# Chemistry of life

Scope

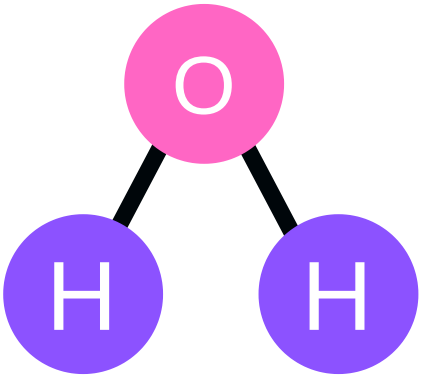
| Topic | Topic breakdown | Investigations |
|---|---|---|
| **Chemistry of life**<br><br>**28 Marks** | Molecules for life:<br>Organic molecules made up of C, H, O and N, P. Cells are made up of proteins, carbohydrates, lipids, nucleic acids and vitamins. (only basic structural detail required)<br>Inorganic compounds<br>Water : 2 H and 1 O<br><br>Minerals: e.g. Na, K, Ca, P, Fe, I, nitrates, phosphates. Macro and micro elements. Main functions and deficiency diseases<br><br>Organic compounds<br><br>Carbohydrates – monosaccharide's (single sugars) e.g. glucose, fructose; disaccharides (double sugars ) e.g. sucrose, maltose; polysaccharides (many sugars) e.g. starch, cellulose, glycogen<br><br>Lipids (fats and oils) – 1glycerol and 3 fatty acids: unsaturated and saturated fats. Cholesterol in foods. *Heart disease*<br><br>Protein – amino-acids (C, H, O and N and some have P, S, Fe). Proteins are sensitive to temperature and pH; loss of structure and function.<br>Role of enzymes in breaking down/synthesizing molecules<br>Influence of temperature and pH on enzyme action<br><br>Lock and key model of how enzymes work<br>Enzymes in everyday life, e.g. washing powders.<br>Mention of Nucleic acids: DNA and RNA – Consisting of C, H, O, N and P (No details of structure required).<br>Vitamins e.g. A, one of B vitamins, C,D and E | INVESTIGATION<br>Food test for glucose<br><br>INVESTIGATION<br>Food test for starch<br><br>INVESTIGATION<br>Food test for lipids<br><br>INVESTIGATION<br>Food test for proteins.<br><br>INVESTIGATION<br>Investigation to test the working of a "biological" washing powder with enzymes.<br>OR<br>Hydrogen Peroxide and chicken liver to demonstrate effect of enzyme.<br>OR<br>Fresh pineapple juice, egg white in plastic drinking straw.<br><br>Observe, measure and record the results of the above experiment done at different temperatures.<br><br>INVESTIGATION<br>Use a microscope or micrographs to observe and draw the structure of a:<br>plant cell (wet mount of onion epidermis), and animal cell (cheek cells) |

# Chemistry of life Notes

Organic molecules are made up of carbon (C), Hydrogen (H) and oxygen (O) and some contain other elements, such as nitrogen (N) and phosphorous (P). Cells are made up of proteins, carbohydrates, lipids, nucleic acids and vitamins.

Inorganic compounds do not contain the element carbon and are not produced by living organisms e.g. water, gases and minerals.

## Water




Water is the most important inorganic compound that is essential for life.

- Water molecules consist of one oxygen (1 O) bonded to two hydrogen molecules (2 H).
- The formula for water is $H_2O$

## Minerals

*Minerals can be divided into two groups i.e. macro elements and micro elements.*

- ***Macro elements** are nutrients that are needed in large quantities*
- ***Micro elements** are nutrients that are needed in small quantities.*

| ELEMENT | FUNCTION | | DEFICIENCY DISEASE | |
|---|---|---|---|---|
| | PLANT | ANIMAL | PLANT | ANIMAL |
| **MACRO-NUTRIENTS** | | | | |
| Sodium **Na** | ---------- -- | -water-salt balance -nerve & muscle function | ---------- | -muscular cramps |
| Potassium **K** | -forms protein & enzymes | -salt-water balance -heart, muscle & nerve function | -chlorosis -slow growth | -muscle weakness -irregular heartbeat |
| Calcium **Ca** | -forms cell walls -root development | -bone & teeth formation -nerve & muscle function | -chlorosis -poor root growth | -rickets |
| Phosphorous **P** | -forms cell membranes -root development | -bone & teeth formation -forms cell membranes | -poor root growth -brown leaves | -bone & teeth weakness -nerve & muscle malfunctioning |
| Magnesium **Mg** | -forms chlorophyll | -bone formation -nerve & muscle function | -chlorosis | -bone weakness -nerve & muscle irritability |
| Nitrogen **N** | -forms amino acids & chlorophyll | -forms amino acids & proteins | -chlorosis | -kwashiorkor in young children |
| **MICRO-NUTRIENTS** | | | | |
| Sodium **Na** | -water-salt balance in cell sap | ---------- | -reduced growth | ---------- |
| Iron **Fe** | -forms chlorophyll | -forms haemoglobin-transport oxygen | -chlorosis | -anaemia |
| Iodine **I** | -energy release | -thyroid gland function-controls metabolism | -poor growth | -goitre |

# Chemistry of life

## Organic compounds

## Carbohydrates

Molecules found in food that provide energy. Divided into three:

- Monosaccharides
- Disaccharides
- Polysaccharides

## Monosaccharides

Single sugar molecules.
Monomers(building blocks) of complex sugars.
Dissolve in water
Examples: Glucose, Fructose & Galactose

## Disaccharides

Made of two monosaccharides
Dissolve in water
Examples: Maltose, Sucrose & Lactose

Glucose + Glucose = Maltose
Glucose + Fructose = Sucrose
Glucose + Galactose = Lactose

## Polysaccharides

Made of many monosaccharides
Dissolve in water
Examples: Starch, Cellulose & Glycogen

## Food test

TEST FOR GLUCOSE:

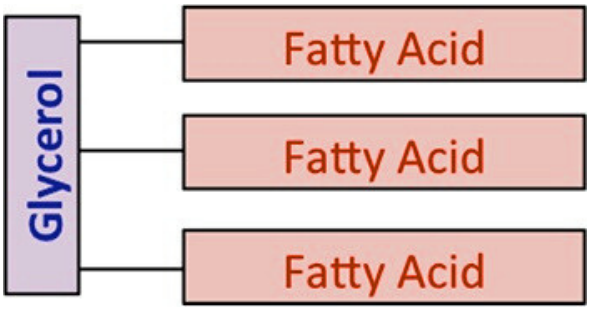
- Add solution(juice) into Benedict's solution and heat it up.
- Observation: Changes from blue to orange or brick red (positive)

TEST FOR STARCH:

- Add iodine solution to a piece of bread
- Observation: Changes to Blue-Black (positive) Remains yellow-brown (negative)

## Lipids

Molecules that are found in oil or butter
Made of monomers (3 Fatty acids & Glycerol)




TWO TYPES OF FATS:

- Saturated fats
- Unsaturated fats

## Saturated fats

Solid at room temperature.
Derived from animal fat
EG. Butter

## Food test

TEST FOR FAT:

- Observation: Greasy on filter paper

## UnSaturated fats

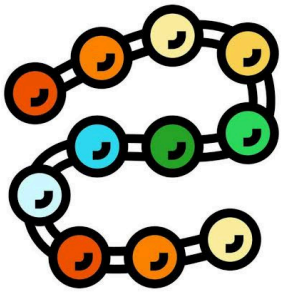
Liquid at room temperature.
Derived from plant fat
EG. Sunflower oil

Saturated fats may increase cholesterol levels in the blood which block arteries. Arteries transport oxygen and a blockage in arteries (atherosclerosis) may cause heart disease

# Chemistry of life

## Organic compounds

### Proteins



**Proteins** are large organic molecules made up of carbon, hydrogen, oxygen and nitrogen atoms.

Made of monomers called amino acids.
Theres about 20 amino acids.
The sequence of amino acids determines the type of protein formed.

Amino acids are joined by peptide bonds to form a polypeptide chain called a protein.

*Proteins are sensitive to pH and temperature. At extreme temperatures or pH they denature (change shape) and lose function*

### Food test

TEST FOR PROTEINS:

- Buiret reagent, a blue solution, is used to test for protein. A deep purple colour is a positive indication of the presence of protein in a solution. The darker the solution the more protein is present.

### Vitamins

**Vitamins** are organic compounds known as micronutrients that are required in small quantities by animals to maintain health. Some vitamins are water-soluble ((Vit. C and B) and must be consumed daily and some are fat-soluble (Vit. A, D, E and K) and stored in the liver and fatty tissues of the body.

| VITAMIN | FOOD SOURCE | FUNCTION | DEFICIENCY DISEASE |
|---|---|---|---|
| A | Carrots, dairy products, fish liver oil | -good eye-sight<br>-healthy skin | -poor night vision<br>-dry, hard skin |
| B1 | Whole grain cereals, lean meat, liver | -healthy appetite<br>-prevents constipation | -beri-beri – nerve & heart disorders |
| C | Citrus fruit -lemons, oranges, tomatoes, green vegetables | -prevents infection<br>-maintains blood vessel walls, gums, teeth | -scurvy – bleeding gums & under skin |
| D | Dairy products, fish liver oil, sunlight | -absorption of calcium - strong bones | -rickets – children<br>-osteomalacia - adults |
| E | Wheatgerm, meat, dairy products | -healthy red blood cells<br>-protection against cancer, heart disease | -infertility<br>-anaemia |

# Chemistry of life

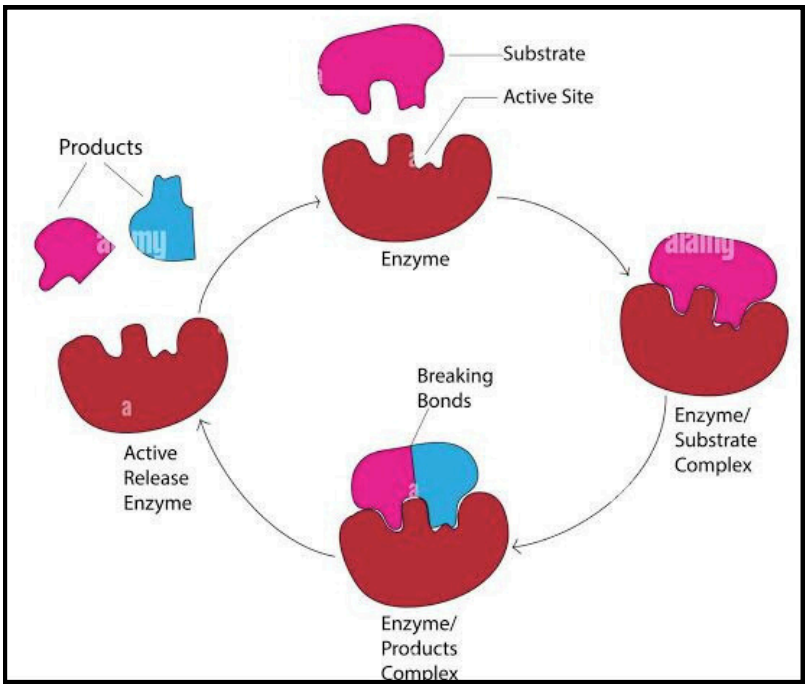
## Organic compounds

### Nucleic acids

**Nucleic acids** are complex organic acids found in a cell's nucleus and are responsible for storing and transferring genetic information.
There are two types of nucleic acids found in cells:

- Deoxyribonucleic acid (DNA)
- Ribonucleic acid (RNA)

### Enzymes




**Enzymes** are protein molecules that control metabolic reactions. They act as catalysts because the increase the rate of the reaction or slow down the rate of the reaction.
Enzymes:

- regulate almost every reaction in the human body
- are specific in their action; each enzyme regulates one particular reaction or type of reaction
- are not altered by the reaction and can function over and over again

**The lock-and-key model:** a theory of how specific enzymes act on specific substrate molecules. Each enzyme targets a specific substrate that fits into its active site.

Enzymes work best at an optimum temperature and in the **human body it is 37°C.**

- At temperatures higher than 37°C, the reaction rate will slow down. *At extremely high temperatures the structure of the enzyme will be destroyed*, and the enzyme will not be able to bind with the substrate molecule.
- *At low temperatures, the enzyme becomes inactive* and the tempo of the reaction will slow down. The structure of the enzyme will not be permanently destroyed.

Enzymes are sensitive to pH. Most enzymes work the most in pH-neutral conditions. Extreme conditions of pH can denature enzymes permanently.

Enzymes are used in:

- Biological washing powders. These enzymes break down stains caused by food, blood, fat or grease. They are extremely effective at low temperatures.
- Meat tenderisers.

# Chemistry of life
## Terminology

| Biological term | Description |
|---|---|
| **Active Site** | a specific region within the enzyme where the substrate binds |
| **Atherosclerosis** | a disease where plaque, a buildup of fatty substances accumulates in arteries |
| **Amino acid** | Monomers of a protein |
| **Atom** | Basic unit of matter |
| **Catalyst** | A substance that speeds up a chemical reaction without being part of the reaction |
| **Compound** | Two or more elements chemically joined |
| **Cholesterol** | A waxy fat-like substance/fatty deposits in body cells |
| **Deficiency** | Lack of something |
| **Disaccharide** | Two monosaccharides/ Two sugar molecule |
| **Element** | A pure substance that cannot be broken down into anything simpler |
| **Iodine solution** | A yellow-brown solution used to test for the presence of starch |
| **Macro nutrient** | Nutrients needed in large amounts |
| **Micro nutrient** | Nutrients needed in small amounts |
| **Monomer** | A building block |
| **Monosaccharide** | Single sugar molecules |
| **Molecule** | Two or more atoms bonded together |
| **Peptide bond** | Bonds between amino acids in a protein molecule |
| **Polysaccharide** | Many monosaccharides/A molecule with More than two sugars |
| **Saturated fat** | Lipids derived from animal fat |
| **Substrate** | A molecule that an enzyme acts upon |
| **Unsaturated fat** | Lipids derived from plant fat |