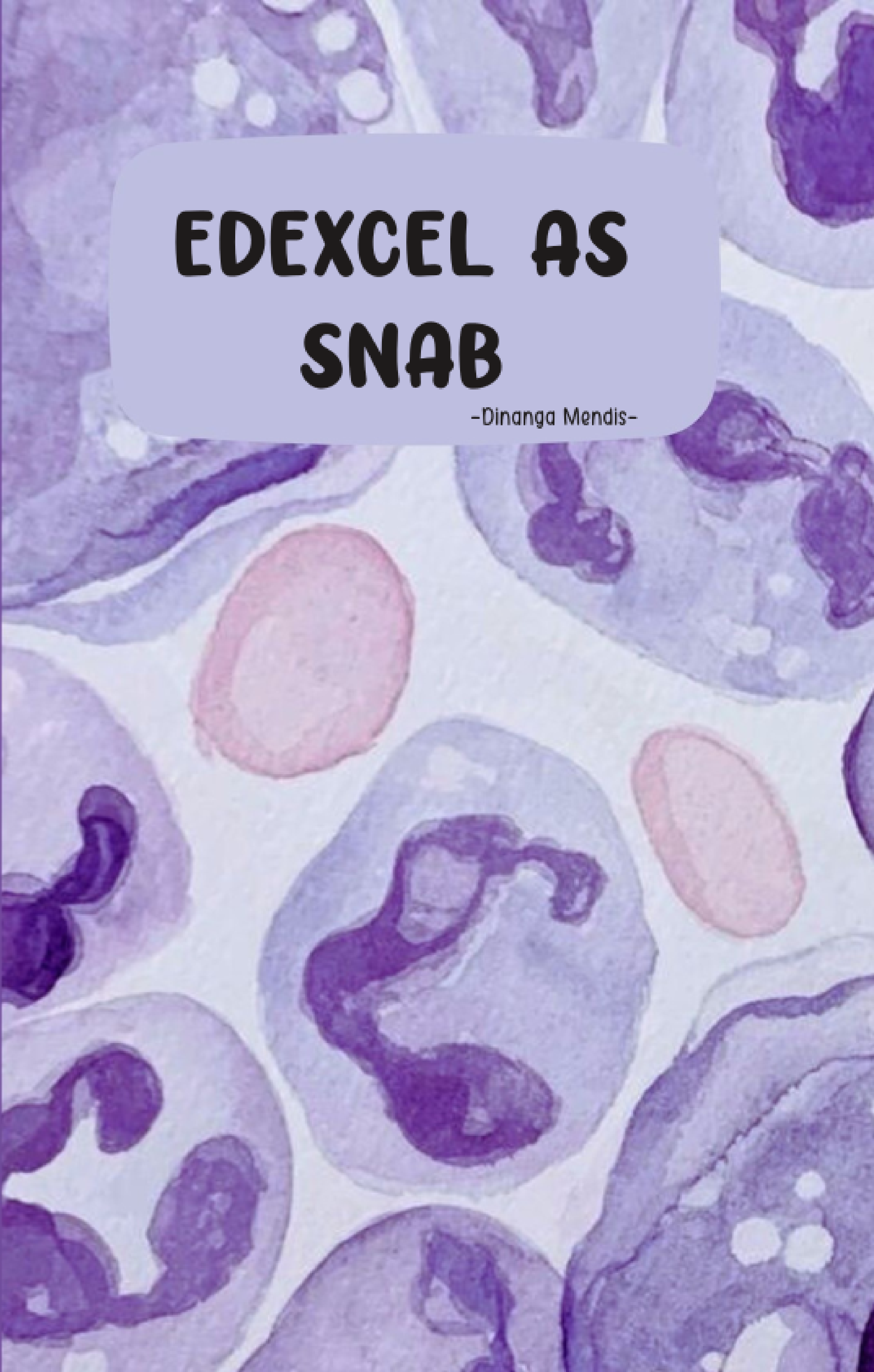
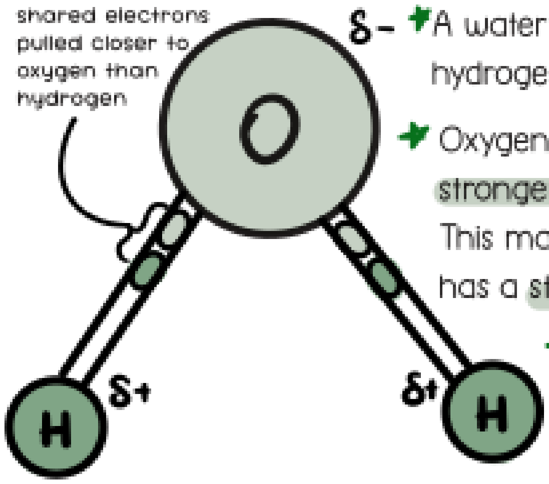


EDEXCEL AS SNAB

-Dinanga Mendis-

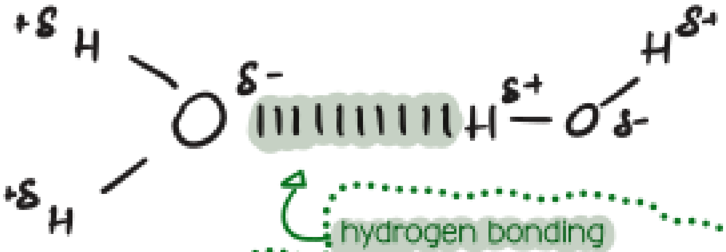
water molecules



- A water molecule consists of one oxygen atom covalently bonded to two hydrogen atoms.
- Oxygen has more protons in its nucleus than hydrogen hence it has a stronger attraction towards the shared electrons compared to hydrogen. This makes oxygen more electronegative than hydrogen therefore oxygen has a stronger pull on the shared electrons
- As a result, the oxygen atom becomes slightly negative ($\delta-$) and the hydrogen atoms become slightly positive ($\delta+$). This creates a permanent dipole, making water a polar molecule.

Importance of water

↳ due water molecules' polarity and its ability to form hydrogen bonds leads to water having unique properties

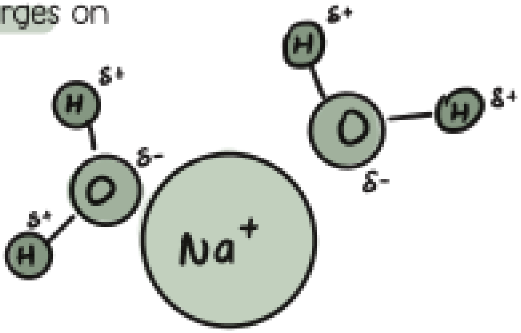


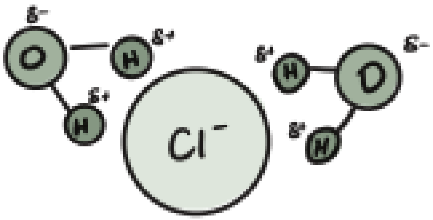
hydrogen bonding

Weak electrostatic intermolecular force of attraction between slightly positive hydrogen and slightly negative oxygen and other polar molecules nearby

1. Water acts as a solvent

- When an ionic substance dissolves the $\delta-$ oxygen atoms in water molecules are attracted to the positive ions while the $\delta+$ hydrogen atoms are attracted to negative ions. Water molecules surround each ion due to electrostatic attraction between the ions and the partial charges on the water molecules





2. High specific heat capacity allows water to be a suitable habitat; helps to maintain optimal temperature within cells and bodies. This is due to presence of many hydrogen bonds requiring a large amount of energy to raise the temperature.

3. High latent heat of vaporisation acts as a coolant (through sweating or transpiration) The presence of many hydrogen bonds requiring large amount of energy to turn liquid water into a gas.

4.Cohesion and adhesion

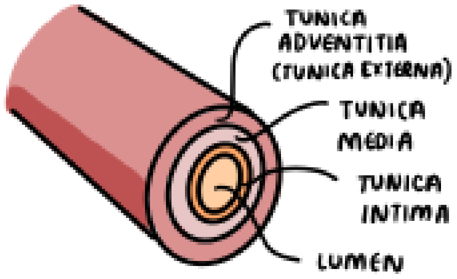
cohesion is the tendency of water molecules to stick together through hydrogen bonds

adhesion tendency of water molecules to stick to other materials.

strong cohesion and adhesion helps water to flow through organisms, carrying substances along with it (for example during transpiration)

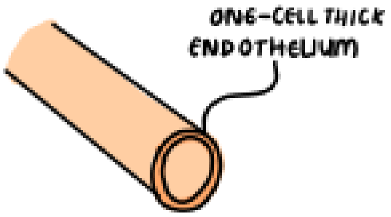
blood vessels

arteries



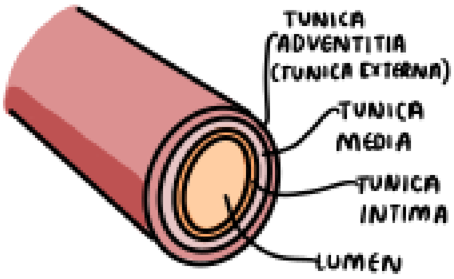
- Carry blood at high pressure away from the heart
- Thick tunica media withstands high pressure
- Elastic fibres stretch under systolic surge, recoil during diastole to maintain pressure
- Smooth tunica intima reduces turbulence
- Smooth muscle regulates blood flow
- Collagen fibres prevent rupture
- Elastic arteries close to the heart, less smooth muscle, high elastic fibre content stretch during systole and recoil during diastole, evens out blood flow during pressure changes.
- Muscular arteries less elastic tissue, more smooth muscle, regulate lumen size, blood flow and blood pressure.
- Arterioles smaller branches leading into capillaries, greater proportion of smooth muscle relative to size.

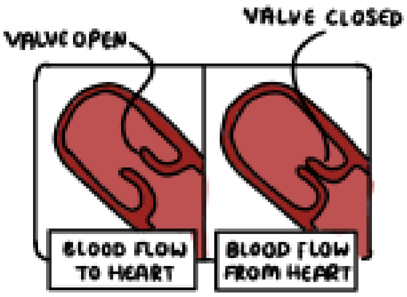
Capillaries



- Exchange of substances between blood and tissues.
- Slows blood flow, reduces pressure for efficient diffusion.
- Very narrow lumen slows flow, close to cells.
- One-cell-thick endothelium short diffusion distance.
- Fenestrations/gaps allow small molecules and plasma to form tissue fluid.
- No tunica media or externa.

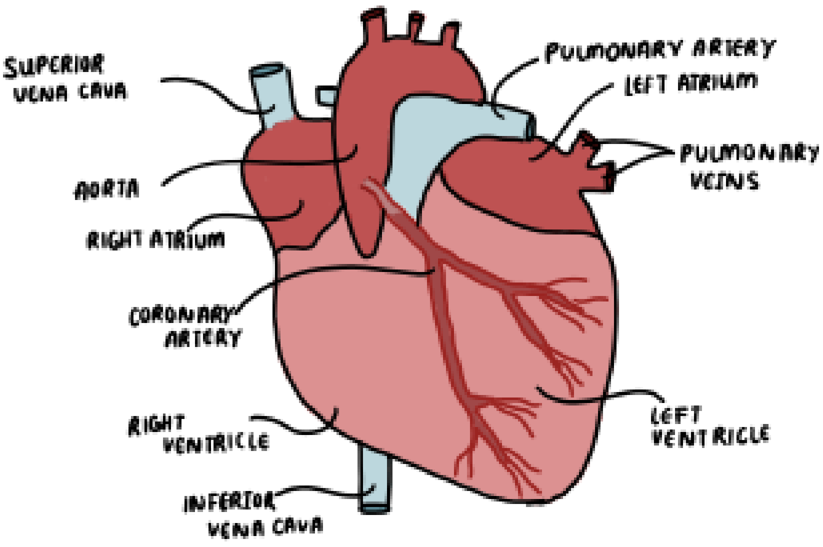
Ventricles



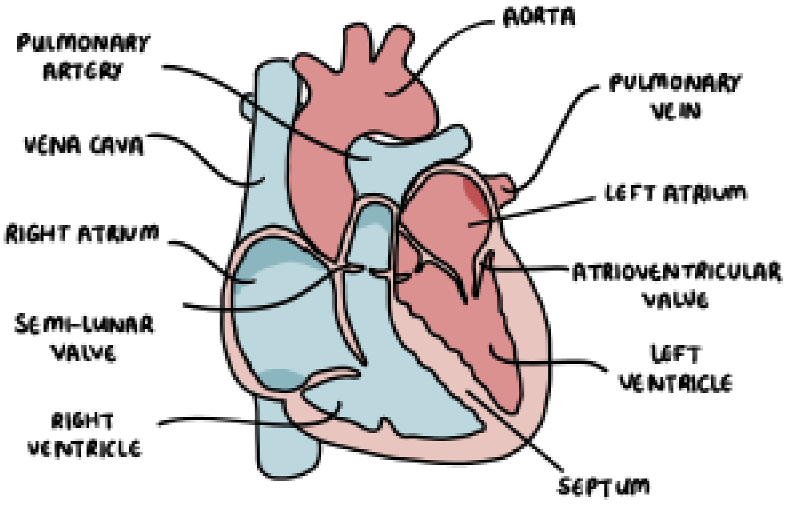


- Return blood to the heart at low pressure.
- Large lumen reduces resistance.
- Thin tunica media (little smooth muscle & elastic tissue) walls not required to withstand high pressure.
- Tunica externa collagen for support.
- Valves (semilunar) prevent backflow.
- Skeletal muscle contraction squeezes veins, aiding venous return.
- All carry deoxygenated blood except pulmonary and umbilical veins.

heart structure



The heart is made up of four chambers divided into two sides. The left side of the heart has a thicker wall, as it needs to pump more strongly to deliver blood all around the body (whereas the right side just needs to send the blood to the lungs). The left side carries oxygenated blood whereas the right side carries deoxygenated blood.

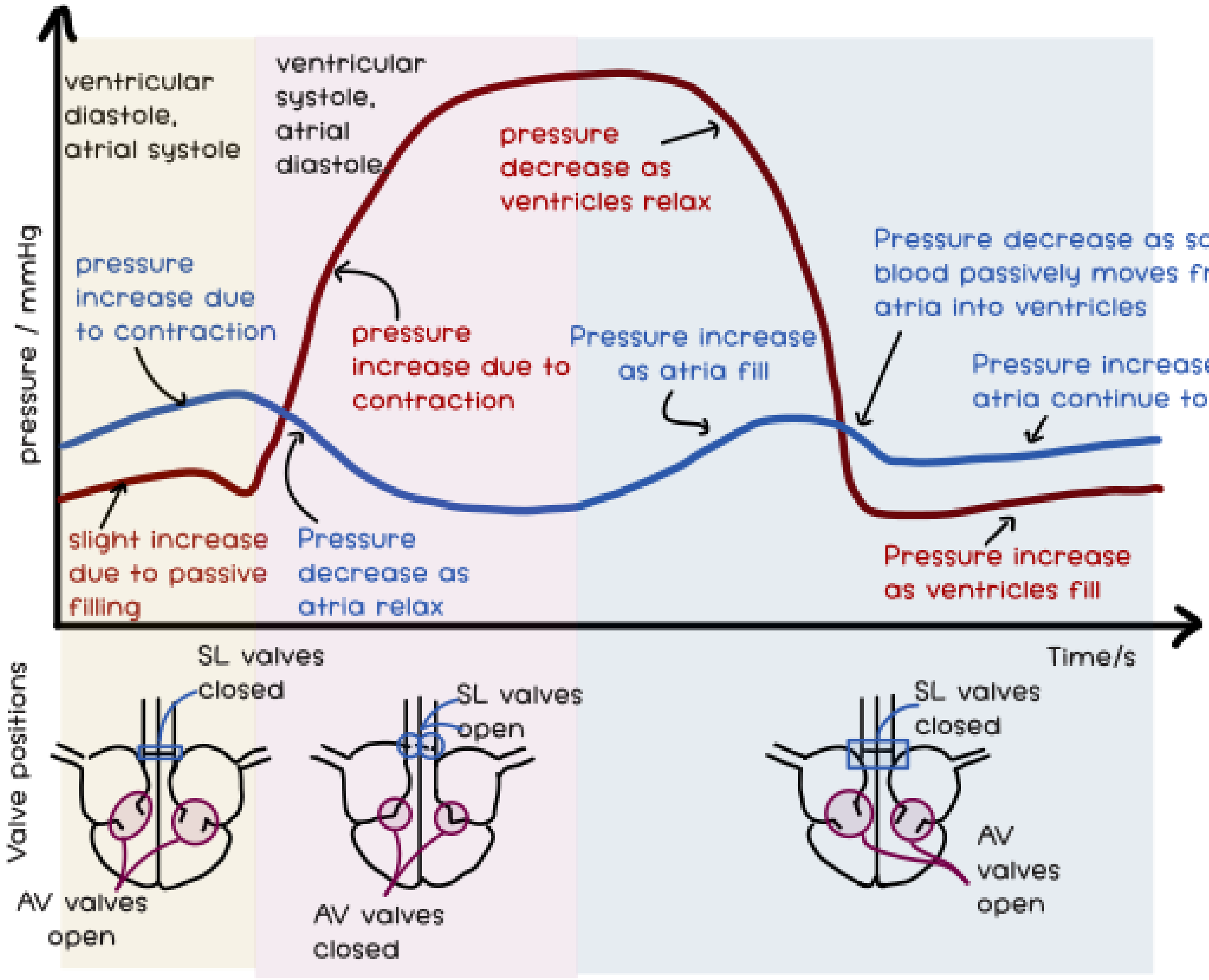


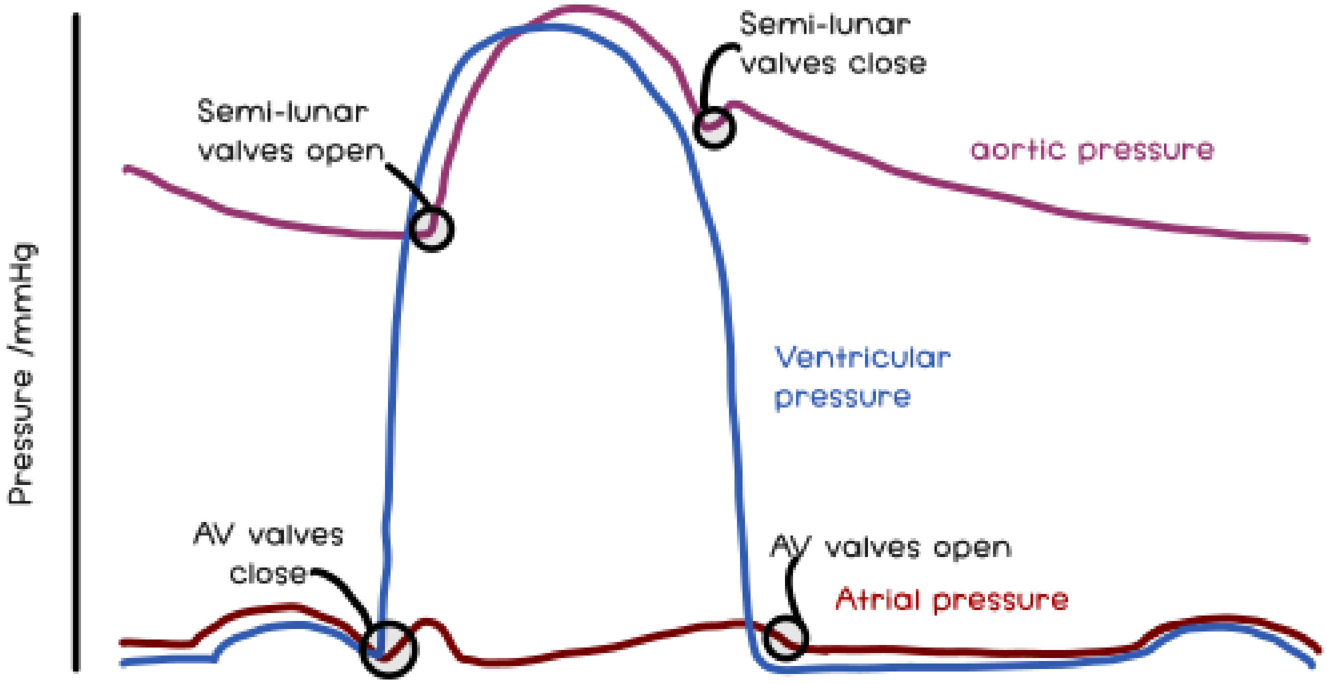
The chambers at the top are called atria and these chambers receive the blood from the veins supplying the heart. Blood flows from the atria to the ventricles, which are separated from the atria by atrioventricular valves to prevent blood flowing in the opposite direction. There are another set of valves between the ventricles and the arteries which are called the semi-lunar valves as they look like little half-moons.

The main artery which takes oxygenated blood from the left side of the heart to the rest of the body is called the aorta whereas the artery which delivers deoxygenated blood between the right side of the heart and the lungs is called the pulmonary artery. The major vein which returns blood from the body to the right side of the heart is the vena cava and the vein which ferries blood from the lungs to the heart is called the pulmonary vein.

heart muscle itself also needs its own blood supply, so that it can get plenty of oxygen and glucose to keep respiring and keep pumping - these are called the coronary arteries. It's a blockage in these coronary arteries which leads to a heart attack.

CARDIAC CYCLE


ventricular diastole, atrial systole
ventricular systole, atrial diastole
pressure decrease as ventricles relax
Pressure decrease as some blood passively moves from atria into ventricles
pressure increase due to contraction
pressure increase due to contraction
Pressure increase as atria fill
Pressure increase as atria continue to fill
pressure / mmHg
slight increase due to passive filling
Pressure decrease as atria relax
Pressure increase as ventricles fill
Time/s
Valve positions
SL valves closed
SL valves open
SL valves closed
AV valves open
AV valves closed
AV valves open



Key points

systole is the short period when heart chambers contract

Diastole is the relaxation of heart chamber

the contraction (or systole) of the heart chambers causes their volume to drop and their pressure to rise

Mechanism of action: a valve opens when pressure before the valve is higher than pressure after the valve and vice versa

1. Atrial systole

* The muscles in the atrial walls contract; meanwhile, ventricular walls are relaxed
* This causes the pressure in the atria to exceed the pressure in the ventricles
* The atrioventricular valves will open, and blood flows from the atria to the ventricles

2. Ventricular systole

* Ventricles contract only when atria have finished their systole and now they're relaxed
* The pressure in the ventricles builds up until it is greater than the pressure in the atria
* This forces the atrioventricular valves to close and prevent any back-flow of blood
* The high pressure in the ventricles causes the semilunar valves to open
* Blood is pumped upwards towards the aorta and the pulmonary artery
* The pressure in the right ventricle (with thinner walls) is lower than that in the left ventricle
* The pressure exerted by both ventricles is usually much higher during periods of exercise

3. Cardiac diastole

* This is the stage when the muscular walls of the atria and ventricles are both relaxed
* The blood flow and the elasticity of the arteries (aorta and pulmonary) cause the pressure in the arteries to be higher than the pressure in the ventricles.
* This causes the semilunar valves to close.
* Blood from the veins (pulmonary and vena cava flows into the atria and to the ventricles
* The heart chambers are now full of blood and ready to start a new cycle

CP 01 - Investigating the Effect of Caffeine on Heart Rate in Daphnia

Why Daphnia are used

- Daphnia (water fleas) are commonly used to investigate the effect of caffeine on heart rate.
- Their transparent body allows the heart to be seen easily under a microscope.
- They possess a relatively simple nervous system, so they are considered less likely to experience pain or stress compared with more complex animals.
- Daphnia are also abundant and widely available as fish food, meaning their use in school investigations has little impact on natural populations.

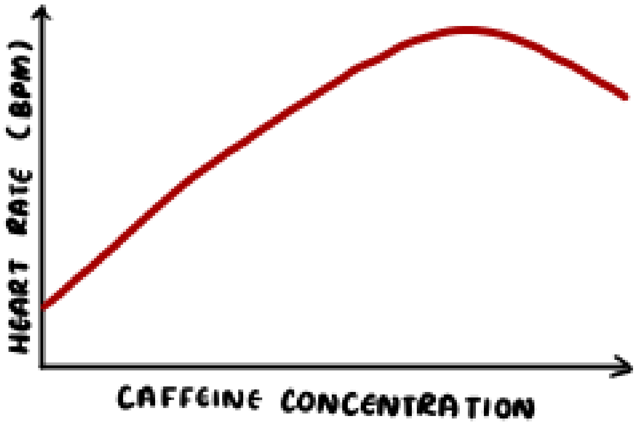
Method

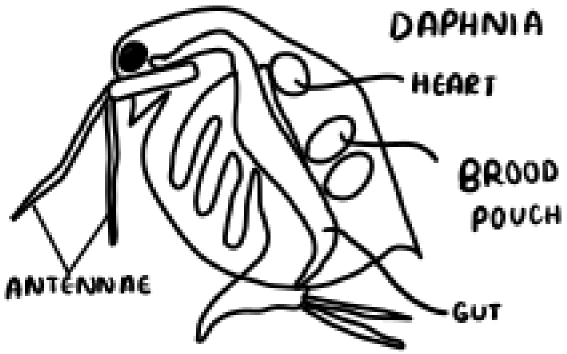
1. Prepare several caffeine solutions of different concentrations, including a control solution containing no caffeine.
2. Use a pipette to transfer a single Daphnia into the well of a cavity slide.
3. Place the slide under a microscope and focus on the heart.
4. Add one drop of the chosen caffeine solution to the Daphnia.
5. Count the number of heartbeats in 20 seconds using a stopwatch and multiply by three to calculate the heart rate per minute.
6. Repeat the investigation several times using different Daphnia to improve reliability.
7. Repeat the procedure for all caffeine concentrations and the control.

Results

Plot a graph with caffeine concentration on the x-axis and heart rate on the y-axis.

- At low to moderate concentrations, heart rate increases as caffeine concentration increases.
- At very high concentrations, the heart rate may decrease because the caffeine becomes toxic to the organism.



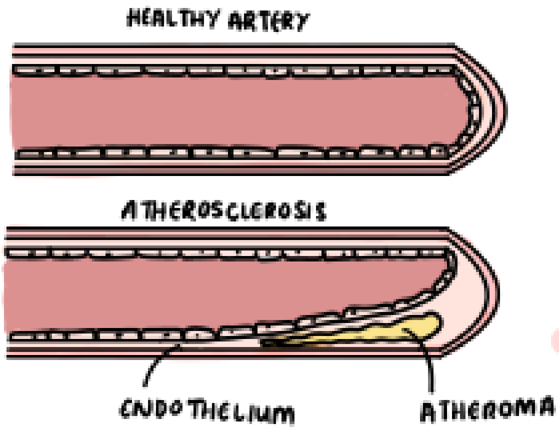


Ethical Considerations

- Using invertebrates is generally considered more ethical than using vertebrates because they have a simpler nervous system.
- It cannot be proven with certainty that Daphnia experience no stress or discomfort during experiments.
- Conditions such as temperature and pH should be kept close to their natural environment to reduce potential stress.
- Daphnia are bred in large numbers as fish food, so their use in practical investigations has little effect on population size or food chains.

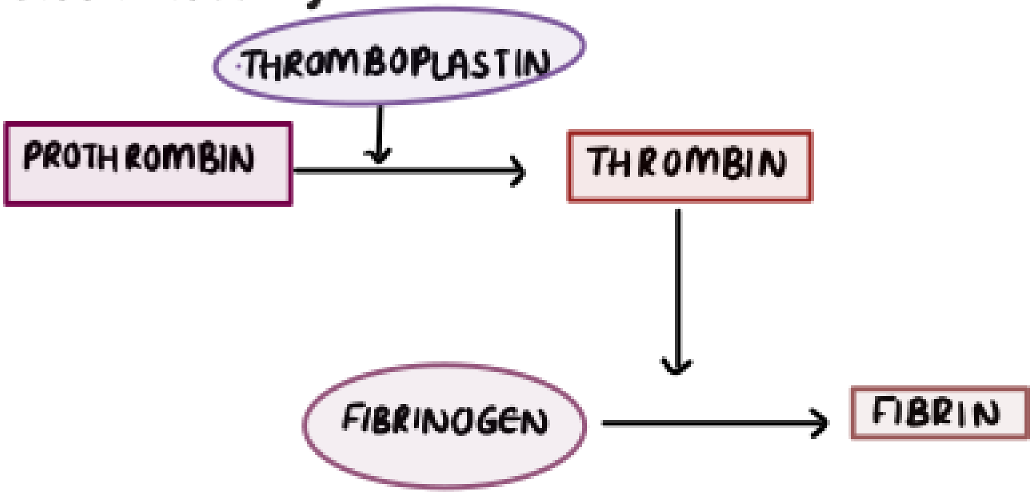
CVD

atherosclerosis



The inner lining of the artery wall (the endothelium) becomes damaged due to high blood pressure (hypertension).
This triggers an inflammatory response - white blood cells move towards the site of damage and absorb cholesterol from the blood, accumulating beneath the endothelium to form a fatty deposit known as an atheroma.
This causes the lumen of the artery to become narrower and restricting blood flow.
This leads to blood pressure to increase further.
The hardening of arteries, caused by the development of atheromas, is referred to as atherosclerosis.

Blood clotting



Clotting cascade The process involves a series of activations where inactive plasma proteins are converted into active enzymes.

1)When a blood vessel is torn plasma, blood cells and platelets flow from the cut vessel.
2)Contact between platelets and tissue (collagen fibers in skin) causes increase number of platelets.
3) Platelets release several substances, two of them are particularly important:
Serotonin Causes contraction of smooth muscles in blood vessel wall, which narrows the blood vessel cutting off the blood flow to damaged area. Thromboplastin An enzyme which sets in progress a cascade of events that leads to formation of a clot.
4)An enzyme called thromboplastin is released from damaged blood vessels. It requires calcium ions in order to function.
5)Thromboplastin catalyses the formation of prothrombin into thrombin, which is itself an enzyme.
6) Thrombin catalyses the formation of fibrinogen into fibrin. Fibrinogen is a soluble protein that is dissolved in the blood. Fibrin is insoluble and forms fibres which tangle together platelets and red blood cells to form a blood clot.

The clotting process is a critical factor in the progression of CVD, particularly following atherosclerosis:
The atheroma ruptures and bursts through the endothelium of the artery, damaging the artery wall.
This triggers blood clotting (thrombosis) at the site of damage.
The blood clot can cause a complete blockage within the artery.
This prevents blood flow in the artery which means that oxygen isn't delivered to the tissues downstream of the artery.
The cells within the tissue cannot carry out aerobic respiration and will start to die.
If the blockage happens within a coronary artery, the blockage will lead to a heart attack. If it occurs in a blood vessel leading to the brain it will cause a stroke and if it happens in an artery in the legs in can cause deep vein thrombosis (DVT).
If a clot blocks an artery supplying the brain, or if a clot formed elsewhere (an embolus) travels to the brain, it causes a stroke by depriving brain cells of oxygen

Aneurysm

The artery bulges and the wall is under greater pressure than usual (due to building up of blood behind the blockage) as a result weakening arterial wall which may split open leading to massive internal bleeding.
-Happens in brain and aorta
-Massive blood loss drops blood pressure and is fatal

Treatment for CVD

drug type	How does it work?	Side effects
Antihypertensives	These drugs reduce blood pressure which reduces the chance of endothelial damage in the arteries, so less chance of atherosclerosis. Antihypertensives come in many types: 1. Diuretics: increase the volume of urine excreted which removes excess fluids and salts from blood and that reduces blood pressure 2. Beta-blockers: block the response of the heart to hormones such as adrenalin which normally speed up the heart rate 3. Vasodilators: widen the arteries to reduce blood pressure	Antihypertensives could reduce blood pressure far too low causing different side effects, including: Rapid beating of the heart Abnormal heart rhythms Fainting Headaches Drowsiness Allergies
Statins	Statins are used to block the active site of an enzyme used in the liver for the synthesis of cholesterol; this helps to reduce the cholesterol levels. With less cholesterol in the blood, there will be less chance of the formation of atheroma, and atherosclerosis is less likely to happen	Muscle and joint pain Statins could reduce the absorption of vitamins Liver and kidney failure Increased risk of diabetes Headaches Nausea
anticoagulants	Reduce blood clotting by interfering with the manufacture of prothrombin by platelets. This means that clots are less likely to form and that reduces the chance of CVD Anticoagulants can also be used to get rid of existing blood clots that have previously formed in arteries	Excessive bleeding during injuries which could be too risky Allergic reactions Damage the to the fetus if the drug was taken during pregnancy
Platelet inhibitors	Drugs like aspirin prevent the formation of a clot by preventing the clumping of platelets (decrease their stickiness); this reduces the chance of blockage of arteries	Excessive bleeding during injuries which could be too risky Diarrhoea Nausea Problems in liver functions

risk factors of CVD

Things which increase our risk of developing cardiovascular disease can be grouped into lifestyle factors and non-lifestyle factors

Unmodifiable risks (non-lifestyle) cannot be changed or controlled by lifestyle choices

1. Genetics
2. Gender men have a higher risk as oestrogen protects women against CVD before menopause
3. Ageing arteries lose elasticity and become narrower with age

Modifiable risks(lifestyle factors) influenced or reduced through lifestyle choices

1. Diet low salt intake, HDL cholesterol and antioxidants reduces risk to CVD
2. High blood pressure pressure below 140/90
3. Smoking chemicals in smoke damage artery linings and narrows it.
4. Inactivity lack of regular exercise increases risk
5. Obesity increases risk of CVD and type II diabetes.

Dietary risk factors

1.Lipoproteins

Lipids are transported around the body in the form of lipoproteins. There are 2 types: High-density lipoproteins (HDL)and low-density lipoproteins (LDL)

LDL

Are harmful lipoproteins.

They are made of cholesterol, saturated fats and protein,

They transport lipids around the body and bind to the cell membrane before being taken into the cell

If there are high levels of LDL the cell membrane becomes saturated and so more cholesterol remains in the blood. Therefore risk of CVD increases

HDL

Are good lipoproteins.

They are made of cholesterol, unsaturated fats and proteins, They carry cholesterol from the body to the liver to breaks it down.

Hence, it reduces blood cholesterol levels. It also removes simple plaques and prevents them from getting bigger

2. Antioxidants

Oxidative stress occurs when free radicals (oxygen molecules with an unpaired electron) exceed the level of antioxidants in the body. Free radicals are highly reactive and can trigger damaging chain reactions in cells, hence damages the endothelial cells leading atherosclerosis

Antioxidants donate electrons to neutralise free radicals without becoming unstable themselves.

Obesity indicators

BMI doesnt distinguish fat vs muscle, may underestimate fat in other older adults, varies by ethnicity, used alongside other measures.

WHR better predictor of CVD risk than BMI, easy and quick to measure

Skin fold thickness

$$BMI = \frac{BODY\ MASS\ (kg)}{HEIGHT^2\ (m^2)}$$

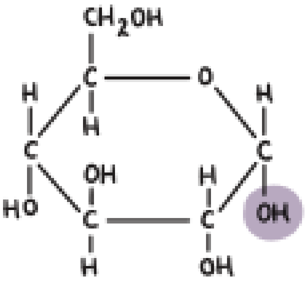
$$WHR = \frac{WAIST\ (cm)}{HIPS\ (cm)}$$

Carbohydrates

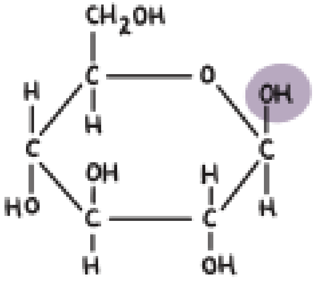
↪ composed of carbon, hydrogen and oxygen

Monosaccharides

- → single sugar monomer
- → general formula = $C_nH_{2n}O_n$
- → hexose sugars (6 carbon atoms) = glucose, fructose, galactose
- → pentose sugars (5 carbon atoms)= ribose, deoxyribose



Alpha-glucose



Beta-glucose

Disaccharides

→ formed when two monosaccharides join together via a condensation reaction forming a glycosidic bond

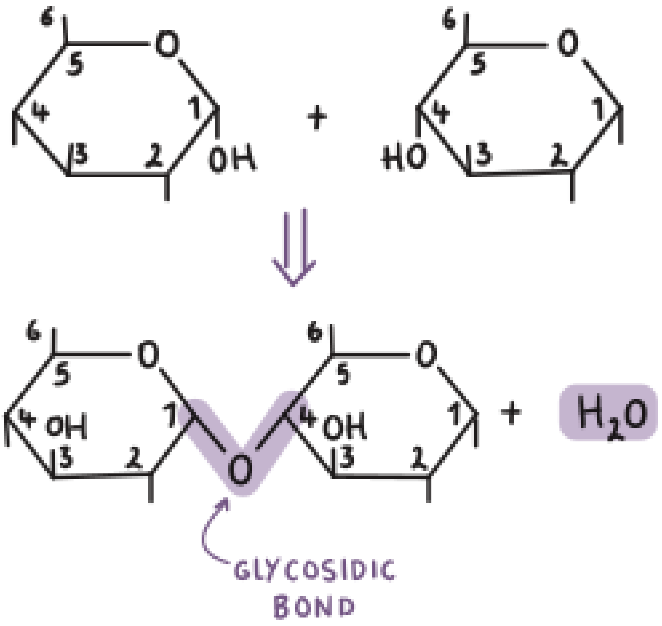
examples

↪ maltose (product of digestion of starch) = α-glucose + α-glucose

↪ sucrose (transport sugar in plants) = α-glucose + fructose

↪ lactose (sugar in milk) = α-glucose + galactose

Condensation reaction



Condensation reaction reaction in which two molecules join by the removal of a water molecule

Hydrolysis reaction breaking down of a larger molecule into smaller molecules by adding a water molecule

Condensation	Hydrolysis
Synthesis of a large molecule by the joining of simpler molecules and removal of water	Breaking down of large molecules by adding water
Reactant = smaller molecules	Reactants = larger molecule
product = larger molecules	Products = smaller molecules
Bonds are formed	Bonds are broken

Monosaccharides	Disaccharides
Both are soluble Made up of carbon, hydrogen and oxygen	
Single unit	Two units
there is a carbon: hydrogen: oxygen ratio	No ratio
No glycosidic bonds	Have glycosidic bonds

Polysaccharides

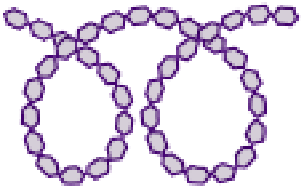
Large carbohydrates that are made up of simple units of monosaccharides joined by glycosidic bonds.

1. Starch

A polymer of alpha glucose that is used as energy storage in plants

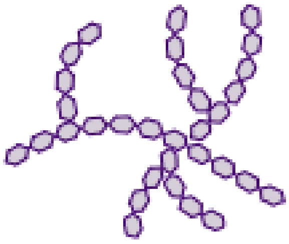
Consists of two types of polysaccharides = amylose and amylopectin

AMYLOSE



An unbranched chain of alpha glucose monomers.
Joined by 1,4-glycosidic bonds that coils into a compact helix (due to hydrogen bonds)

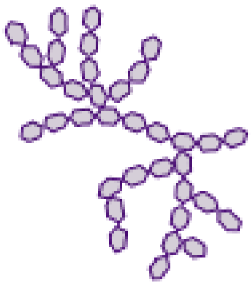
AMYLOPECTIN



Branched chain containing both 1,4 and 1,6 glycosidic bonds

The branched chains increases surface area which allows enzymes such as amylase to quickly hydrolyse the molecule and release glucose when required by the plant for respiration

2.glycogen



Polymer of alpha glucose that is used as an energy storage in animals

Linked by 1,4 and 1,6 glycosidic bonds

Similar to amylopectin but more branched

Extensive branching creates very compact molecule with many terminal ends

Branched chains provides increased surface area allowing glucose molecules to be easily hydrolysed for respiration

Features of a storage polysaccharide

Compact large numbers of glucose molecules (and therefore more energy content) can be stored in a less space inside the cell

Branched many glucose terminals enabling many glucose molecules to be broken down at the same time (hydrolysed)

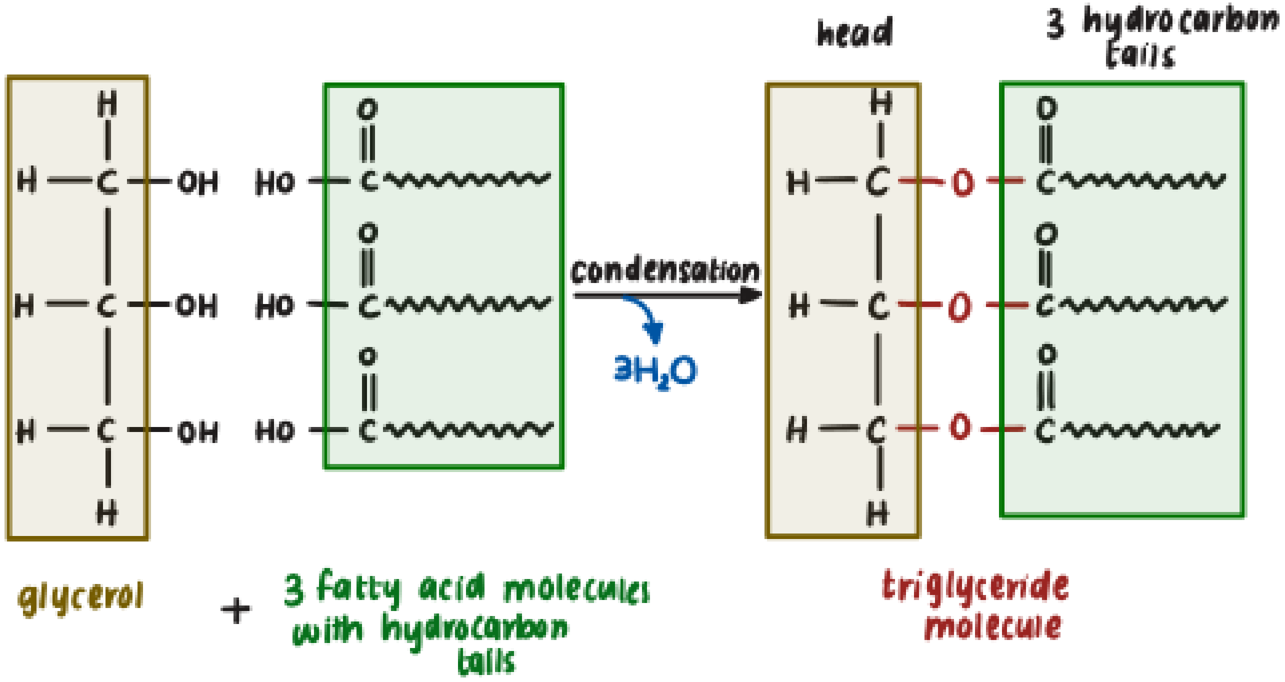
Insoluble doesn't dissolve incubator and therefore doesn't affect the osmotic pressure inside the cell

Lipids

↪ Composed of carbon, hydrogen and oxygen. However, lipids contain much lower proportion of oxygen than carbohydrates.

Triglycerides

↳ Synthesized in a condensation reaction (also known as esterification) where one molecule of glycerol joins with three fatty acids



For each fatty acid that joins to one of the hydroxyl (-OH) groups on the glycerol, an ester bond is formed, and one molecule of water is released.

Therefore, the formation of one complete triglyceride molecule produces a total of three ester bonds and releases three molecules of water

Fatty acid tails depend on:

number of carbons which determines the length of the chain

types of bonds between the carbon atoms can be either single (saturated) or double (unsaturated)

Unsaturated fatty acid	Saturated fatty acid
Made of carbon, hydrogen and oxygen linked by covalent bonds Glycerol head and 3 fatty acid tails	
One or more carbon -to-carbon double bond	Single carbon-to-carbon bond
High C:H ratio Low H:C ratio	Low C:H ratio High H:C ratio
Branched and distant because of kinks at the position of double bonds	Straight and tightly packed
the distant fatty acids cannot form strong intermolecular forces which result in cower melting points	High melting point because of strong intermolecular forces of attraction

CP 02 - Investigating the Vitamin C Content of a Food Sample

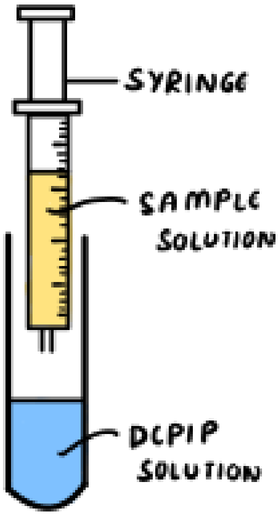
DCPIP is a blue dye that is reduced by vitamin C, causing it to change from blue to colourless. The amount of vitamin C present can be determined using a calibration curve.

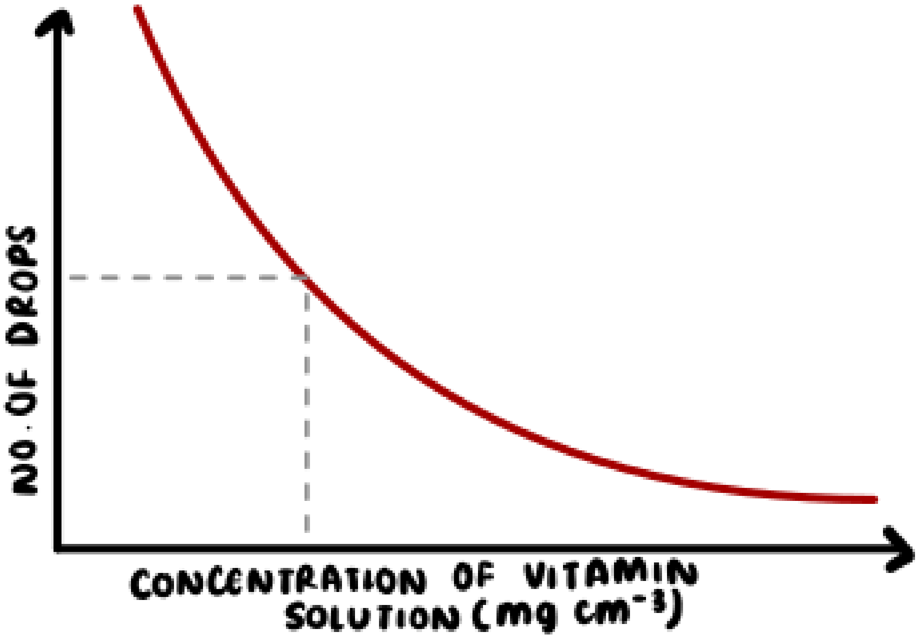
Method

1. Prepare a 1 mg cm^{-3} vitamin C solution and make serial dilutions to produce concentrations of 0.5, 0.25, 0.125, and 0.0625 mg cm^{-3}.
2. Measure the same volume of DCPIP into separate test tubes.
3. Add the vitamin C solution dropwise, shaking for 30 seconds after each addition until the blue colour changes to colourless.
4. Record the number of drops (or volume) of vitamin C solution needed to decolourise the DCPIP.
5. Repeat each concentration three times and calculate the mean.
6. Repeat the procedure for all the serial dilutions.
7. Plot a calibration curve with vitamin C concentration on the x-axis and the volume (or number of drops) required to decolourise DCPIP on the y-axis.
8. Test the unknown food sample using the same method, then use the calibration curve to determine its vitamin C concentration

Control Variables

- Temperature
- Volume of DCPIP
- Time spent shaking the solution
- Same drop size (or same measuring equipment) throughout the experiment





epidemiology of CVD

A branch of medical science studying the patterns of diseases and their causes in a population group it focuses on a majority rather than minority (community-based approach)

- **Correlation:** A change in one variable is reflected by a change in another. For example, smoking rates and lung cancer rates both increased over time.
- **Causation:** A change in one variable is directly responsible for the change in another.
- **Risk:** the likelihood of something unfavorable to happen
- **Actual risk** = measurable, statistical probability.
- **Perceived risk** = how risky an activity feels, shaped by emotions and society.

Features of valid study design

Valid Variables The study should have a single independent variable (what is changed), a clear dependent variable (what is measured), and all other potential variables must be controlled (kept constant).

Large Sample Size A large number of subjects make the results more representative of the population and increases reliability.

Control Group A group that does not receive the treatment (e.g., is given a placebo). This allows for comparison to determine if the independent variable was truly responsible for the observed effect.

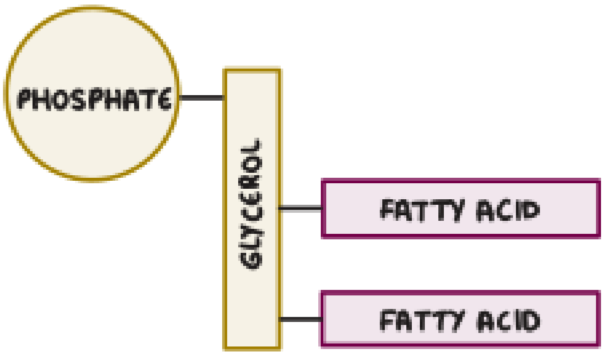
Long Duration For chronic diseases like CVD, studies must run for many years to observe the development of the condition.

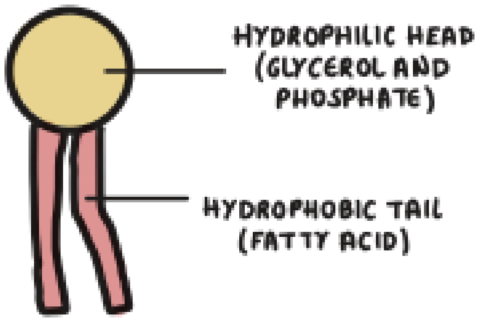
Repeatability/Reproducibility Results should be repeatable (the same researcher gets the same results) and reproducible (other researchers get the same results) to ensure they are reliable and not due to chance.

Statistical Tests Used to determine if the observed differences between groups are statistically significant (unlikely to have occurred by chance). Statistical tests such as the correlation coefficient determine if there is a correlation between factors or if there is a significant difference (T-test) between two samples.

cell membrane

phospholipids




HYDROPHILIC HEAD (GLYCEROL AND PHOSPHATE)
HYDROPHOBIC TAIL (FATTY ACID)

↳ a type of lipid used as a structural component of the cell membrane.

↳ phospholipid is made up of two parts:

A hydrophilic 'head'
A hydrophobic 'tail'

↳ The hydrophilic head contains glycerol and phosphate.

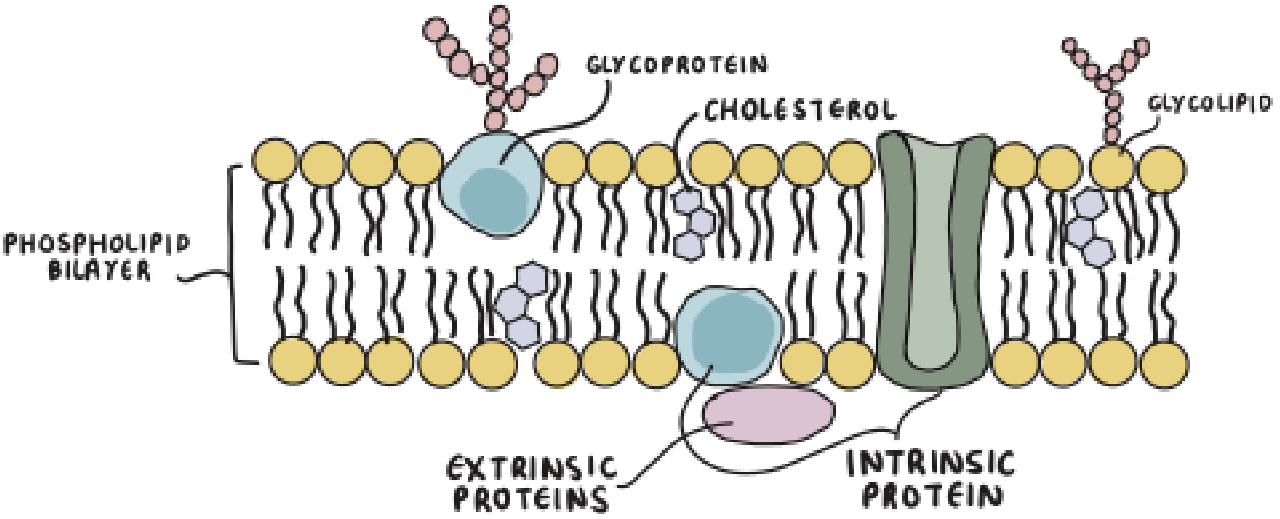
↳ The hydrophobic tail contains fatty acids.

↳ The phosphate group is polar and so attracts water (hydrophilic) whereas the fatty acid tails repel water (hydrophobic). The types of molecules are classified as amphipathic molecule

Fluid mosaic model

"Fluid" Phospholipid molecules and some proteins molecules are in continuous motion sideways within their monolayer, exchanging places and bumping into each other and giving the membrane a flexible structure that is constantly changing shape

"Mosaic": This term refers to the random distribution of proteins also because they vary in shape, size and pattern in the phospholipid bilayer.



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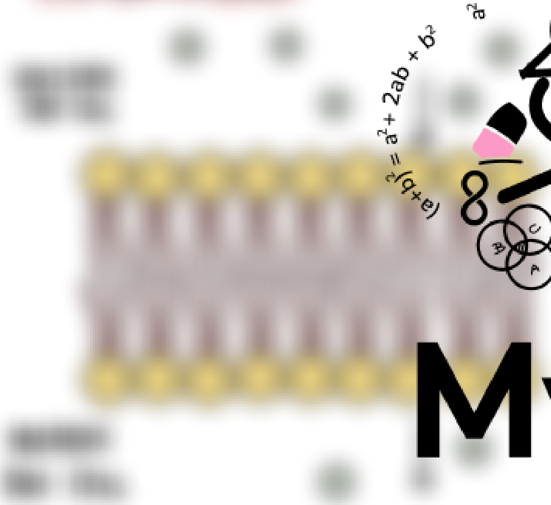

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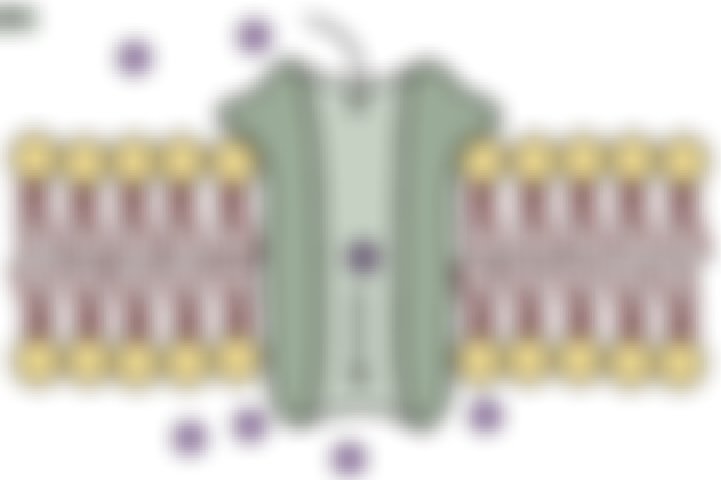

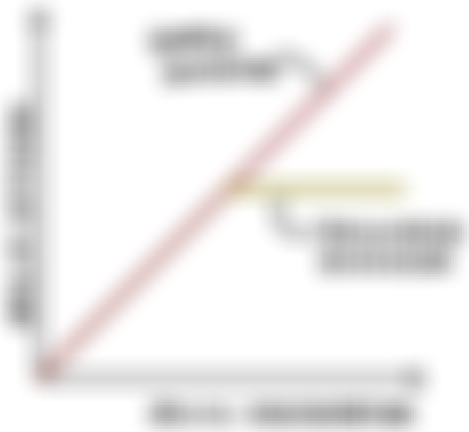

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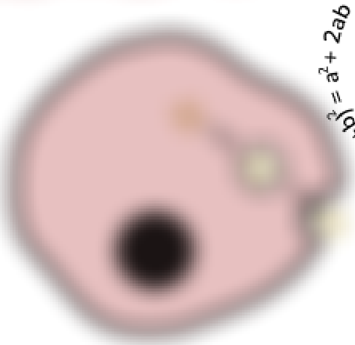

CP 03 - Investigating Cell Membrane Permeability

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Method (Temperature Investigation):

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Control Variables:

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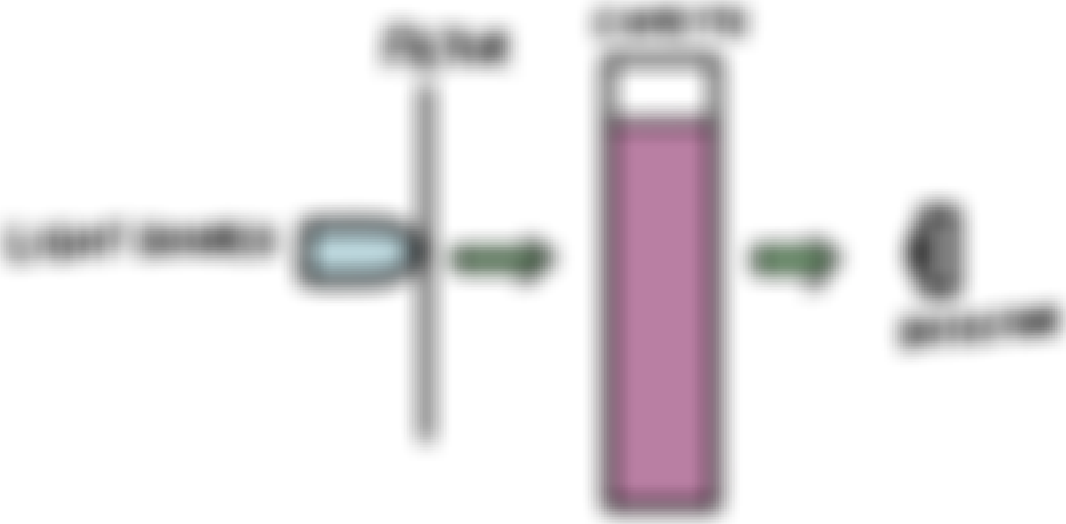

Effect of Temperature on Membrane Permeability

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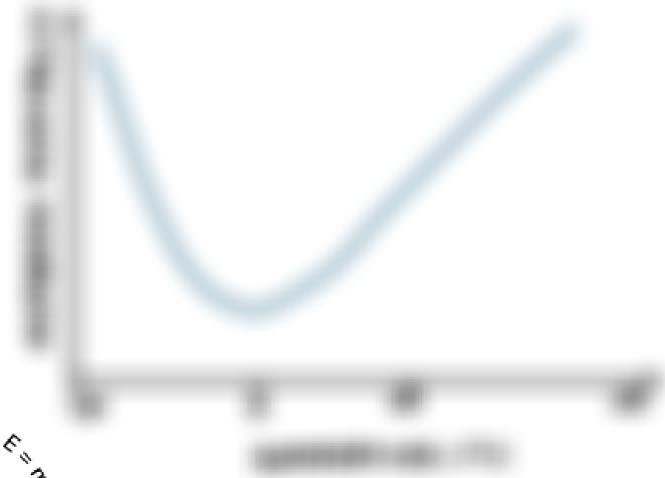

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Effect of Ethanol on [illegible]

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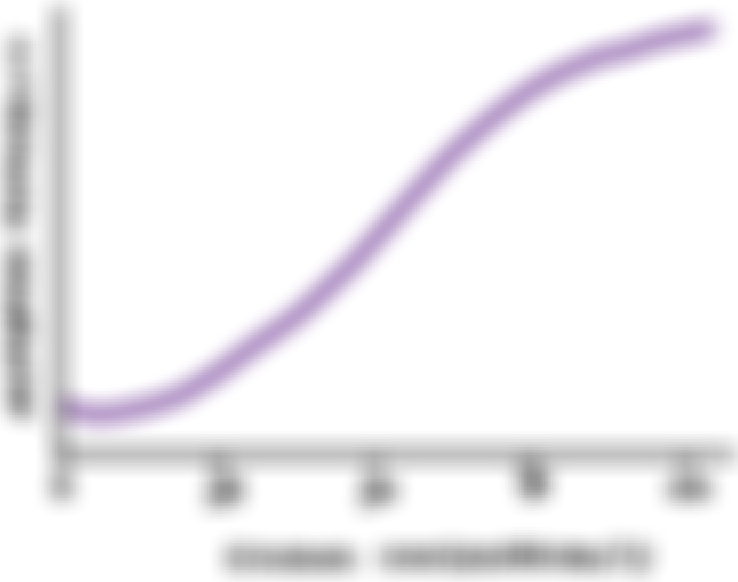

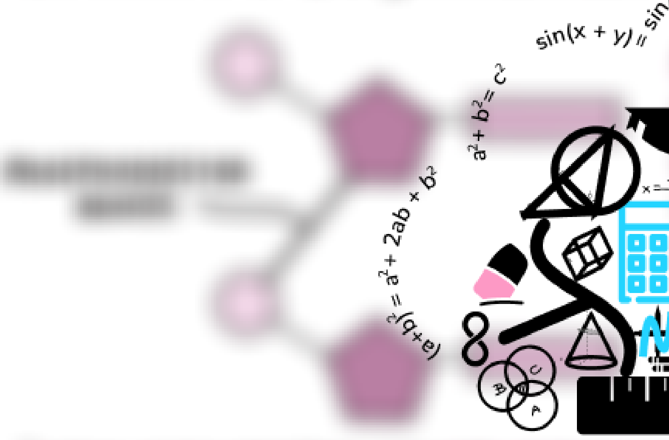

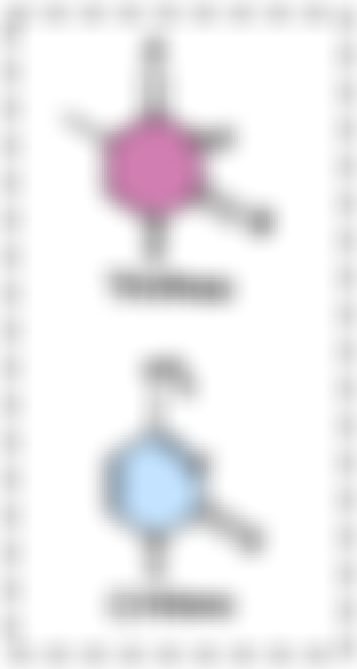

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GENETIC CODES

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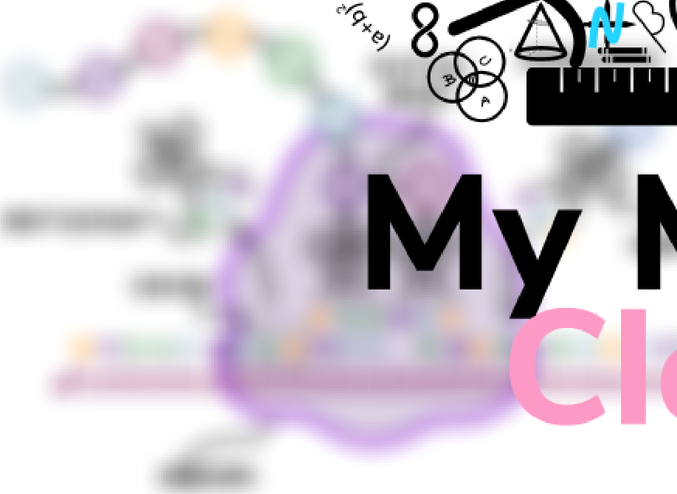

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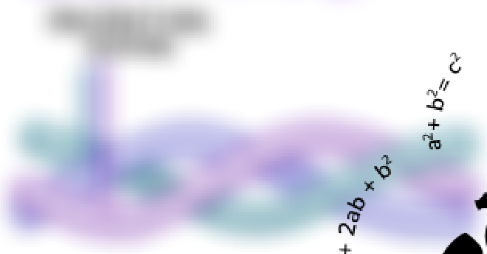

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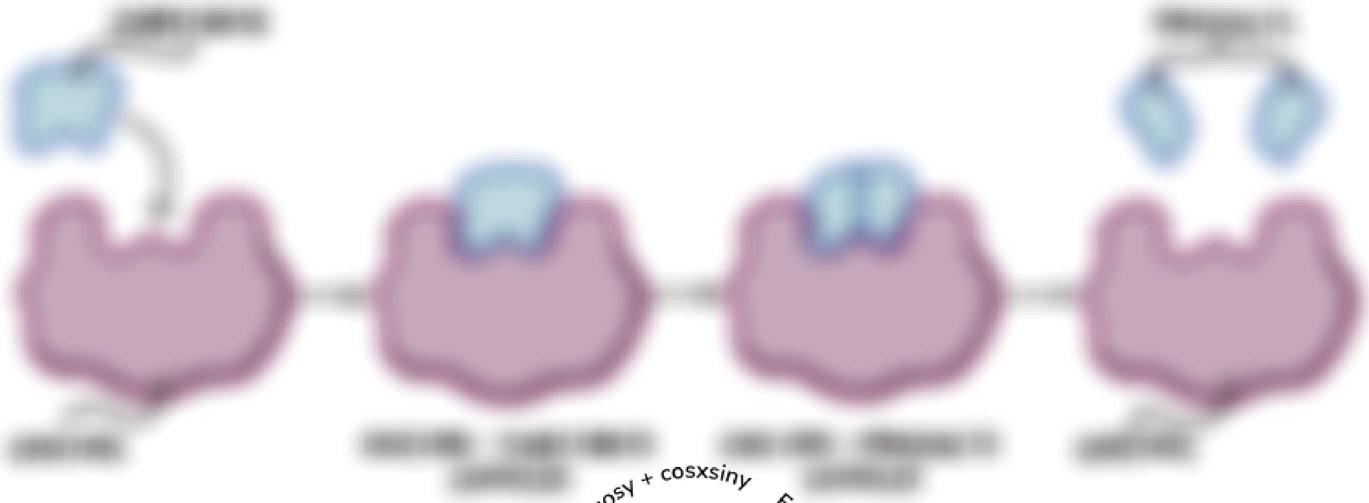

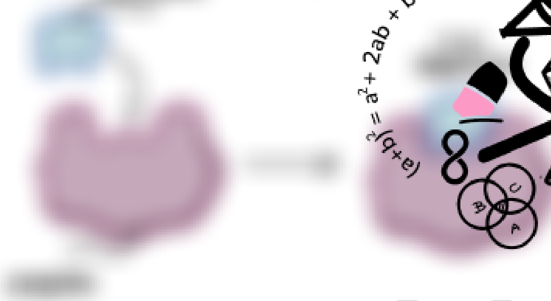

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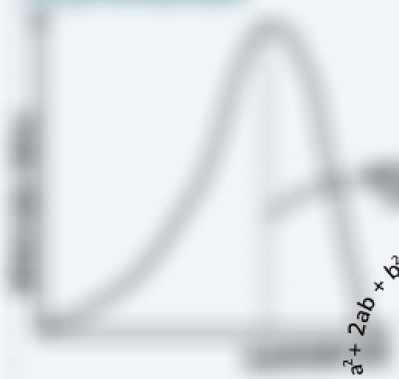

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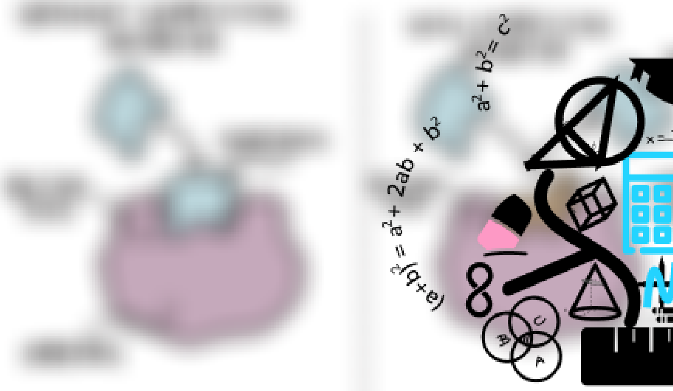

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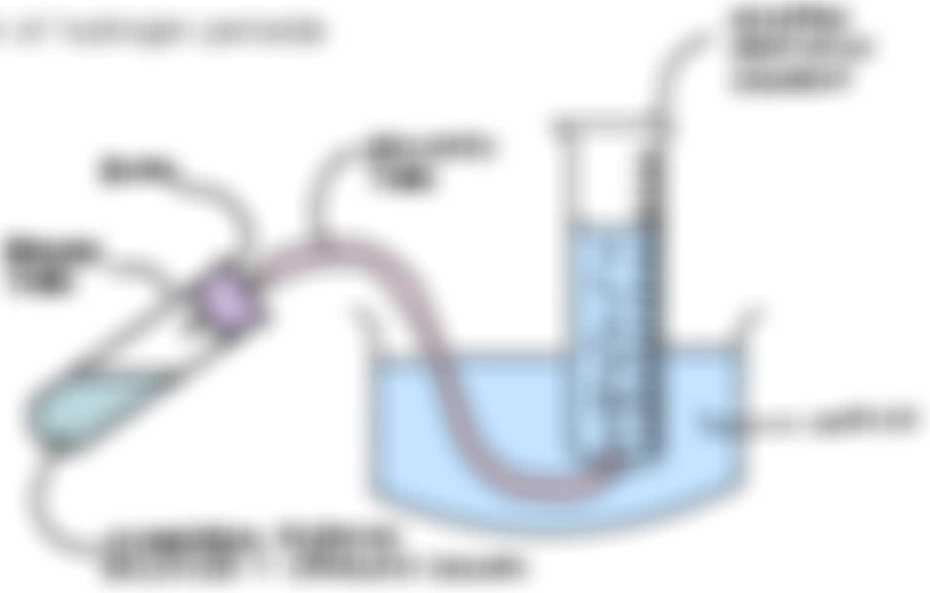

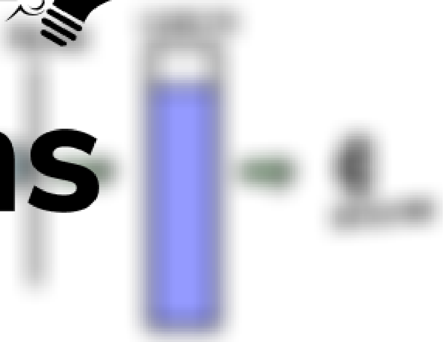

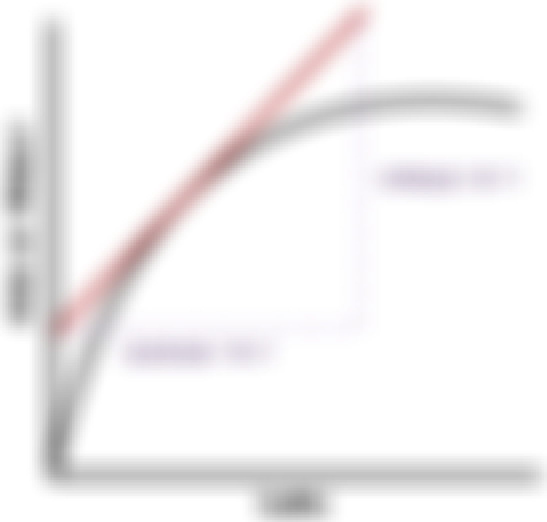

MUTATIONS

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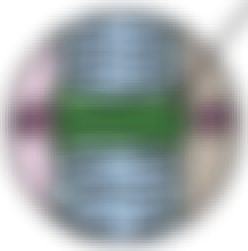

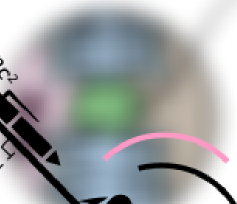

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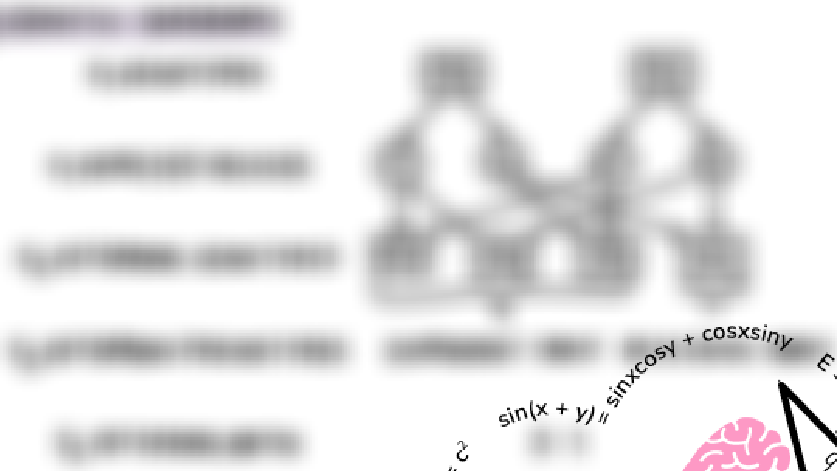

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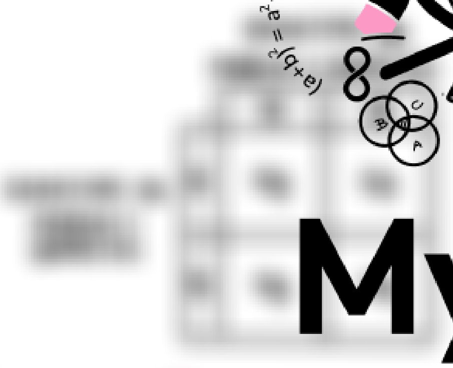

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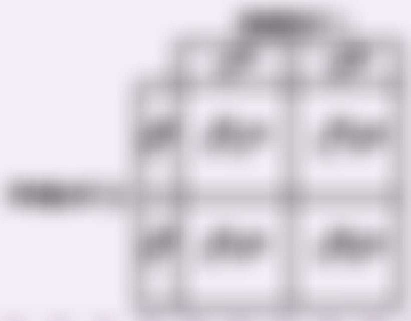

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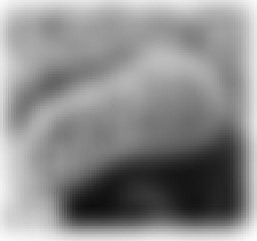

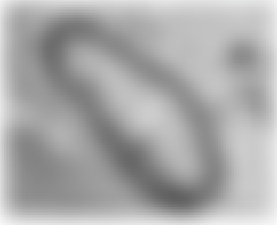

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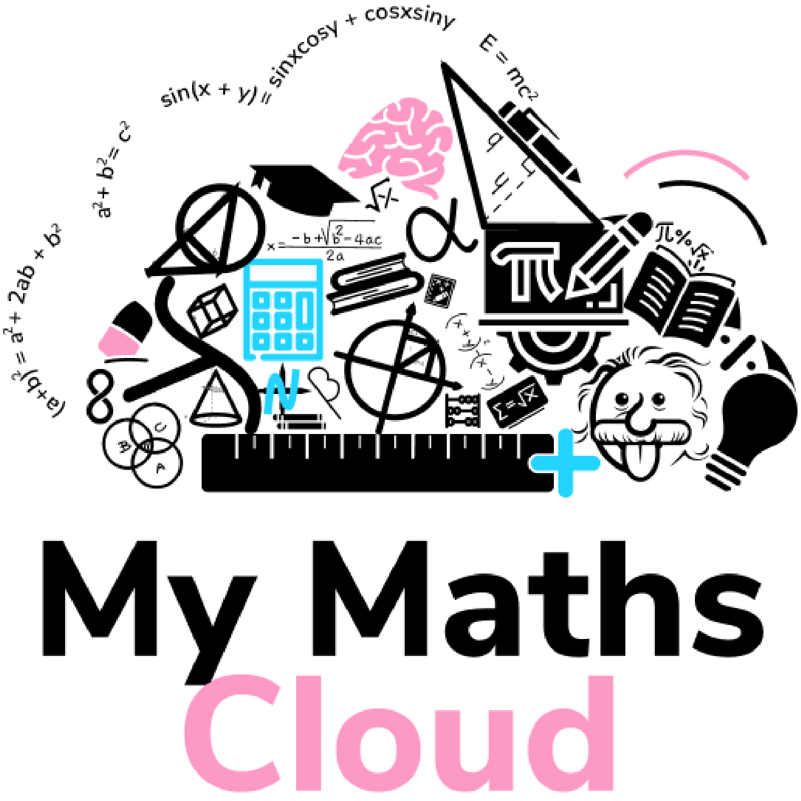
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E = mc²
a² + b² = c²
(a+b)² = a² + 2ab + b²
My Maths
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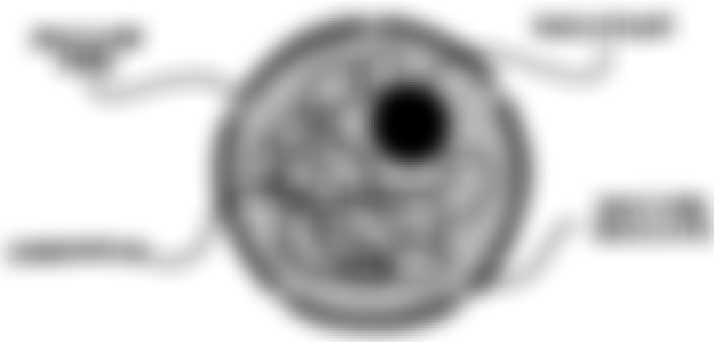

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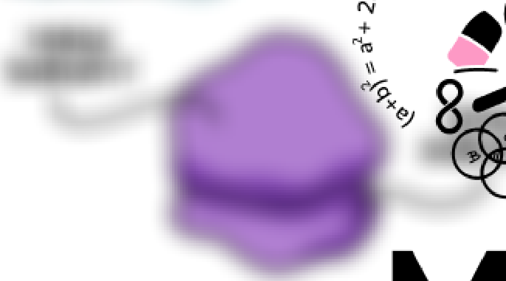

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sin(x + y) = sinxcosy + cosxsiny
E = mc²
My Maths Cloud

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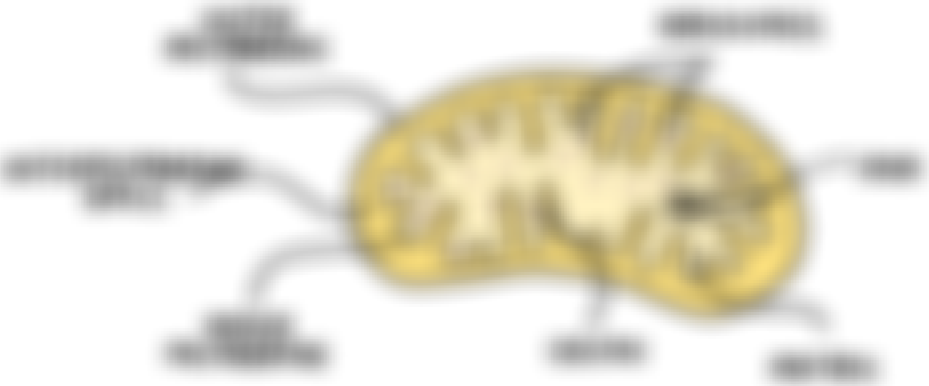

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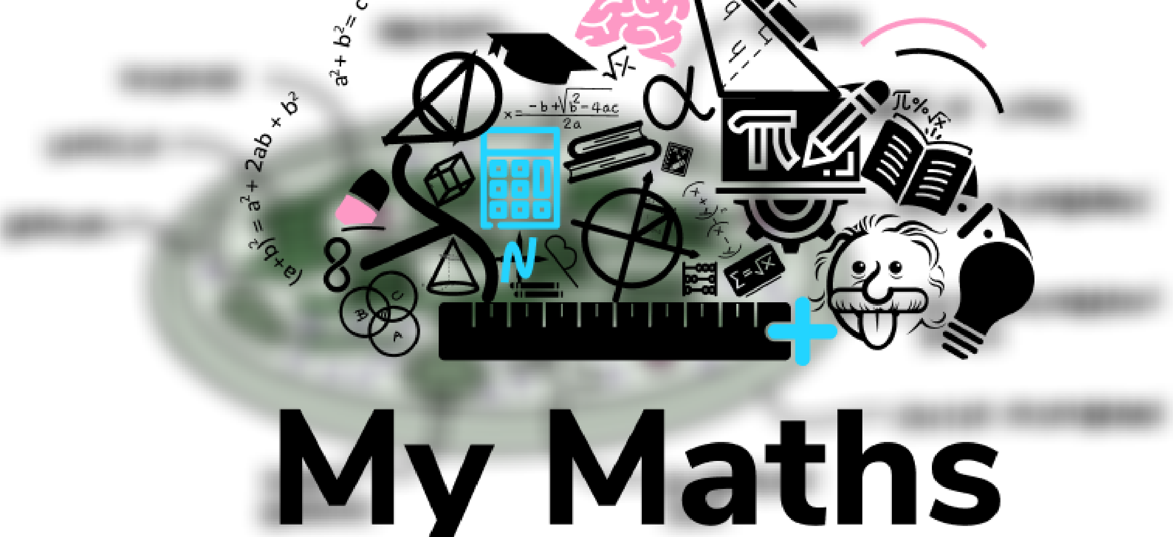

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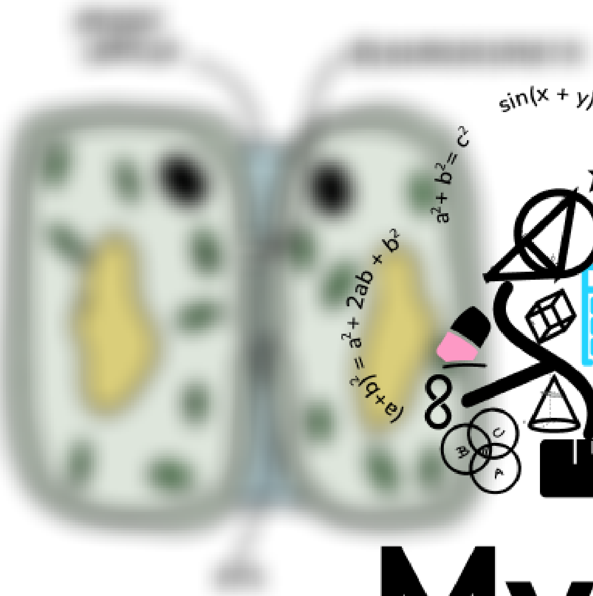

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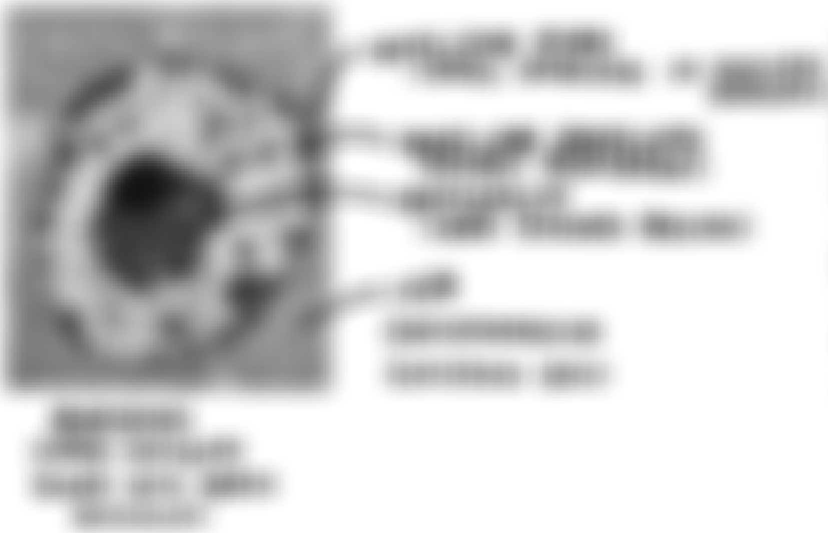

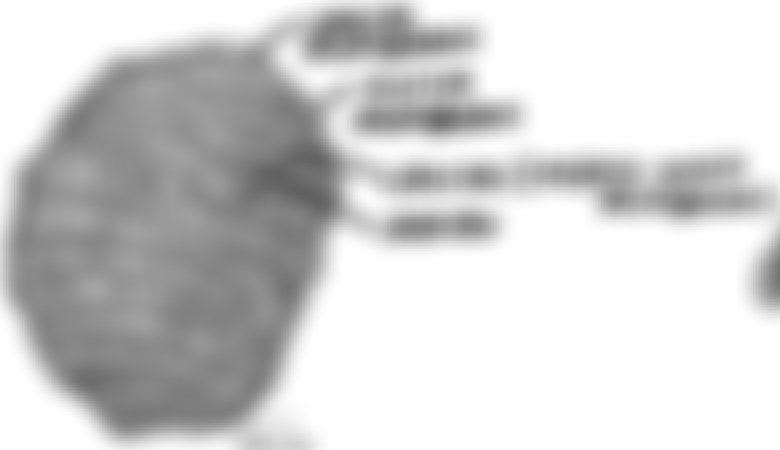

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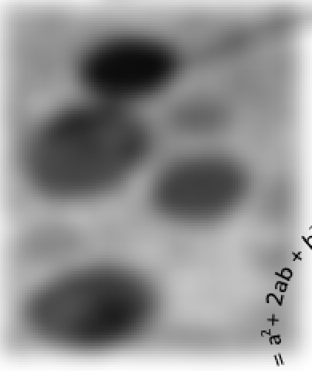

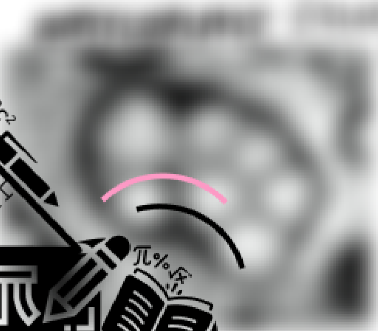

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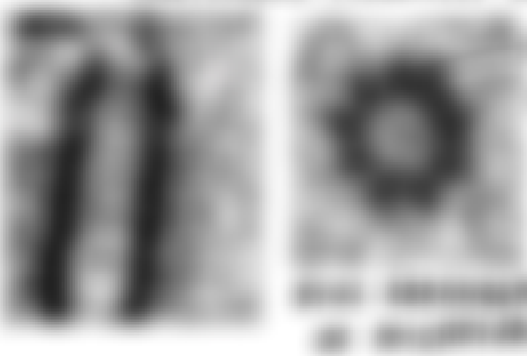

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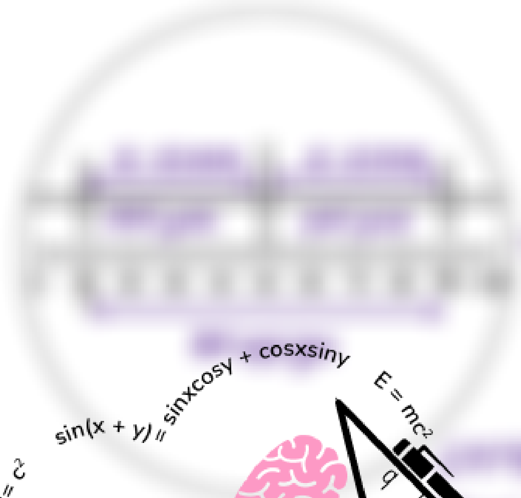

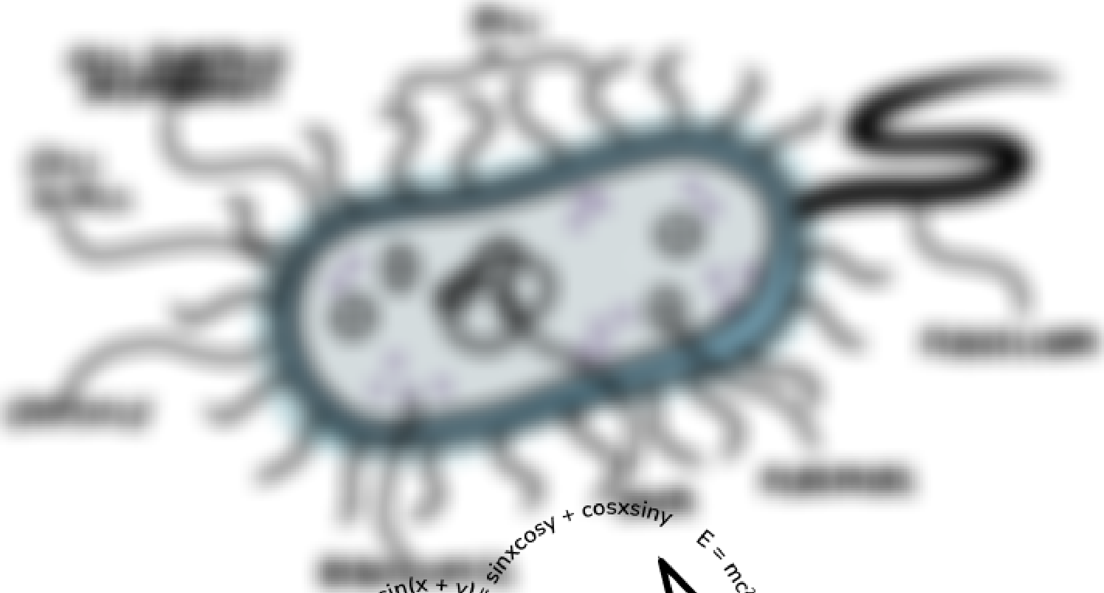

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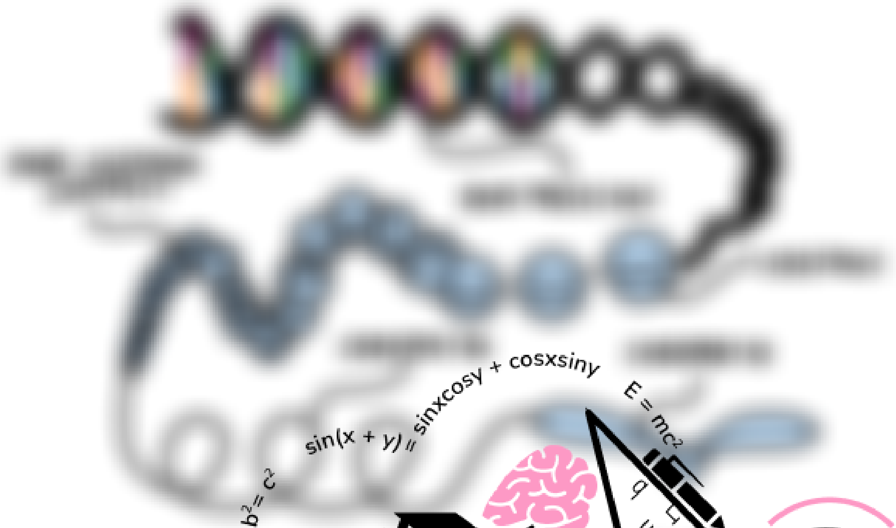

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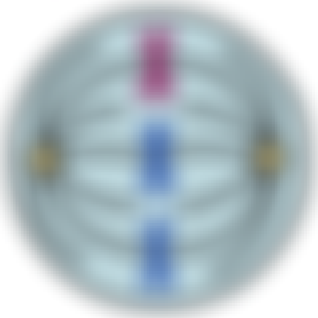

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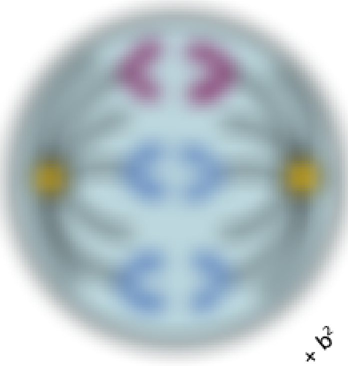

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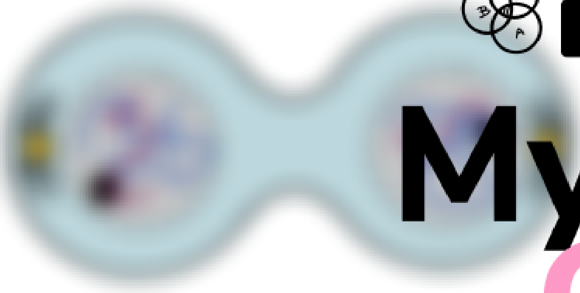

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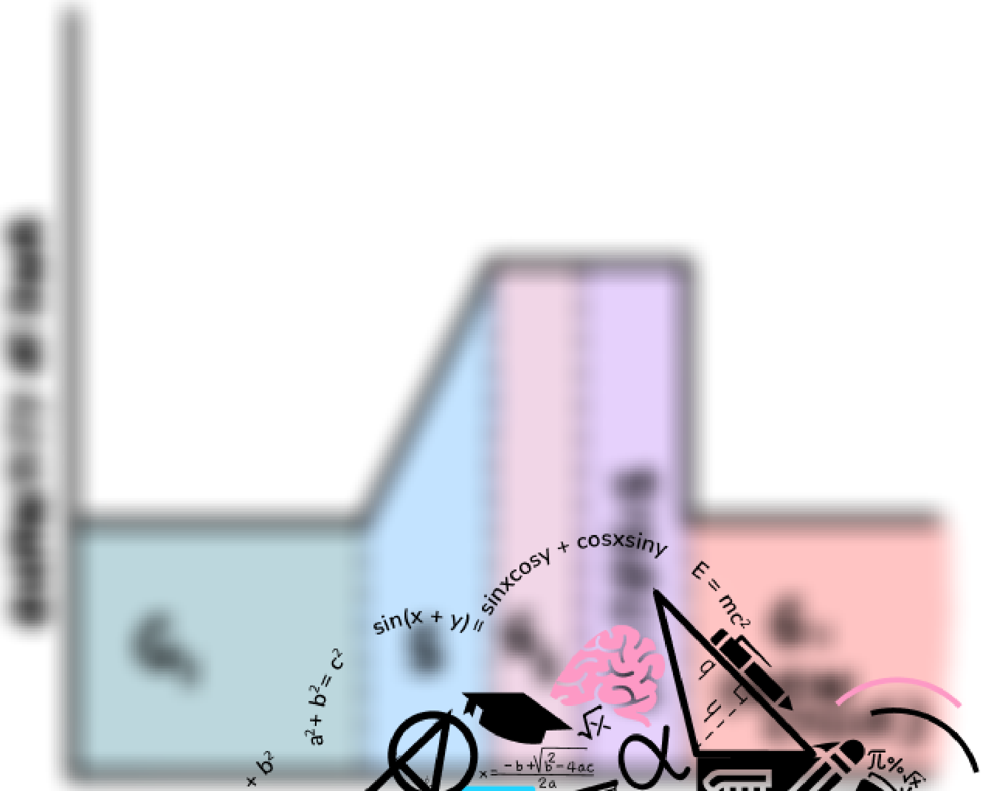

CP 6 - Investigating the Mitotic Index in Plant Root Tips

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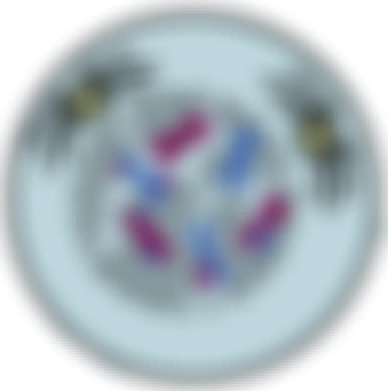
MEIOSIS

Meiosis is a type of cell division that occurs in sexually reproducing organisms.

Prophase I



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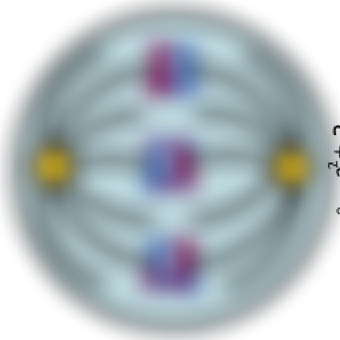
Metaphase I



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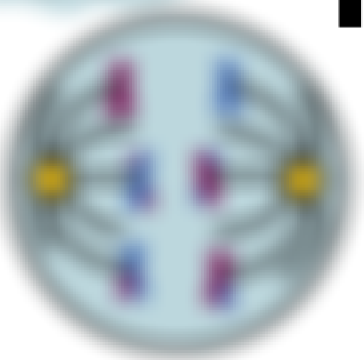
Anaphase I



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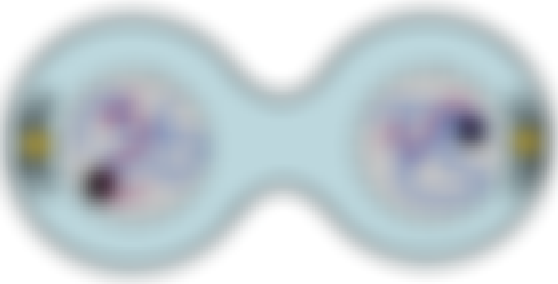
Telophase I



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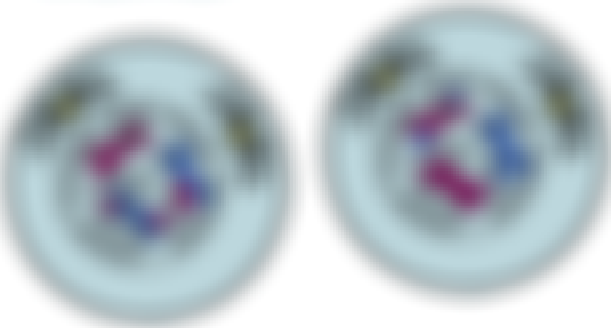

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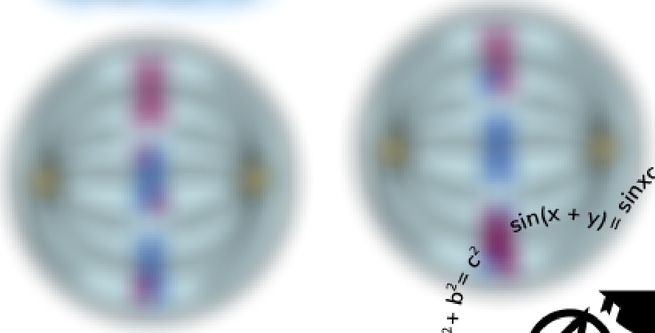

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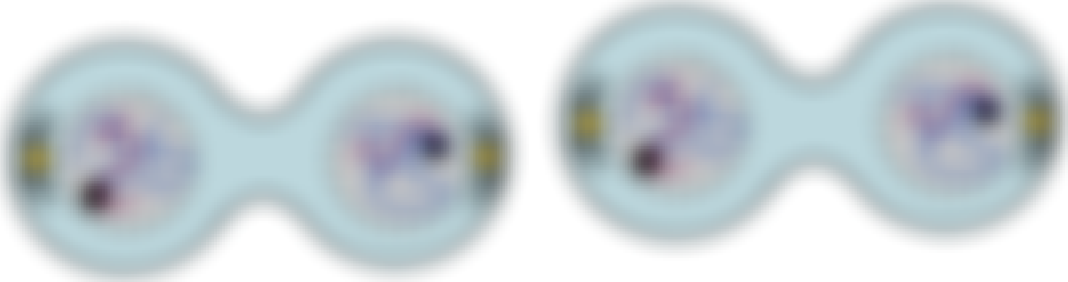

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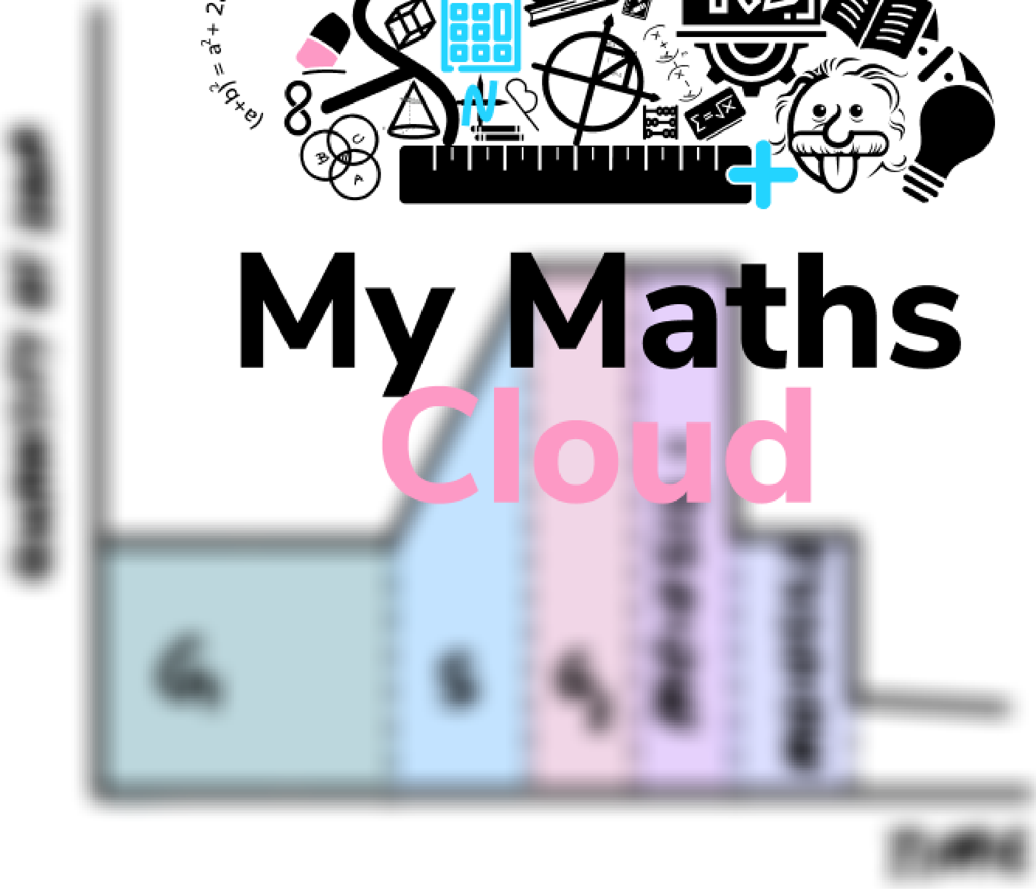

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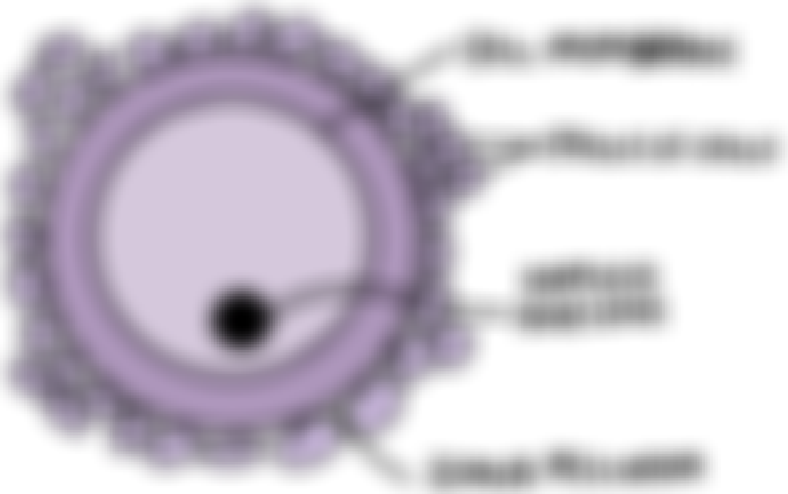

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My Maths
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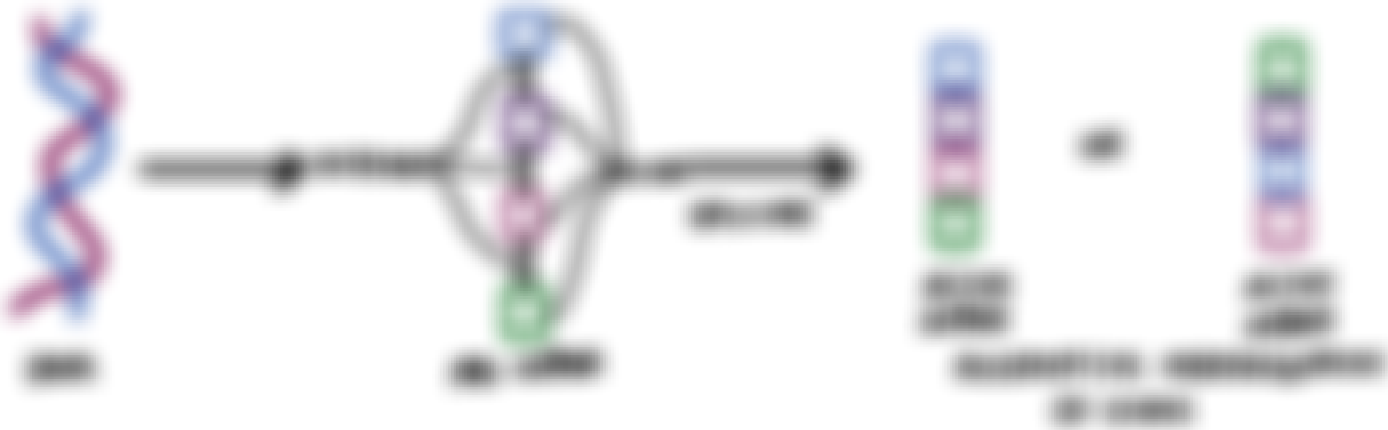
post-transcriptional modification



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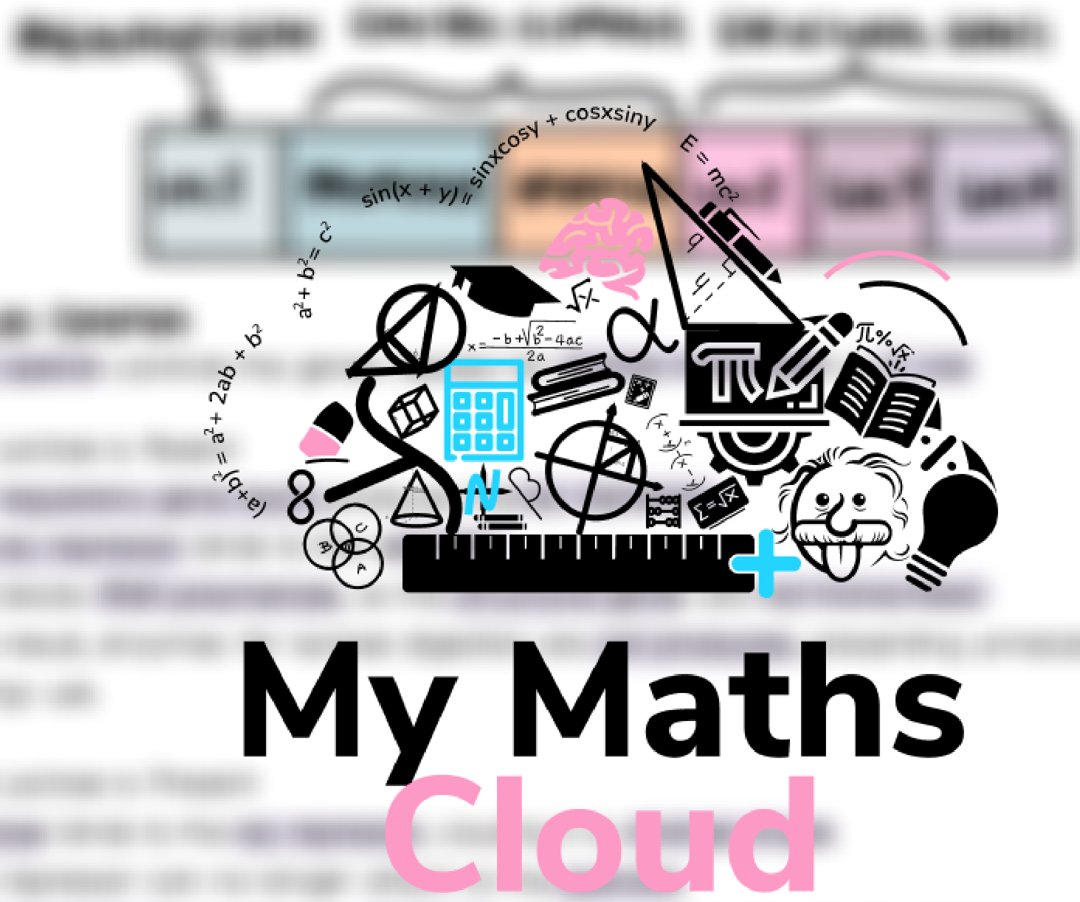
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E = mc²
a² + b² = c²
(a+b)² = a² + 2ab + b²
My Maths
Cloud

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STEM CELLS

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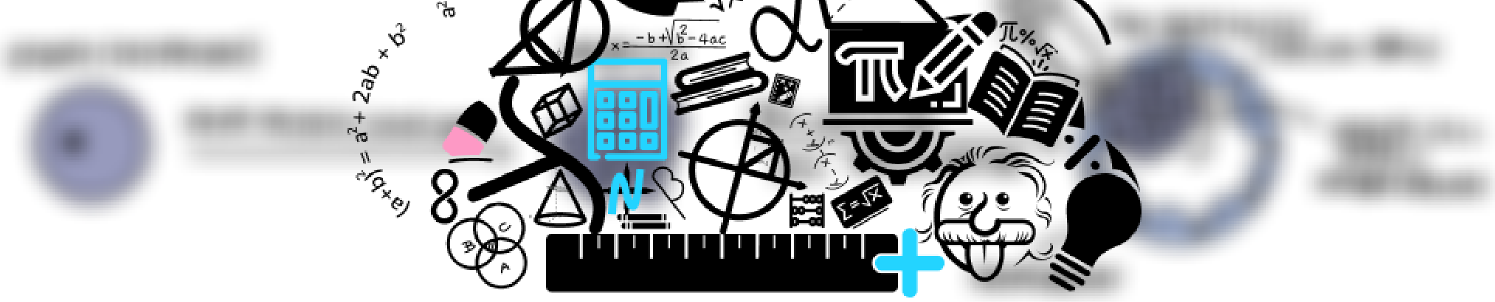

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My Maths
Cloud

Dihybrid inheritance

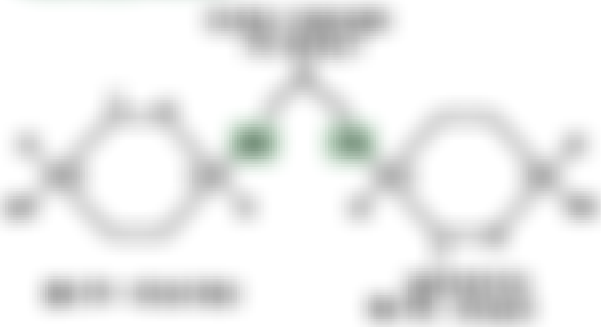
- This describes the inheritance of two different genes located on different chromosomes (unlinked) in the gametes.
- Takes place during independent assortment. Because the genes are on separate chromosomes, they are inherited independently of one another during meiosis. This leads to up to four different combinations of alleles in the gametes.
- A cross between two heterozygous individuals with genes (e.g. AaBb × AaBb) produces a [illegible] ratio in the offspring of [illegible].

Gene linkage

- The locus is the position of a gene on a chromosome.
- Genes located on the same chromosome are called linked genes and are usually inherited together.
- Linked genes are separated [illegible] during meiosis.
- For crossing over to separate the genes, a [illegible] must form between their loci.
- The closer together two genes [illegible] between them.
- Therefore, genes with [illegible] together, so offspring are more likely to [illegible].

[illegible]

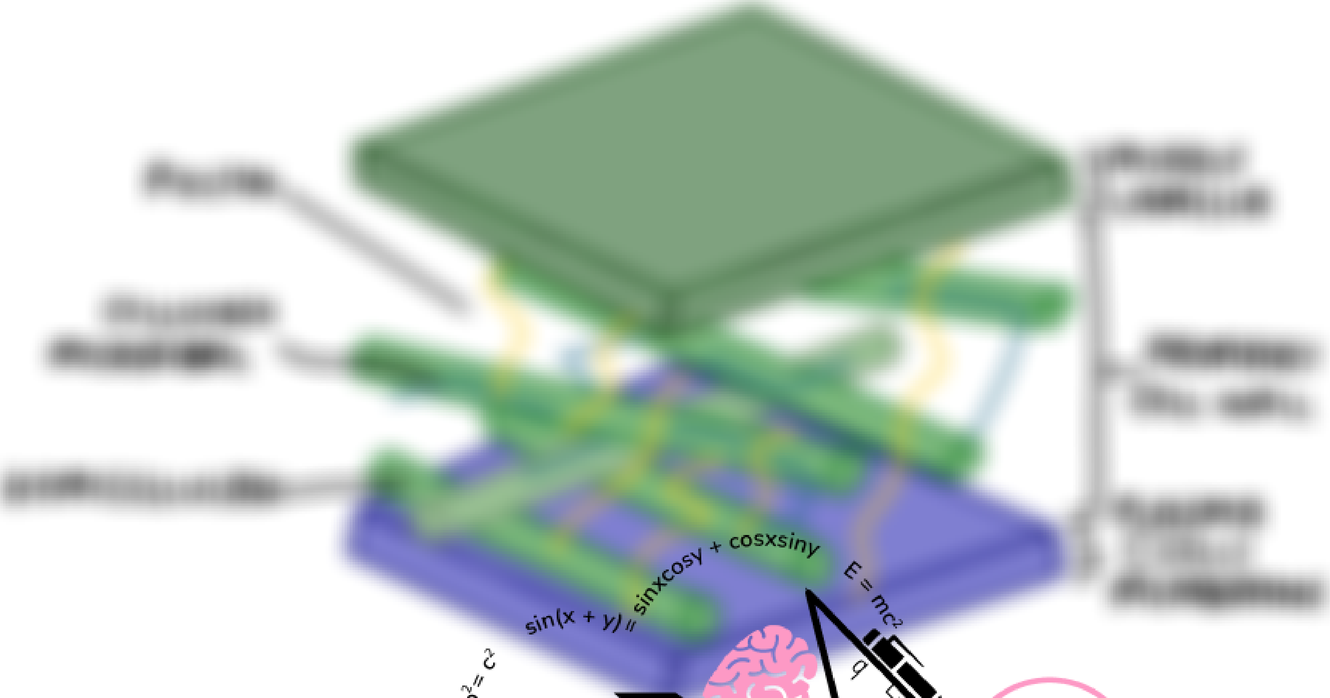
[illegible]



[illegible]

[illegible]

[illegible]	[illegible]
[illegible]	
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]



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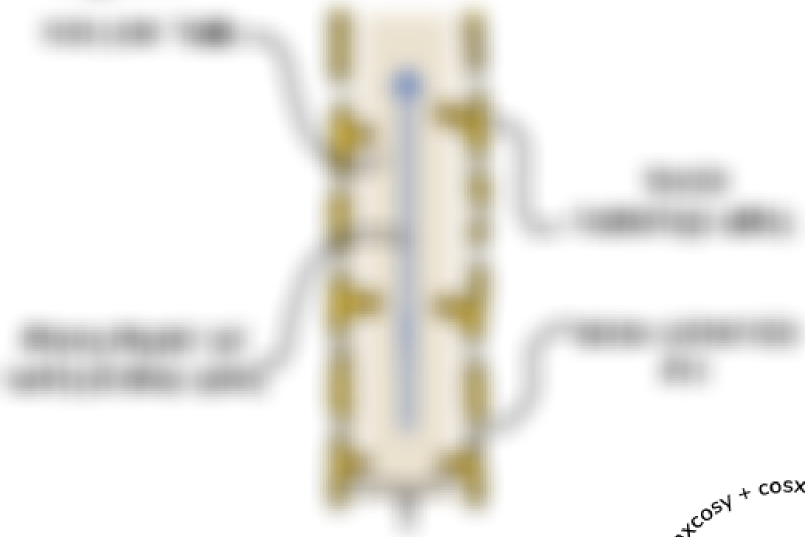
VASCULAR BUNDLES

[illegible]



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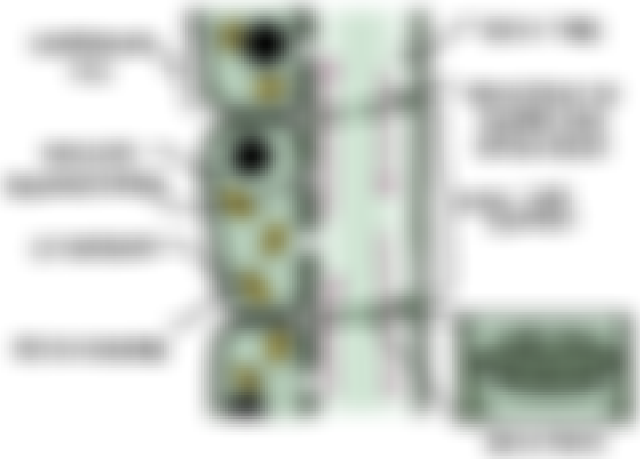
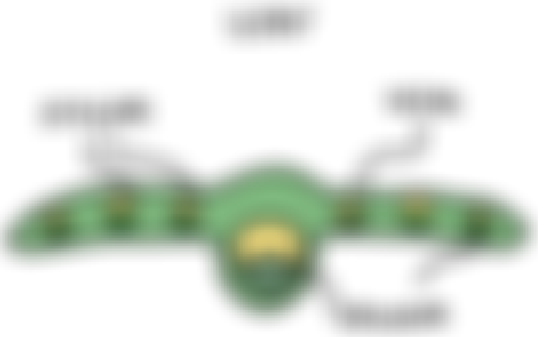
[illegible]

[illegible]



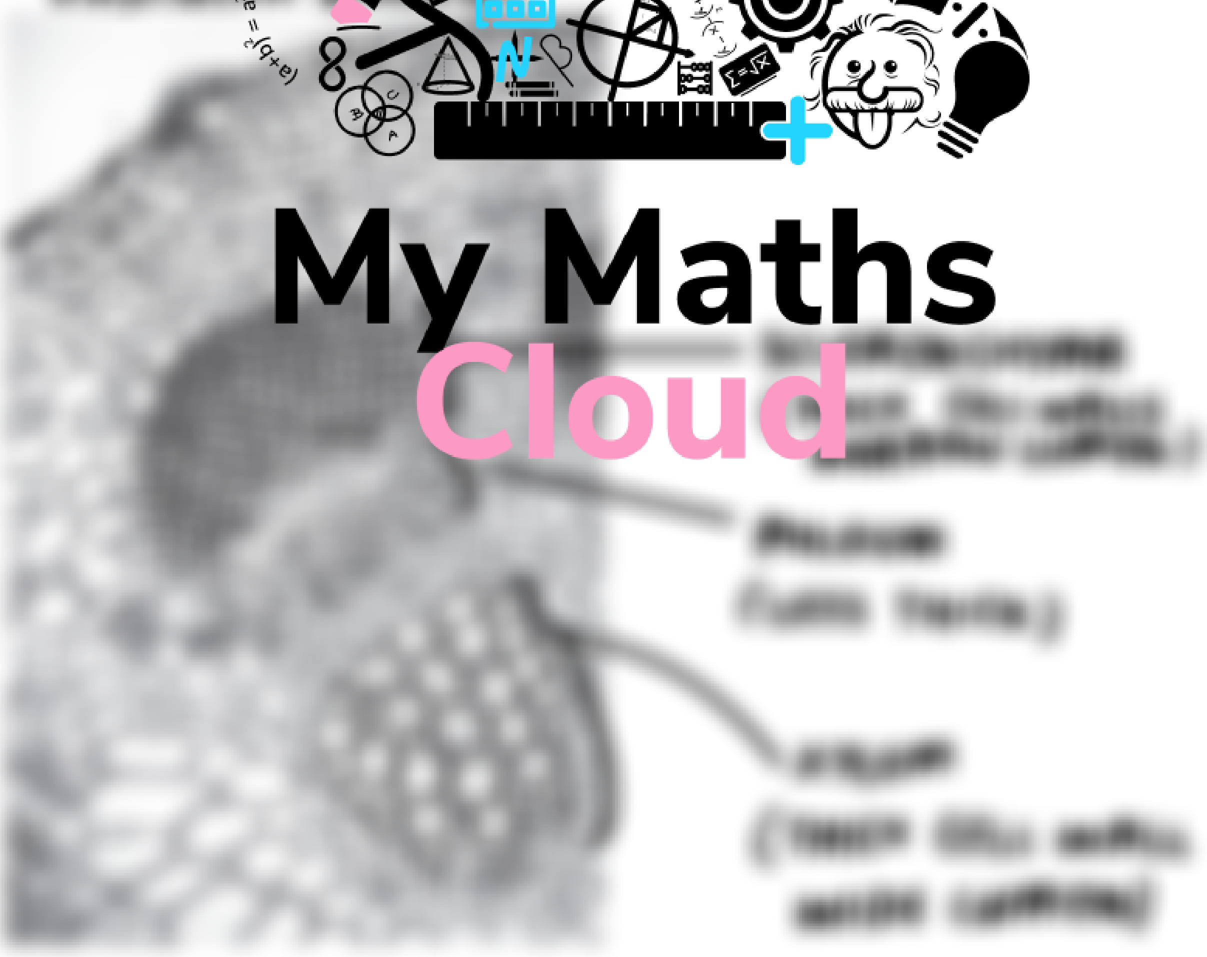


CP 04 - Dissecting Plant Stems to Observe Vascular Bundles

1. [illegible]
2. [illegible]
3. [illegible]
   - [illegible]
   - [illegible]
4. [illegible]
5. [illegible]

[illegible]

[illegible]



CP 05 - Measuring the Tensile Strength of Plant Fibres

[illegible]

[illegible]

1. [illegible]
2. [illegible]
3. [illegible]
4. [illegible]
5. [illegible]
6. [illegible]

[illegible]

[illegible]

Cp [illegible]- Investigating the Effect of Mineral Ion Concentration on Plant Growth

1. [illegible]
2. [illegible]
3. [illegible]
4. [illegible]
5. [illegible]
6. [illegible]
7. [illegible]

[illegible]

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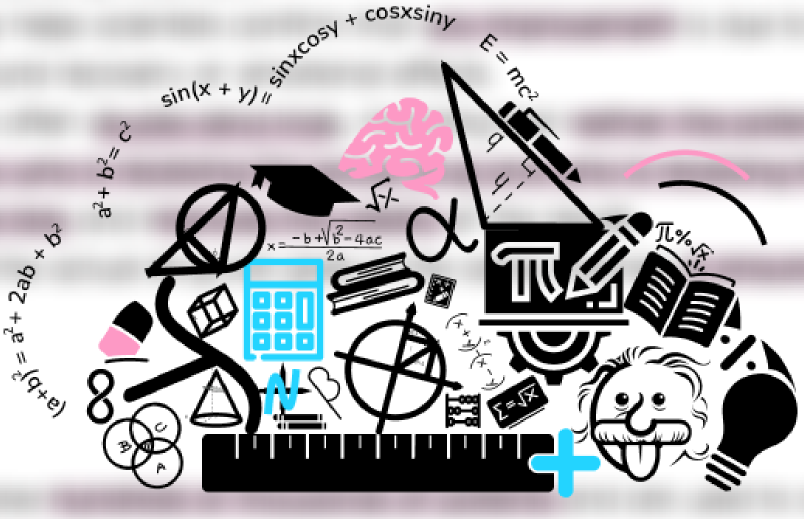
[illegible]



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[illegible]

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Cp 6.6 - Preparing Plant Extracts and Testing Antimicrobial Activity

Preparing a Plant Extract

1. [illegible]
2. [illegible]
3. [illegible]
4. [illegible]
5. [illegible]

Testing Antimicrobial Activity

1. [illegible]
2. [illegible]
3. [illegible]
4. [illegible]
5. [illegible]
6. [illegible]
7. [illegible]

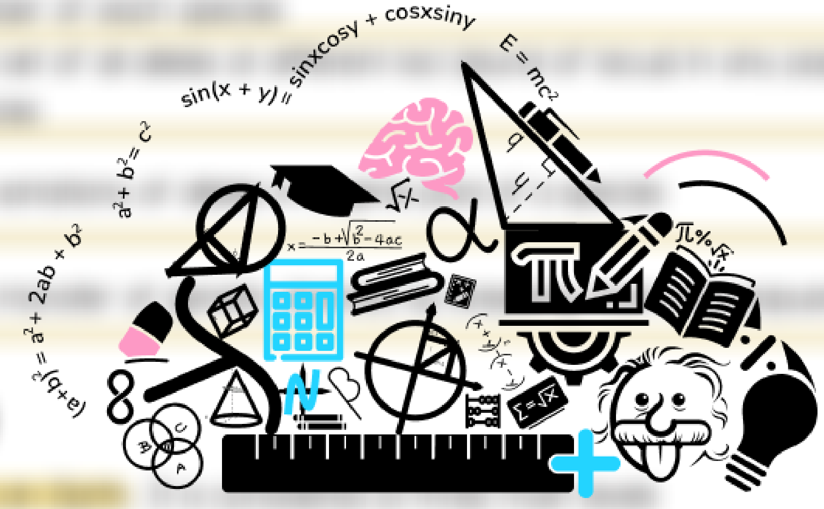
Aseptic Techniques

- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]

[illegible]

[illegible]

[illegible]



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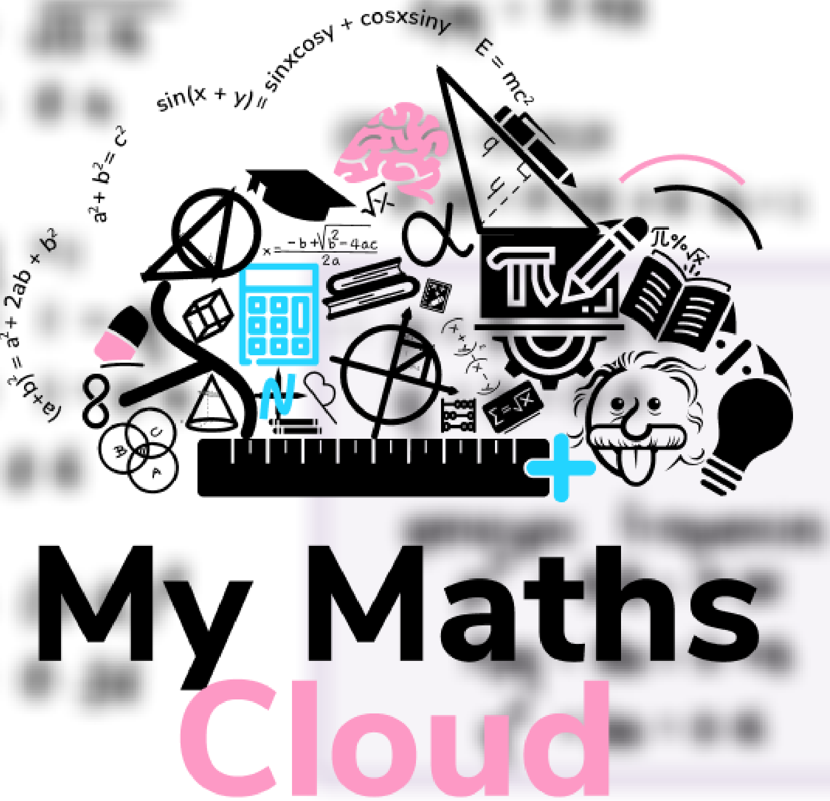
[illegible]

[illegible]

[illegible]



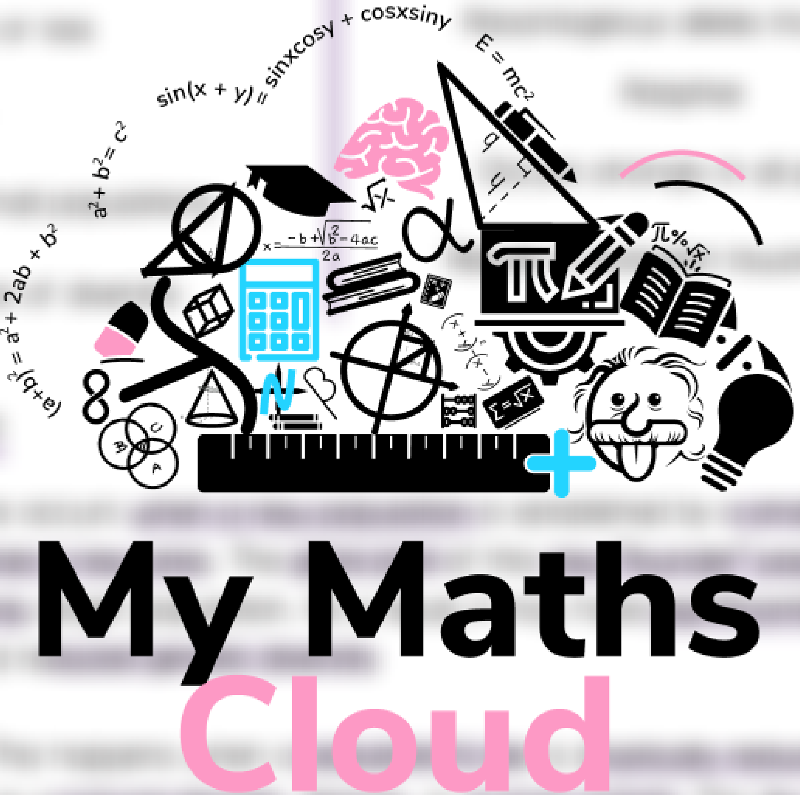
[illegible]

1. [illegible]
2. [illegible]
3. [illegible]
4. [illegible]
5. [illegible]

[illegible]

[illegible]

[illegible]


sin(x + y) = sinxcosy + cosxsiny
E = mc²
a² + b² = c²
(a+b)² = a² + 2ab + b²
x = −b ± √(b² − 4ac) / 2a
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[illegible]

[illegible]

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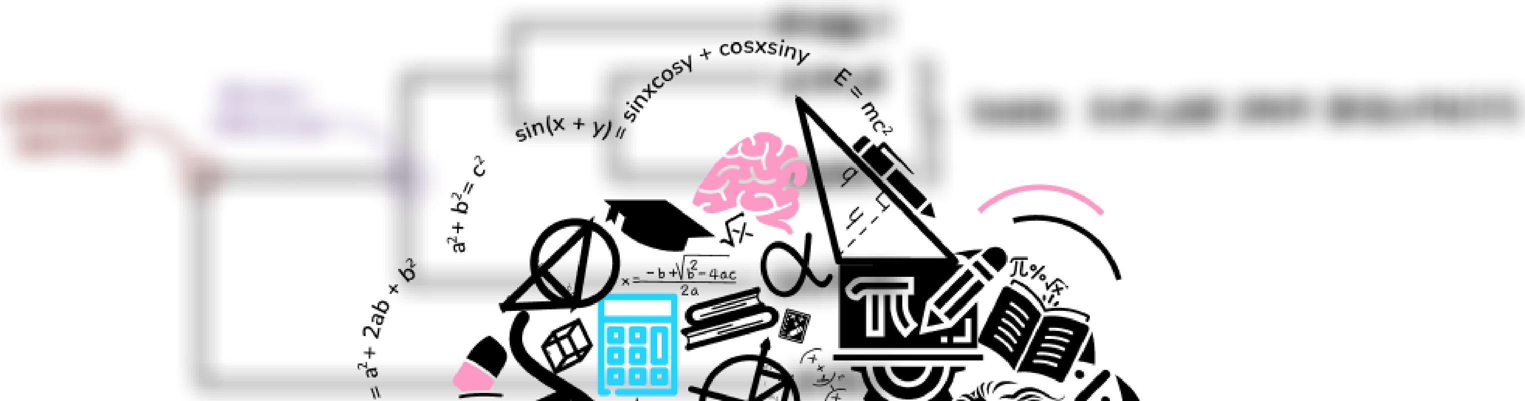

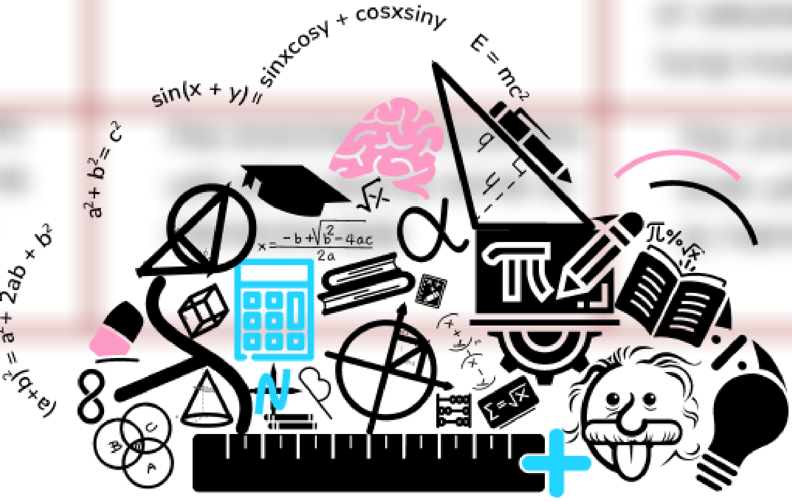

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