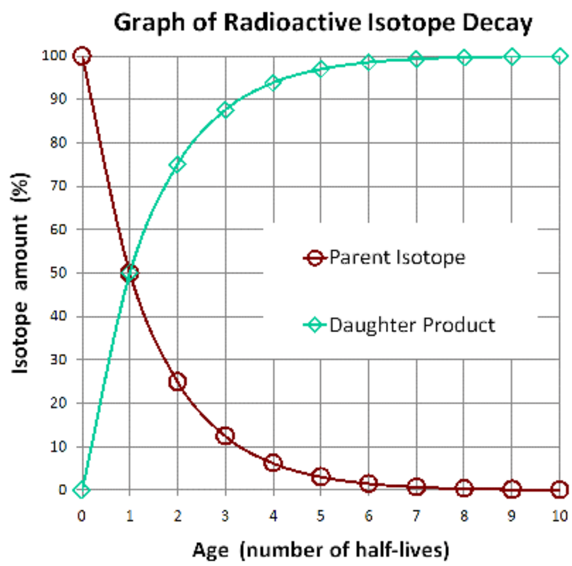
- Milankovitch cycles (glacial and interglacial <ice age> periods based off irregular orbit of earth)
- Effect of greenhouse gasses and correlation with temp increase



DATING

Radiometric dating: (absolute dating) rocks and fossils (only carbon 14 for biological organisms that died) are dated by the ratio of parent to daughter isotopes.

Isotope		Half-life of parent (years)	Useful range (years)
Parent	Daughter		
Carbon 14	Nitrogen 14	5,730	100 - 30,000
Potassium 40	Argon 40	1.3 billion	100,000 - 4.5 billion
Rubidium 87	Strontium 87	47 billion	10 million - 4.5 billion
Uranium 238 Uranium 235	Lead 206 Lead 207	4.5 billion 710 million	10 million - 4.6 billion



GAS ANALYSIS

Atmospheric changes cause ecosystem changes and vice versa

→ *e.g. gas bubbles in ice cores*

Main gas analysis techniques:

- **Mass spectroscopy**
- **Chromatography**
- **SHIMP (Sensitive High Resolution Ion Microprobe)**

Measures:

- Greenhouse gas emissions
- Pollutants
- Ozone depleting gasses
- Atmospheric composition e.g. oxygen
  Which impact natural ecosystems

EVOLUTION IN AUSTRALIA

- geological/evolutionary isolation Approx 50 m.y.a Australia split from Gondwana (which split from Pangea)—**therefore divergent evolution began**
    - As it drifted its climate changed from
      High humidity
      Lots of regular rain
      Cooler temps

      To →

      Hotter
      More seasonal rain
      Less humidity
    - There was no longer tectonic plate influence → Australia became flatter and soil fertility declined
    - Australia formed west to east →east was newer and has more recent volcanic activity, west is older and less volcanisation.
- This meant that rainforests clustered around north and east coast and most evolved into sclerophyll forests

Australian Geographical History

- Split from Antarctica 450 m.y.a
- Major flux in atmospheric CO_2
- Major flux in air and water temp.

El Niño – southern oscillation (ENSO)

- Natural dynmanic variation in yearly climactic cycle caused by pacific ocean temp variations
    - Caused ice ages
    - More arid etc conditions in australia

SCLEROPHYLL FORESTS

Sclerophyll forests – plants became dry and woody because of climate and poor soil fertility.

- Adapted to harsh dry climates and nutrient deficient soil
- Have hard tough leaves with waxy cuticles to reduce water loss
- Some have toxic indigestible chemicals
- Woody stems and tough, thick, evergreen leaves
    - *e.g. eucalyptus trees (800 dif. Species) and acacia (900-1000 dif. Species)*

Evidence

- Originated 35-50 m.y.a
- Eucalyptus and acacia spread coincided with charcoal deposits (due to fires – hotter and drier climate)
- Pollen samples showed sclerophyll growth.

- Gondwanan species had to remain near coast – more rainfall and better soil.
- Sclerophyll adapted/diversified to fill newly opened ecological niche

-

This is evidence that the vegetation changes were due to continental drift

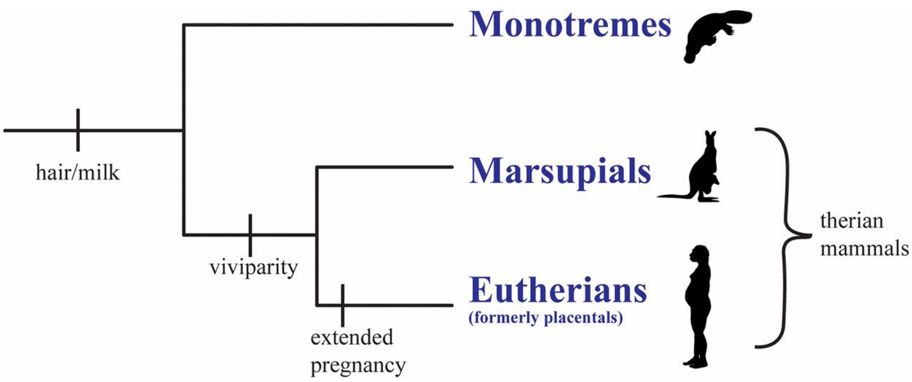
- Glossopteris and gangamopteris which was found all across Gondwana went extinct and was replaced with sclerophyl

Selection pressure

- fire
    - plants became fire resistant and some even need it to reproduce
- poor soil
- less water

SMALL MAMMALS – DECLINE OF MEGAFAUNA

Small mammals – evolved from megafauna as habitat/environment lost the ability to provide enough food.



- as rainforests died out arboreal (tree swelling) mammals did too
- >> large land dwelling mammals took over (megafauna)
    - *Kangaroos*
        - 25 m.y.a kangaroos were arboreal
        - 15-20 m.y.a they diversified to love in arid area and had to expand range
            - Adapted to bipedal locomotion and hopping (save energy and move a lot)
            - Teeth adapted to grass and sclerophyll plants
- 15,000 y.a kangaroo related megafauna died (walked not hopped) as they couldn't get enough food.

REASONS FOR CHANGE

	BIOTIC	ABIOTIC
SHORT TERM	**Introducing invasive species –** damages ecosystems, displaces native species, especially detrimental to isolated places (e.g. islands)	**Weather events –** can destroy habitats, food sources, etc.
LONG TERM	**Introduction of photosynthetic plants –** as opposed to chemosynthesis, changed composition of atmosphere	**Climate change –** wet and cool to dry and warm **Soil fertility decline -** as volcanism decreased (because of continental drifing)
LONG TERM / SHORT TERM	**Isolation – habitat fragmentation –** can lead to loss of resources, space, food etc. (e.g. by deforestation)	

FUTURE ECOSYSTEMS

Ecosystems provide us (for free) with 4 services:

- **Support services**
  - E.g. Nitrogen,
  - Phosphorus,
  - Oxygen,
  - Carbon cycles
- **Provisionary services**
  - E.g. fibres
  - Fuel
  - Food
  - Water
  - Medicine
- **Regulatory services**
  - E.g. plants filter water
  - Plants regulate carbon dioxide in atmosphere
  - Fungi decompose things.
- **Cultural services**
  - E.g. pretty flowers

We need biodiversity to function

Equatorial rainforests – most biodiverse places

Resistance to change – areas with higher biodiversity are more resistant to change because they are less interrelaint on each other (if one species dies less organisms care/suffer)

Trees role in biodiversity –

- Carbon sinks
- Provide habitat
- Stabilise and fertilise soil
- Filter water and lower water table (water sink)

ANTHROPOGENIC CHANGE

Anthropogenic selection pressures – human induced.

- **Habitat destruction**
- **Introduced species**
- **Over exploitation**
- **Pollution**
- **Climate change**

Deforestation – lowers biodiversity. It destroys one habitat (direct) and impacts neighbouring ones (indirect)

Cascade effect – removing trees causes direct problems, e.g. habitat loss, and then has a cascade effect. (e.g. causes run off to be poorly managed → rising of water table → flooding.)

Desertification – over irrigation, overfarming, and deforestation can eventually leads to desertification (when water table rises and carries salts and minerals that make the soli infertile)

➔ **E.***g. gobi desert grows 36,000 km/year*

Global Warming – removing trees makes more pollution > global warming rise, less carbon sinks > global warming rise.

Invasive species – destroy ecosystems, remove food sources, cause unnatural ecological relationships

➔ *Cane toads killing Tasmanian devils.*

Overhunting / overharvesting –

➔ *E.g. hunting wolves to protect cattle*

MODELS

Since European settlement: extrapolated to future

- Soil erosion
- Increased soil salinity
- Soil compaction
- Water and soil pollution
- Extinction of natives
- Introduced species
- Land clearing

Types of data collected to make a model:

ABIOTIC	BIOTIC
- Air temp - Wind speed - Atmospheric CO2 - Precipitation - Sea surface temp	- Vegetation cover - Distribution and abundance of species - biodiversity

Modelling:

- a variable is manipulated
- a mathiatical formula is used to simulate climate and other processes and extrapolate
- equations simulate change
  - ➔ ***e.g. GCM*** *– global climatic model, divides earth up into 15000 km^3 cubes which are monitored and …*
  - ➔ ***Species distribution model –***
    1. *Locate where a species is found (understand ecological niche requirements)*
    2. *Determine conditions needed for life and success of species*
    3. *used with equations for model*

MINING SITES

Types of mines: Open cut and underground

Open cut mine rehabilitation techniques:

collect seeds of native plants before digging

1. return soil in order (because topsoil is fertile)
2. recreate geological topography (e.g. hills were hills were)
3. recreate water source (e.g. if river was there etc.)
4. add native plants
5. add animal needs that need time to get there (e.g. tree hollows)

LAND DEGREDATION FROM AGRICULTURE

Problems caused by agricultural practice:

- land clearing
- introduction of species
- overgrazing
- alteration of water source / course
- over-irrigation
- soil erosion → sedimentation in water course *
- salinity *
- water pollution (e.g. insecticides)

many lands become unusable by these

good agricultural practices:

- planting trees as windbreaks (reduces soil erosion) and to lower water table
- limiting tilling (tilling: turning over the soil to access more fertile bits)
- reducing stocking rates
- crop rotation
- fencing off eroded areas
- using drip irrigation

salinity caused by agriculture:

- when trees are removed their roots cannot hold down water table
- water table rises and brings with it salts
- salinity ruins soil

To fix:

- plant deep rooted soil resistant plants
- use drip irrigation
- minimise tilling
- etc etc good agricultural practices ^^^