

Name: _____ () Class: _____ Date: _____

CHAPTER 3: NUTRIENTS

Learning Outcomes:

Candidates should be able to:

- (a) list the **chemical elements** which make up:
 - carbohydrates
 - fats
 - proteins
- (b) state the **main roles** of carbohydrates, fats and proteins in living organisms:
 - carbohydrates as an immediate source of energy
 - fats for insulation and long-term storage of energy
 - proteins for growth and repair of cells
- (c) describe and carry out tests for:
 - starch (using iodine in potassium iodide solution)
 - reducing sugars (using Benedict's solution)
 - protein (using biuret solution)
 - fats (using ethanol)
- (d) state that large molecules are synthesised from smaller basic units:
 - cellulose, glycogen and starch from glucose
 - polypeptides and proteins from amino acids
 - lipids such as fats from glycerol and fatty acids

Use the knowledge gained in this section in new situations or to solve related problems

NUTRIENTS

Nutrients are chemical substances in food that provide energy and materials needed by the body.

Main nutrient groups:

- **Carbohydrates**
- **Fats**
- **Proteins**
- Vitamins
- Minerals
- **Water**

Organic compounds that are obtained from **living** organisms and contain **carbon**. (**Provide ENERGY**)

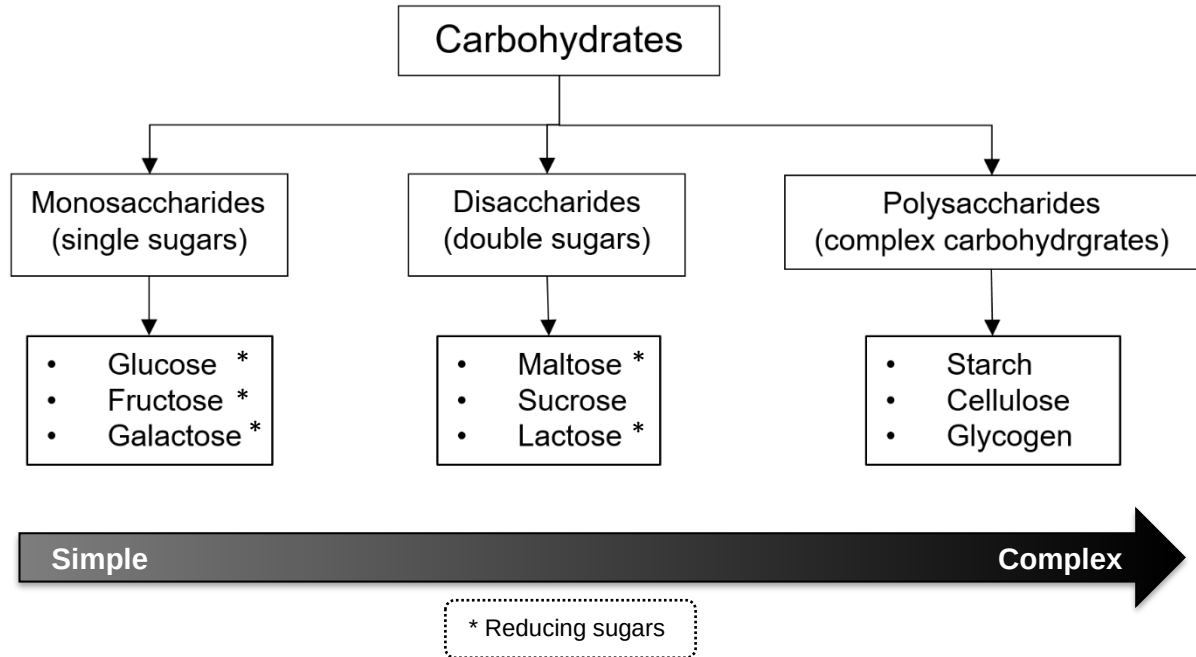


CARBOHYDRATES

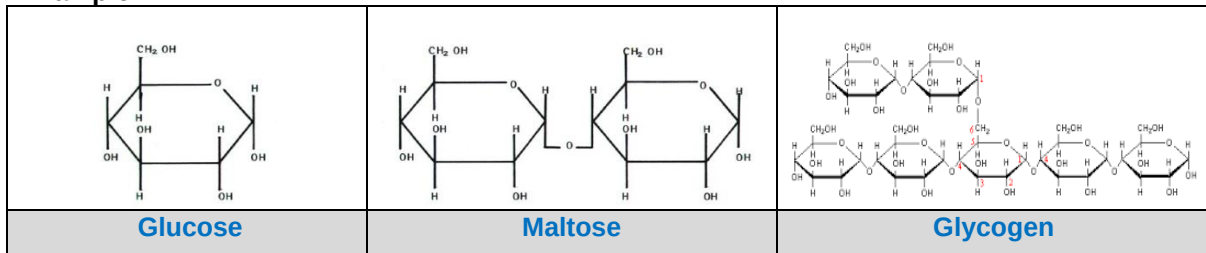
Carbohydrates are organic compounds made up of **carbon**, **hydrogen**, and **oxygen**.

The hydrogen and oxygen atoms are present in the ratio 2:1

- General formula: $C_nH_{2m}O_m$
- E.g. glucose $C_6H_{12}O_6$

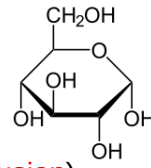


Example:



Monosaccharides

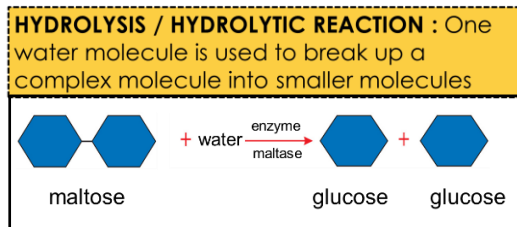
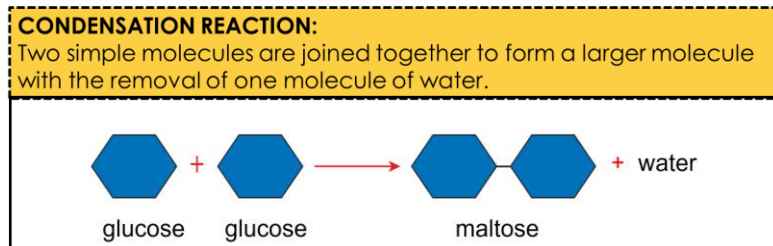
- Greek “*monos*”: single, “*sacchar*”: sugar
- **Simplest** of all carbohydrates.
- Cannot be broken down into smaller molecules.
- Can pass through **cell membranes**. (Recall: via what process? **Diffusion**)
- Examples: **glucose, fructose, galactose**



Glucose	Fructose	Galactose
Found in animals and plants	Common in plants	Milk sugar in animals

Disaccharides

- Consists of **2 monosaccharides** chemically bonded together.
- These 2 molecules of single sugars are bonded together via a **condensation reaction**.

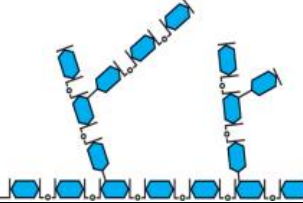
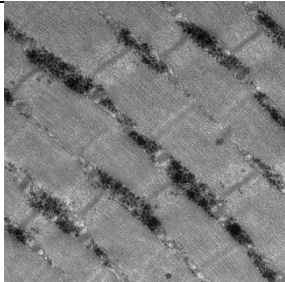
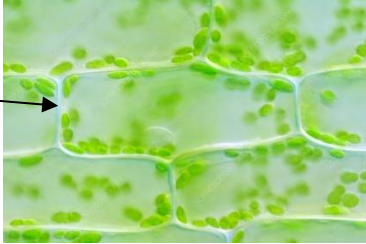


- Examples: **maltose, lactose, sucrose**

Maltose	Sucrose	Lactose
Found in malt, from wheat	Cane sugar	Milk sugar
Glucose + glucose → maltose + water	Glucose + fructose → sucrose + water	Glucose + galactose → lactose + water

Polysaccharides (complex carbohydrates)

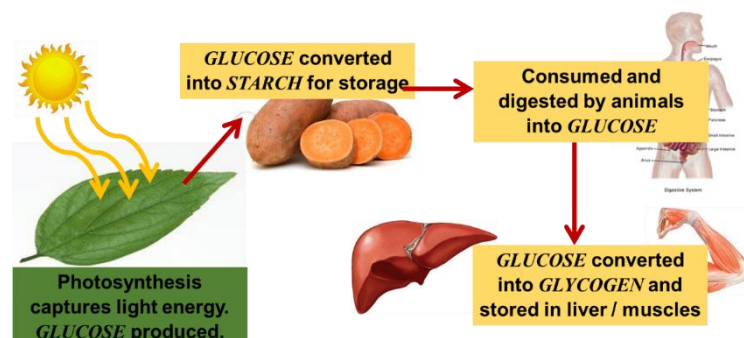
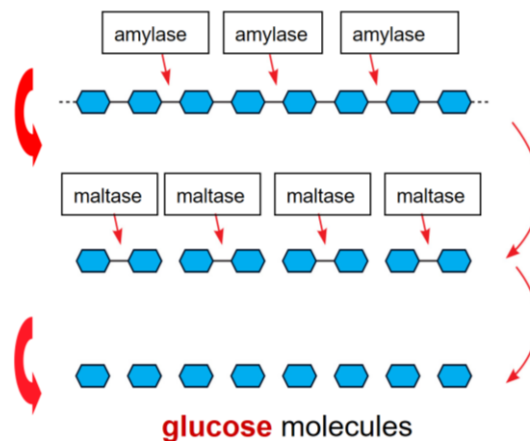
- 'Poly': many
- Many monosaccharide units joined together by **condensation** reaction
- Examples: **Starch**, **glycogen** and **cellulose**

Starch	Glycogen	Cellulose
		
• A storage form of carbohydrates in plants • Found in storage organs in plants	• A storage form of carbohydrates in mammals • Digested to form glucose when needed	• Cellulose cell wall protects plant cells • Serve as dietary fibres to prevent constipation
		

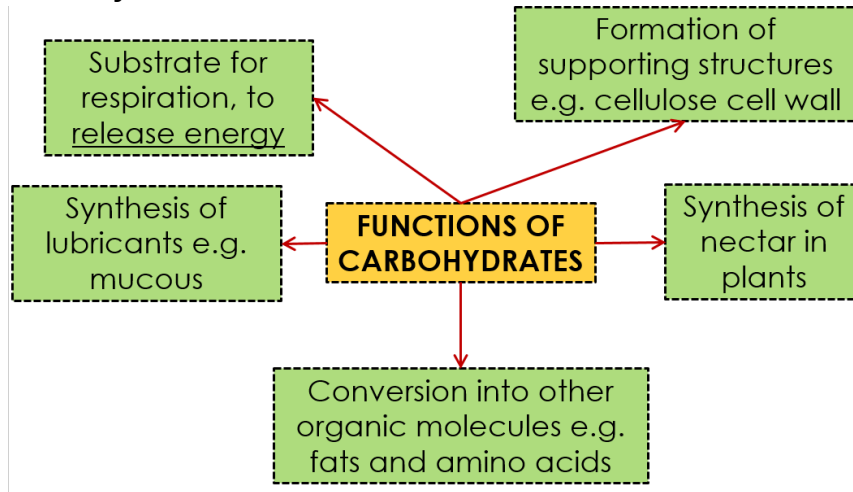
HYDROLYSIS OF STARCH

Starch is broken down into maltose molecules by **amylase**.

Maltose molecules are broken down into glucose by **maltase**.



Function of carbohydrates:



Test for carbohydrates



Testing for starch – iodine test

1. Add 2 cm³ of food sample to a clean test tube.
2. Add a few drops of iodine solution to the test tube.

If starch is present: Iodine solution turns from brown to blue-black.

If starch is absent: Iodine solution remains brown

Testing for **reducing sugars** – Benedict's test

1. Add 2 cm³ of Benedict's solution to 2 cm³ of food sample in a test tube.
2. Shake the mixture.
3. Place the contents in a boiling water bath for 5 minutes.

If reducing sugar is present

- **In trace amounts:** A green precipitate is formed
- **In moderate amounts:** A yellow precipitate is formed
- **In large amounts:** A brick-red precipitate is formed

If reducing sugar is absent: solution remains blue

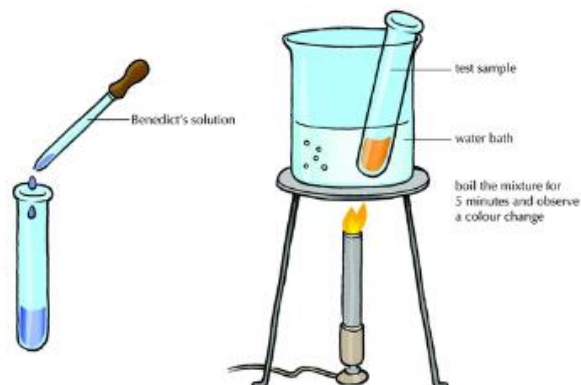
Blue Benedict's solution forms green precipitate which then changes colour to yellow, then to brick-red.



Scan to see the colour of Benedict's solution when reducing sugar is present/absent



Scan to watch how the test for reducing sugar is carried out



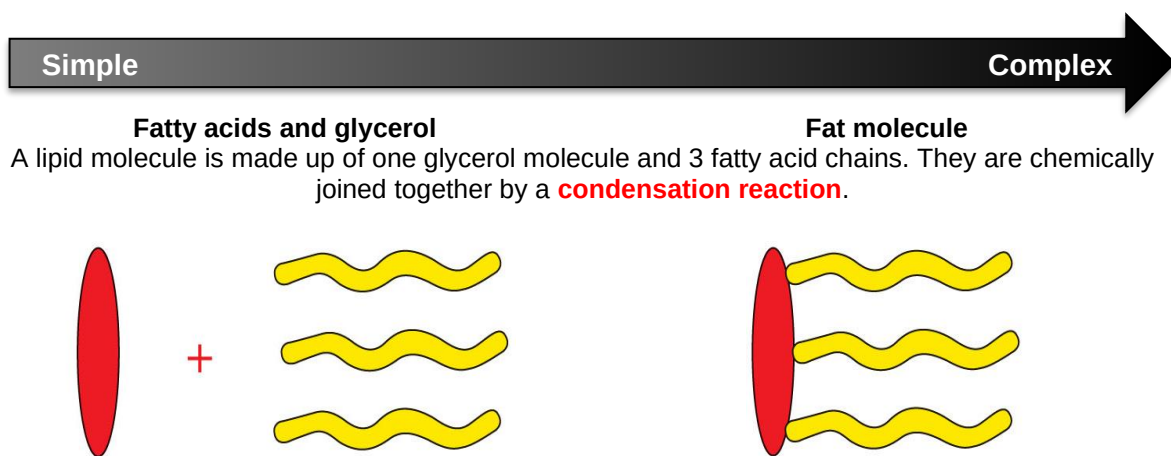
FATS

- Organic molecules consisting of **carbon, hydrogen** and **oxygen**.
- Fats contain **less oxygen in proportion to hydrogen**
- Proportions of elements in fats are **not fixed**, hence no general formula.
- Animal fats, plant fats.

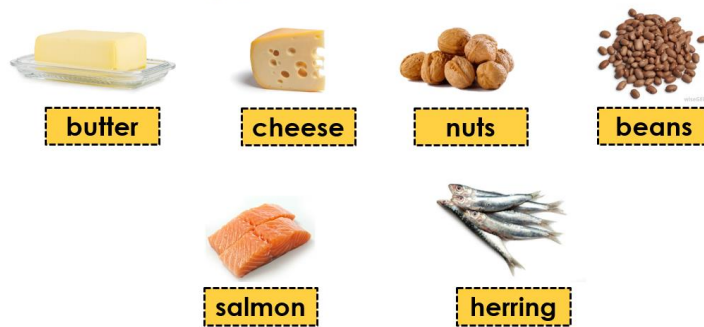


From simple to complex

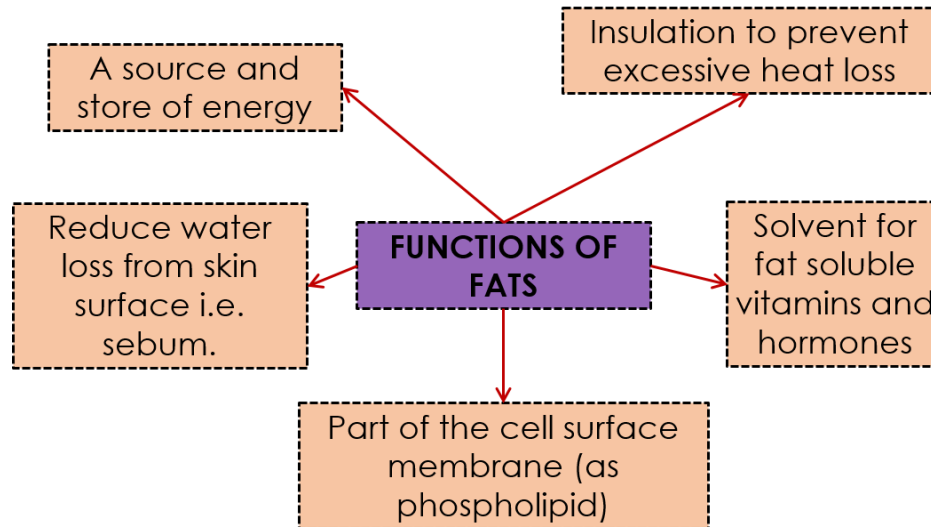
- Fats are made of **glycerol and fatty acids**



Sources of fats



Function of fats:



Testing for fats:

Testing for fats – Ethanol emulsion test

1. Add 2 cm³ of ethanol to 2 cm³ of food sample in a test tube.
2. Shake the contents of the tube vigorously to dissolve
3. Add 2 cm³ of distilled water into the test tube and shake the mixture.

If fats are present: A white emulsion is formed

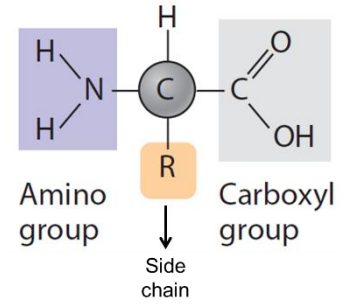
If fats are absent: The solution remains clear



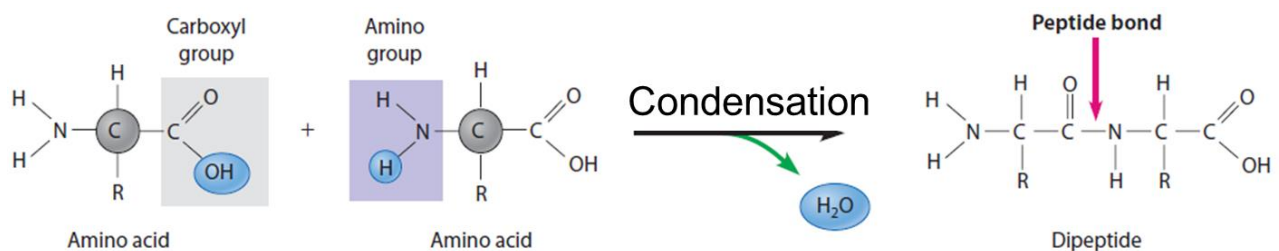
Scan to watch how the ethanol emulsion test is carried out

PROTEINS

- Proteins are complex organic substances made of **carbon**, **hydrogen**, **oxygen** and **nitrogen**. **Sulfur** may also be present.
- Each protein molecule is made up of smaller basic units called **amino acids**.
- An amino acid is made of an amino group, acidic group and a side chain (denoted by **R**)

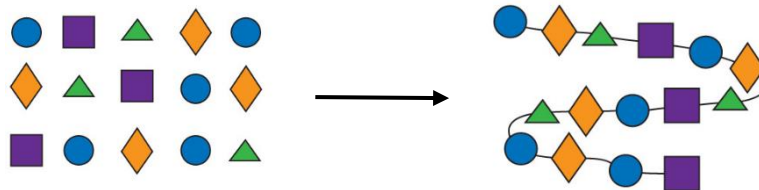


Amino acids can link up through **condensation reactions**



*don't need to know the exact chemical structure of amino acids. Just need to know which elements make up proteins.

Repeated condensation reactions with more amino acids gives rise to polypeptide chain.



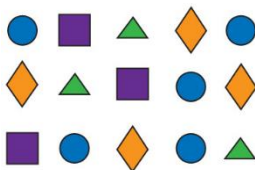
From simple to complex

Simple

Complex

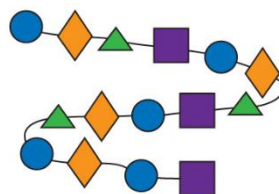
Amino acids

The basic units of proteins. There are 20 different kinds of amino acids.



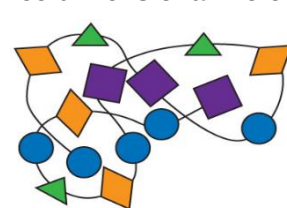
Polypeptides

Amino acids joined together by peptide bonds form a long chain known as a polypeptide.



Proteins

Proteins are formed when two or more polypeptide chains fold together to form a complex, **three-dimensional molecule**.



Function of proteins:

- Proteins are used in the **synthesis of new protoplasm for growth and repair of worn-out body cells**.
- In the synthesis of **enzymes** and some **hormones**.
- In the formation of antibodies to combat diseases.

Proteins are essential to human health. People who do not receive enough protein may develop a protein deficiency disease known as **kwashiorkor**.



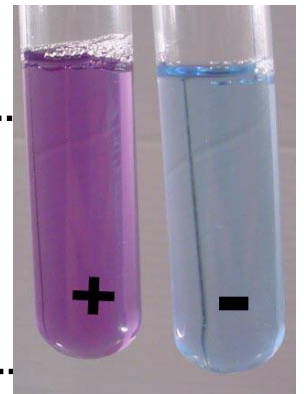
Testing for proteins

Testing for proteins – **biuret test**

1. Add 2 cm³ of biuret's solution to 2 cm³ of food sample into a test tube.
2. Shake thoroughly

If proteins are present: Solution turns from blue to violet / lilac

If proteins are absent: Solution remains blue



Scan to see the colour of the solution when protein is present/ absent



Scan to watch how the biuret's test is carried out

A sample of egg albumen solution was tested using the biuret test. Which of the following shows the result of the test and the deduction which can be made?

TEST
yourself

	result	deduction
A	blue-black colour	protein present
B	blue-black colour	starch present
C	violet colour	protein present
D	violet colour	reducing sugar present