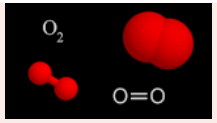
Science Particles

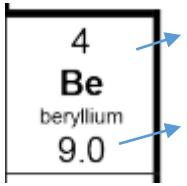
Trinity MAT

Key term	Definition
Atom	The smallest particle of an element.
Molecule	Two or more atoms joined together. 
Chemical reaction	One or more new substance(s) are formed. A chemical reaction is irreversible.
Physical change	No new substance is made. Often a change of state. A physical change is reversible.

Properties of the Atom

Atomic radius is typically about 1 x 10^{-10}m

Subatomic particle	Relative mass	Relative charge
Proton	1	+1
Neutron	1	0
Electron	0.0005	-1



Atomic number
Number of protons in the nucleus

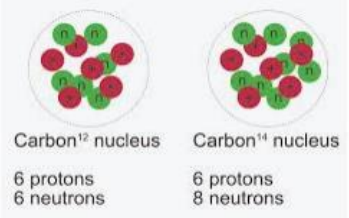
Relative Atomic Mass (RAM)
Number of protons + neutrons in the nucleus

Ions

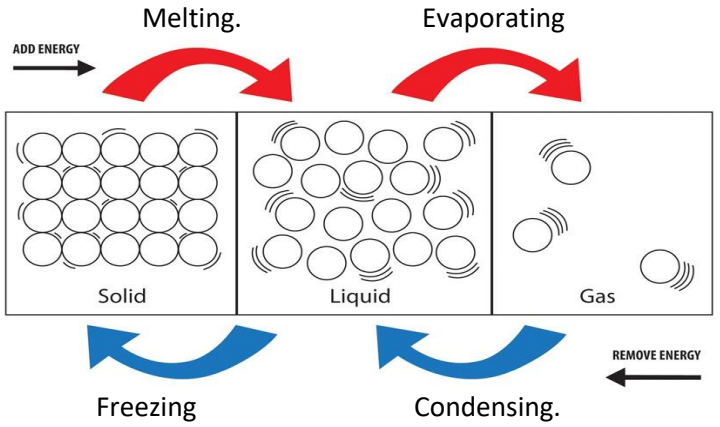
A charged particle formed when an atom loses or gains electrons.
Positive ions are formed when electrons are lost.
Negative ions are formed when electrons are gained.

Isotopes

Same number of protons but different numbers of neutrons e.g. isotopes of carbon (carbon-12 and carbon-13)



Particle models



Solid: Particles have a regular, uniform arrangement. Vibrate around a fixed point. Strong forces of attraction. Dense
Liquid: Particles in a random arrangement. Slide over each other. Medium forces of attraction and density.
Gas: Particles in a random arrangement. Move quickly in all directions. Weak forces of attraction and low density.

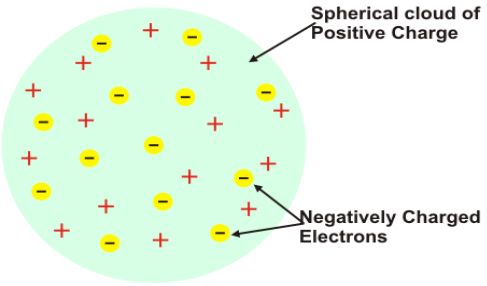
The attractive forces between particles are called electrostatic attraction. These are due to the positive and negative charges for the particles.

Atomic Models

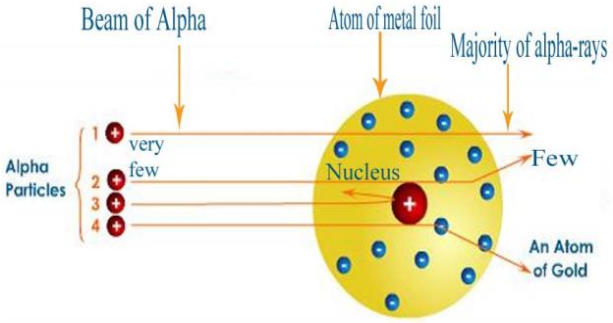
Thomson
(Plum pudding model) Discovered the electron. Suggested that **electrons were distributed evenly throughout the positive atom.**

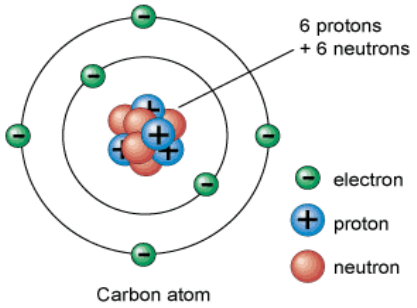
Rutherford
(Gold foil experiment) Evidence suggested the atom was **mostly empty space with a small, dense, positive nucleus**.

Bohr
Discovered that **electrons orbit the nucleus in shells**.



Thomson's Plum-Pudding Model

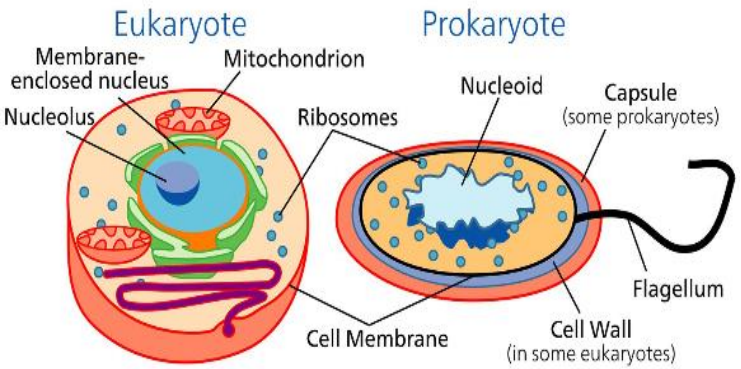




Science Cells – Cell Structures

Trinity MAT

Key Term	Definition
Nucleus	Contains genetic material, which controls the activities of the cell
Cytoplasm	Most chemical processes take place here, controlled by enzymes
Mitochondria	Most energy is released by respiration here
Ribosomes	Protein synthesis happens here
Cell membrane	Controls the movement of substances into and out of the cell
Cell Wall	Strengthens the cell
Chloroplast	Contain chlorophyll, which absorbs light energy for photosynthesis
Vacuole	Filled with cell sap to help keep the cell turgid
Microscope Cell Staining	A technique used to enable better visualisation of cells and cell parts under the **microscope**. By using different **stains**, a nucleus or a cell wall are easier to view.
Magnification	The magnifying power of a microscope
Resolution	The shortest distance between two points that can be made out as separate objects e.g. how well you can see detail.



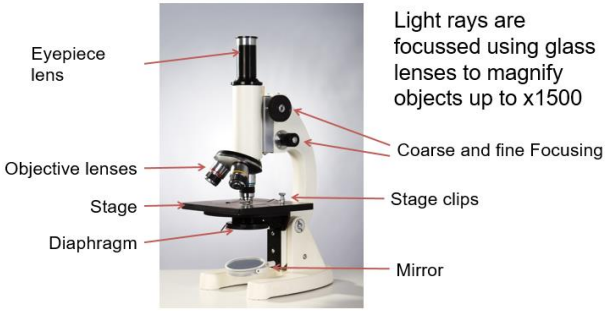
Magnification Calculations

Length of object = length of magnified object ÷ magnification

Example, if a specimen appeared 10mm in length under a microscope with a magnification of 1,000 times, the calculation of the actual length would be:

Length of object = 10 ÷ 1000
= 0.01 mm

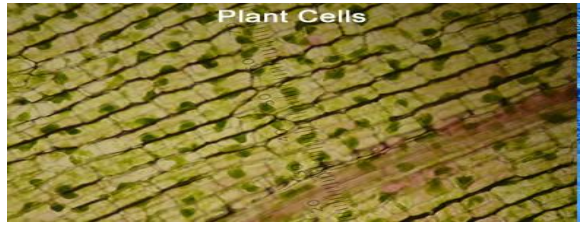
Light Microscopes

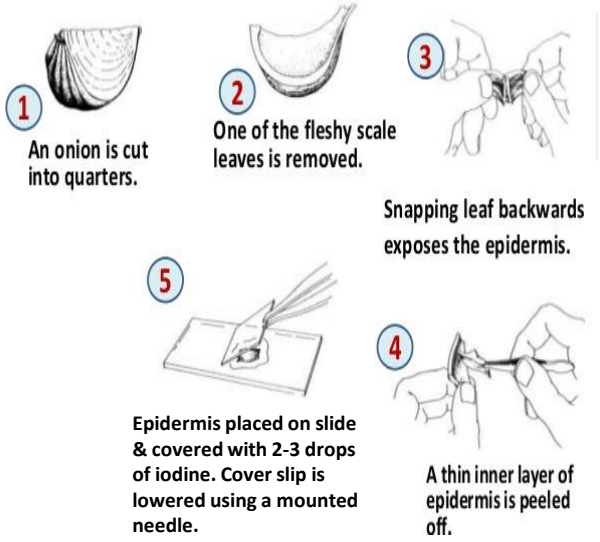


Light microscope:
✓ Can view living specimens
✓ Can view in colour
X Low resolution
X Low magnification

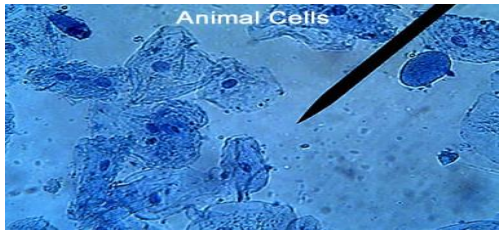
Electron Microscope
✓ High magnification
✓ High resolution
X Expensive
X Specimens are non-living
X Black and white images

PRACTICAL :Onion cells slide





PRACTICAL: Cheek cells slide



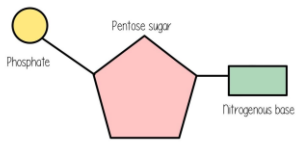
1. Take a clean cotton swab and gently scrape the inside of your mouth.
2. Smear the cotton swab on the centre of the microscope slide for 2 to 3 seconds.
3. Add a drop of methylene blue solution and place a coverslip on top.
4. Remove any excess solution by allowing a paper towel to touch one side of the coverslip.
5. Place the slide on the microscope, with 4x or 10x objective in position and find a cell. Then view at higher magnification

Science Cells – What happens in cells?

Trinity MAT

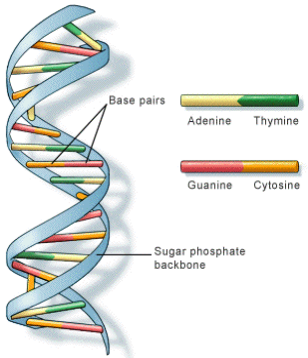
Key Term	Definition
Double Helix	The structure of DNA
Polymer	Long chained molecule made of repeating monomer units
Monomer	Small molecule, join together to form polymers
Nucleotide	Monomer of DNA. Complementary nucleotides bond together (A-T, C-G)
Protein	Polymer made of amino acids. Structure determined by DNA coding.
Enzyme	Biological catalyst
Substrate	Molecule complementary to enzyme active site
Rate	How quickly something happens.
Optimum	The best conditions, where the rate is the highest
Denatured	Active site of an enzyme is changed.
Complimentary	Structures that fit together

Amino Acid Structure



DNA Is a polymer. It is made of lots of monomers. These are called nucleotides (bases). Nucleotides pair up to create the double helix structure of DNA.

DNA Structure



Enzymes

Enzymes are biological catalysts, they speed up reactions in living things. Enzymes act on substrates following the lock and key mechanism shown in the picture to the right (the enzyme is the lock and the substrate is the key). Enzymes have a specific complementary shape to one substrate.

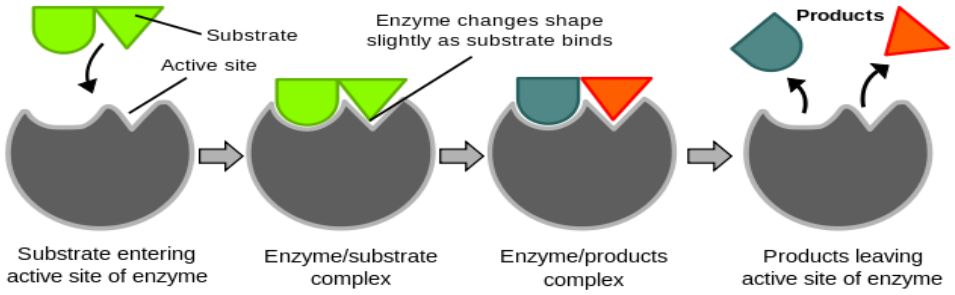
Lots of factors can affect the rate of an enzyme controlled reaction. The optimum conditions are achieved when the rate of an enzyme controlled reaction is at it's highest.

Enzymes can be denatured by certain conditions. This means the active site changes shape, is no longer complementary to the substrate and the reaction cannot take place.

Enzymes in the Digestive System

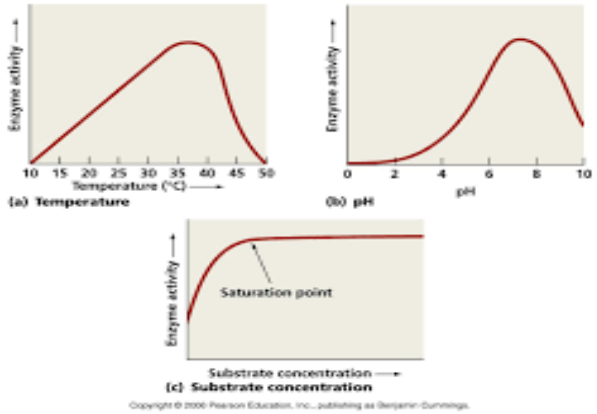
Enzymes in the digestive system act to break down polymers in food into monomers that can be absorbed into the blood:

Enzyme	Polymer	Monomer
Amylase	Starch	Sugars
Protease	Protein	Amino Acids
Lipase	Lipids	Fatty acids + glycerol



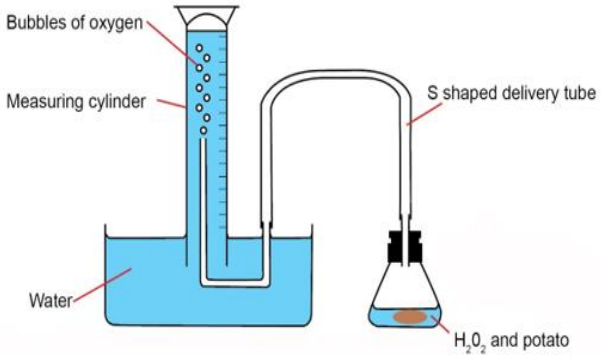
Factors that can affect the rate of enzyme controlled reactions

- → pH
- → Temperature
- → Concentration of enzyme
- → Concentration of substrate



PRACTICAL: Rates of enzyme controlled reactions

Hydrogen peroxide is broken down by the catalase enzyme found in potatoes. Oxygen gas is produced. The volume of gas is measured over 5 minutes to calculate rate. This is repeated with differing concentrations of hydrogen peroxide.



Science Cells – Respiration

Trinity MAT

Key Term	Definition
Mitochondria	Structure found in the cytoplasm of cells. Site of respiration
ATP	Energy carrying molecule found in cells
Aerobic	In the presence of oxygen
Anaerobic	Without oxygen
Lactic Acid	Molecule produced in anaerobic respiration in animals. Causes muscle cramp.
Metabolic Rate	The speed at which chemical reactions transfer energy from food.

Respiration

Respiration takes place in the mitochondria of cells, it is an enzyme controlled reaction.
Respiration is used to release energy from glucose, this energy can be used for reactions and processes in an organism such as movement, digestion and reproduction.

Aerobic Respiration

Takes place in the presence of oxygen. Produces 38 ATP molecules.
Word equation: Glucose + Oxygen ->Water + Carbon Dioxide
Balanced Symbol Equation: $C_6H_{12}O_6 + 6H_2O \rightarrow 6H_2O + 6CO_2$

Anaerobic Respiration in Animals

Takes place during times with limited oxygen. Produces 2 ATP molecules. Produces lactic acid which causes muscle cramps. Lactic acid can be broken down by oxygen.
Word equation: Glucose -> Lactic Acid

Anaerobic Respiration in Plants and Microorganisms

Takes place during times with limited oxygen. Produces 2ATP molecules. Produces ethanol which is an alcohol. This process is also known as fermentation, and is a process needed for making bread, beer and wine.
Word equation: Glucose -> Ethanol + Carbon Dioxide

Biological Molecules

Biological molecules are found in our diet. They are broken down by enzymes in the digestive system to form small molecules which can be absorbed into our blood. These molecules can be used in reactions such as respiration. All of the biological molecules contain carbon, hydrogen and oxygen.

Biological Molecule	Function
Lipid	Found in fats and oils. Used for insulation and as a source of energy.
Carbohydrate	Often made of smaller molecules such as sugars. Used as a sources of energy.
Protein	Made of amino acids. Used for growth and repair of cells in the body.

PRACTICAL: Testing for Biological Molecules

Test for starch:
1. Place a small amount of food on the spotting tile or in a test tube.
2. Add a few drops of iodine solution to the food.
3. Orange iodine solution turns blue–black if starch is present.

Test for sugar:
1. Place a small amount of food in a test tube.
2. Add enough Benedict's solution to cover the food.
3. Place the test tube in a warm water bath for 10 minutes.
4. Blue Benedict's solution turns orange–red on heating if a sugar such as glucose is present.

Test for lipids (fat):
1. Place a small amount of food in a test tube.
2. Add a few drops of ethanol to the test tube.
3. Shake the test tube and leave for 1 minute.
4. Pour the solution into a test tube of water.
5. Ethanol added to a solution gives a cloudy white layer if a lipid is present.

Test for protein:
1. Place a small amount of food in a test tube.
2. Add 1 cm^3 of sodium hydroxide solution and then add a few drops of copper sulfate solution. Alternatively add 1 cm^3 of Biuret reagent.
3. Pale blue colour turns purple if protein is present.

Science Cells – Photosynthesis

Trinity MAT

Key Term	Definition
Chloroplast	Found in the cytoplasm of plant cells. Site of photosynthesis
Chlorophyll	Pigment found in leaves, absorbs light for photosynthesis
Limiting factor	A factor that limits the rate of a reaction
Starch	Polymer of glucose
Iodine	Stain used to detect starch. Turns blue/black if starch is present.

Photosynthesis

Photosynthesis is an enzyme controlled reaction that takes place in the chloroplast of plants to form glucose, which is used in respiration to release energy and to form carbohydrates such as starch and cellulose.

Plants use light as a source of energy for this reaction, chlorophyll (a pigment found in leaves) absorbs light.

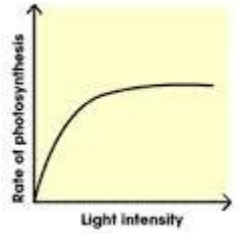
Word equation: Water + Carbon Dioxide -> Glucose + Oxygen
Balanced Symbol Equation: $6H_2O + 6CO_2 \rightarrow C_6H_{12}O_6 + 6H_2O$

The inverse square law

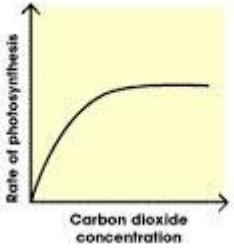
When you double the distance from the light source, the light intensity falls by a factor of 4.

Relative light intensity = 1 ÷ distance from light source^2

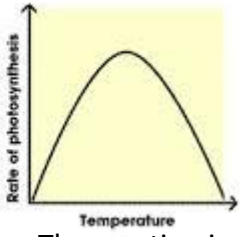
Rate limiting factors



Light is the source of energy for the reaction.

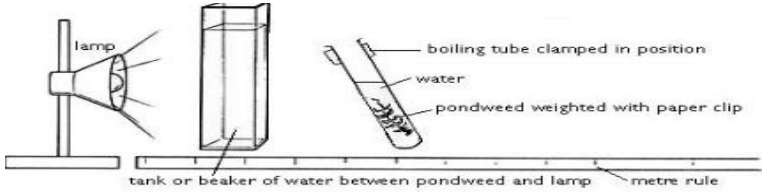


CO_2 is a reactant of the reaction.



The reaction is controlled by enzymes that are denatured at high temperatures

PRACTICAL Investigating the factors that can affect the rate of photosynthesis (light intensity)

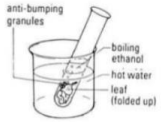


Method

1. Fix a ruler to your desk so that you can easily move your plugged-in lamp along it.
2. Place the boiling tube rack (and plant) at 0cm along the ruler
3. Place the lamp as close as you can to 0cm so that it's shining on the leaves
4. Allow the plant to adjust to this light
5. Count the number of bubbles escaping from the cut end in one minute
6. Record your data and repeat until values are concurrent.
7. Repeat the experiment for all of the distances you decided, starting with the shortest distance and getting further away from the lamp

PRACTICAL: Starch Testing

Starch is a polymer of glucose. If a leaf contains starch, this means it contains glucose. This is how we investigate if photosynthesis has taken place in a plant. Iodine will turn blue/black in the presence of starch.

Method		Reason
Step 1: Put a leaf in boiling water for about 5 minute, until it is soft.		To break down the cell walls so chemicals can enter the cell.
Step 2: Put the leaf in a test tube with ethanol for a while.		To remove the green pigment (chlorophyl). This is for us, to more clearly see a colour change when we add iodine.
Step 3: Rinse the leaf in water.		To make it soft again.
Step 4: Spread the leaf out on a white tile/saucer/petri dish.		To stain any starch, if present. Turns blue/black if starch is present. Stays yellow/brown if no starch is present.
Step 5: Drop a few drops of iodine on the leaf