



**CHAPTER 4:**  
**CHEMICAL COMPOSITION**  
**OF THE CELL**

- ELEMENT IN THE CELL

1. There are about 92 element occurring naturally in nature.
2. From these 92 element, only about 25 element are needed to build living organisms.
3. Not all these element found in all living cell.
4. Main element (CHON) are the most frequently found elements in cells, forming about 96% of the human body mass.
5. Trace-elements are the elements are found in small quantity in cells, but are important in biological processes.

# CHEMICAL COMPOUNDS IN THE CELL

1. Chemical compounds in the cell can be divided into two major group:
  - Organic
  - Inorganic
2. Organic compounds are:
  - Chemical compounds **contain carbon** (exception are carbon monoxide, carbon dioxide, carbides and carbonates which are typically considered as inorganic)
  - Are usually found in and originate from living organism.
  - Usually consist of macromolecules (large molecules).
3. Inorganic compounds are:
  - Chemical compounds that **do not contain carbon**
  - Usually a smaller and simpler than organic compounds
  - Founds in cells water, acids, alkalis and mineral salts

- There are 4 main group of organic compounds in cells:

- I. Carbohydrates

- II. Lipids

- III. Proteins

- IV. Nucleic acids

- Carbohydrates

- I. The carbohydrates are made up of carbon, hydrogen and oxygen. The ratio of hydrogen to oxygen atoms in a molecule usually 2:1.

- II. Many carbohydrates have the general formula  $C_x(H_2O)_y$  where  $x$  is approximately equal to  $y$ .

- III. Three basic types of carbohydrates are monosaccharide, disaccharides and polysaccharides

- **Monosaccharide**

- i. Monosaccharide also called simple sugar

- ii. The common monosaccharide are six-carbon sugar with a molecular formula of  $C_6H_{12}O_6$

- iii. Example of monosaccharide are glucose, fructose (fruit sugar) and galactose

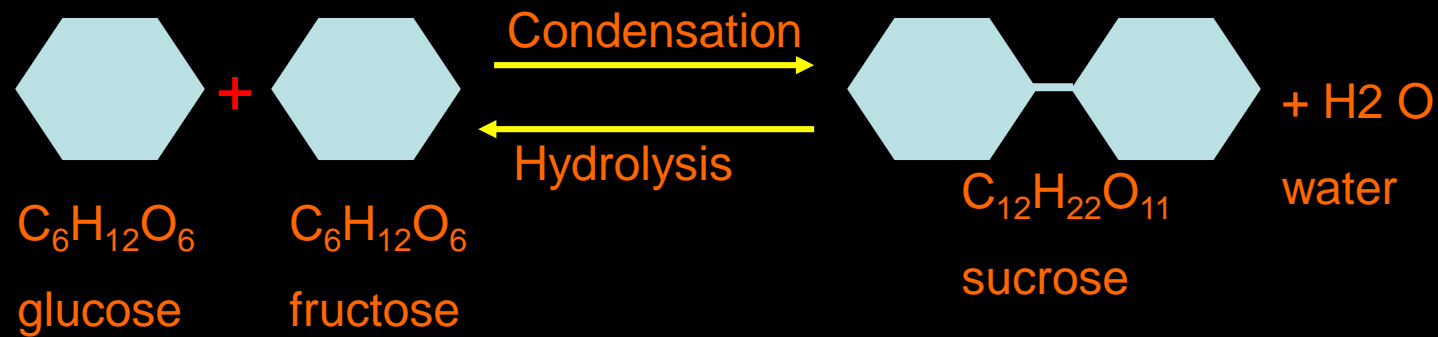
- iv. Glucose is the most common monosaccharide and respiratory substrate

- v. Monosaccharide are sweet-tasting crystalline substances which are soluble in water

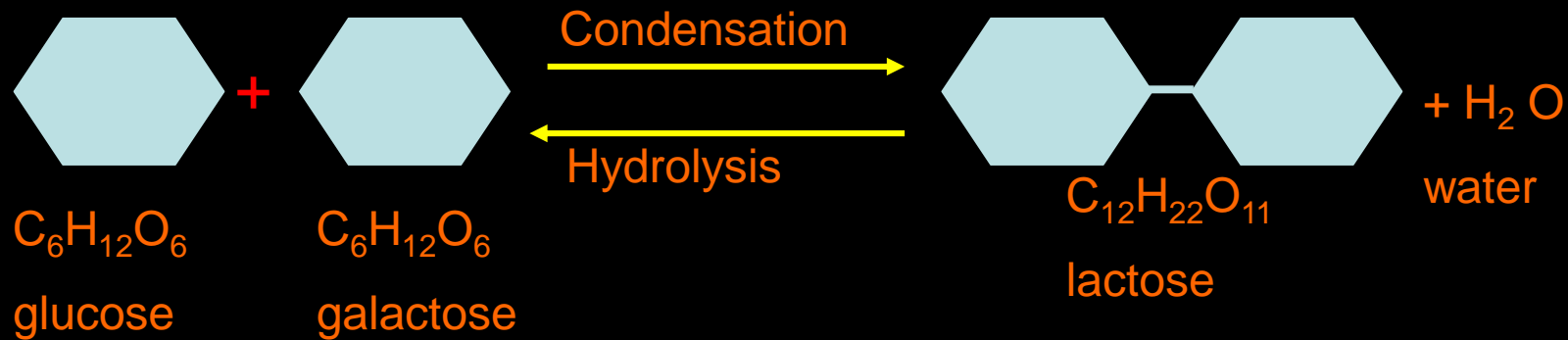
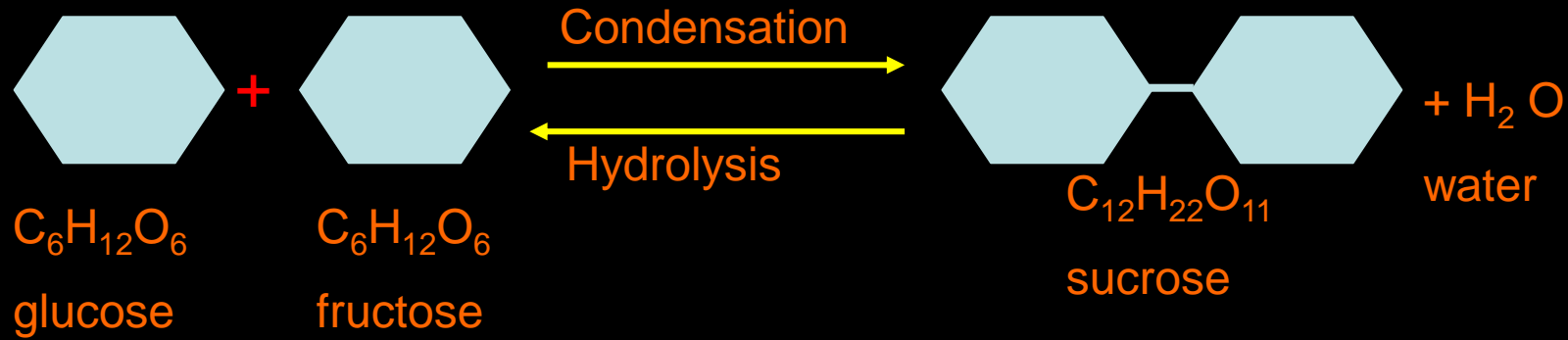
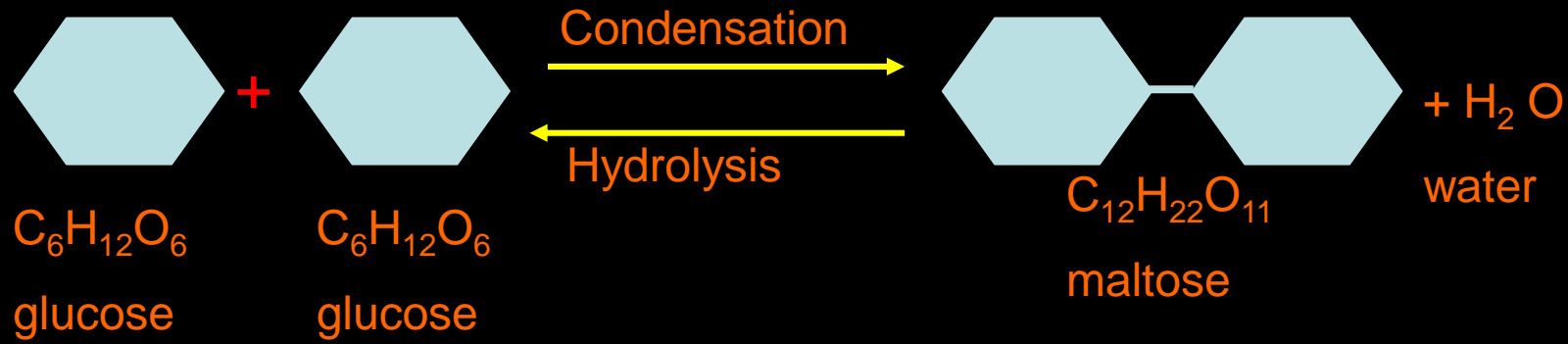
- **Disaccharides**

- i. Disaccharides are formed from two monosaccharide molecules combining together with the elements of a molecule of water. The chemical reaction of the formation is known as condensation.
- ii. The general formula of a disaccharides is  $C_{12}H_{22}O_{11}$
- iii. Disaccharides also called double sugar.
- iv. Disaccharides can be broken down to their constituent monosaccharide by a chemical reaction involving the addition of water. The reaction is know as hydrolysis.

- v. Like monosaccharide, they are sweet-tasting crystalline substances that are soluble in water.



- vi. The most common disaccharides are maltose, lactose and sucrose.

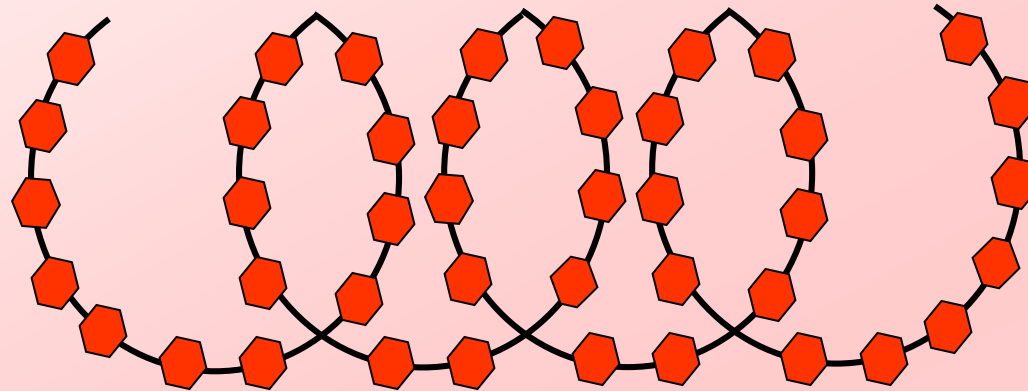




- **Polysaccharides**

- i. Many monosaccharide molecules join together in a condensation reaction (with the removal of water molecules) to form a large polysaccharides molecules.
- ii. Polymerisation is the process of condensing many individual monosaccharide molecules to form a large polysaccharides molecules.
- iii. In polymerisation, the individual monosaccharide molecule are called monomers.
- iv. Polymerisation of monosaccharide forms:
  - Glycogen – in humans and animals
  - Starch and cellulose – in plants

 glucose



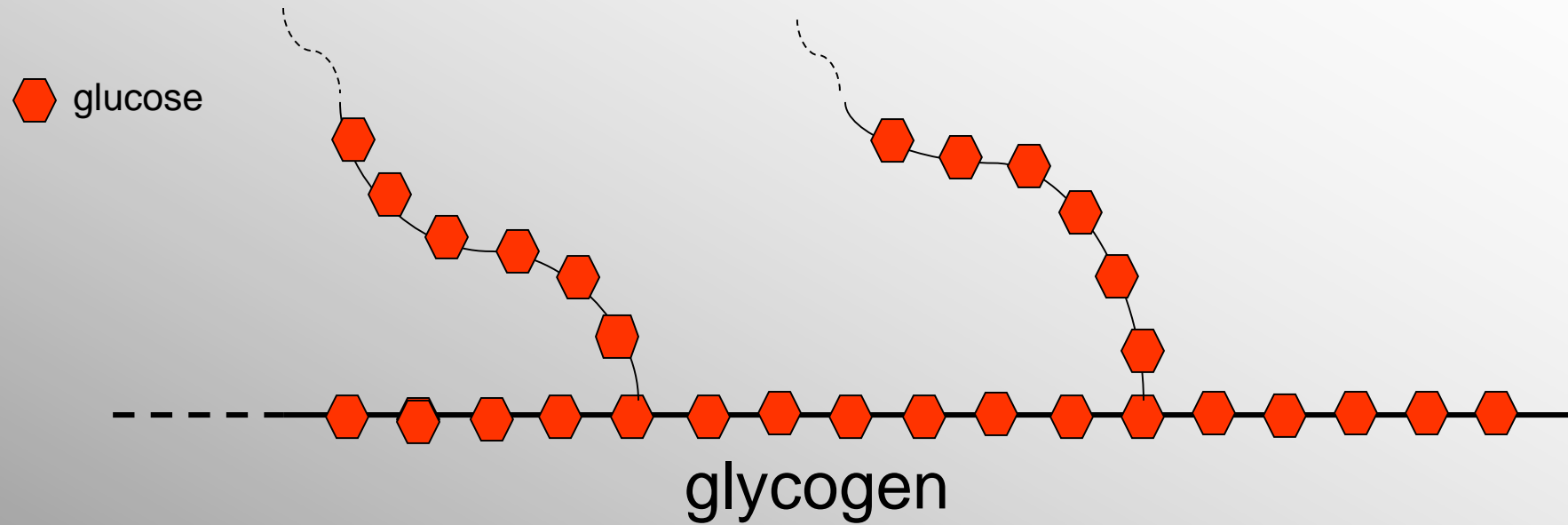
Starch structure

Sub unit: Glucose


Consists of two components.

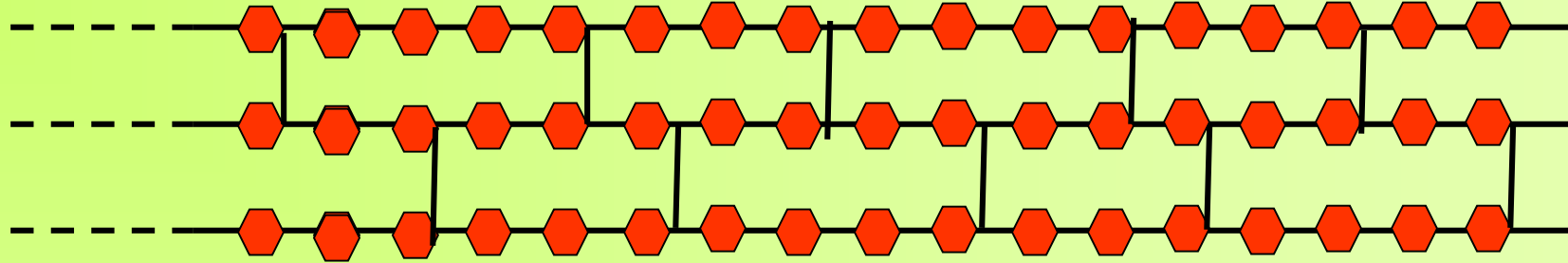
- a) Unbranched, helical chains of glucose units
- b) Branched chains of glucose units

Major storage of carbohydrate in plants



- Sub unit: Glucose
- Molecules with many side branches
- Major storage of carbohydrates in animals and fungi, for examples, in muscle cells and liver cells

 glucose



cellulose

Straight unbranched chain of glucose units

Plant cell wall

- Reducing and non-reducing sugar
  - a) Some sugars act as mild reducing agents
  - b) Two common test reagent to test for reducing sugar are:
    - i. Benedict's reagent (alkaline solution of  $\text{CuSO}_4$ )
    - ii. Fehling's reagent (alkaline solution of  $\text{CuSO}_4$ )
  - c) Reducing sugars reduce  $\text{Cu}^{2+}$  (blue solution) to  $\text{Cu}^+$  (brick red precipitate) in both reagents.

- Proteins

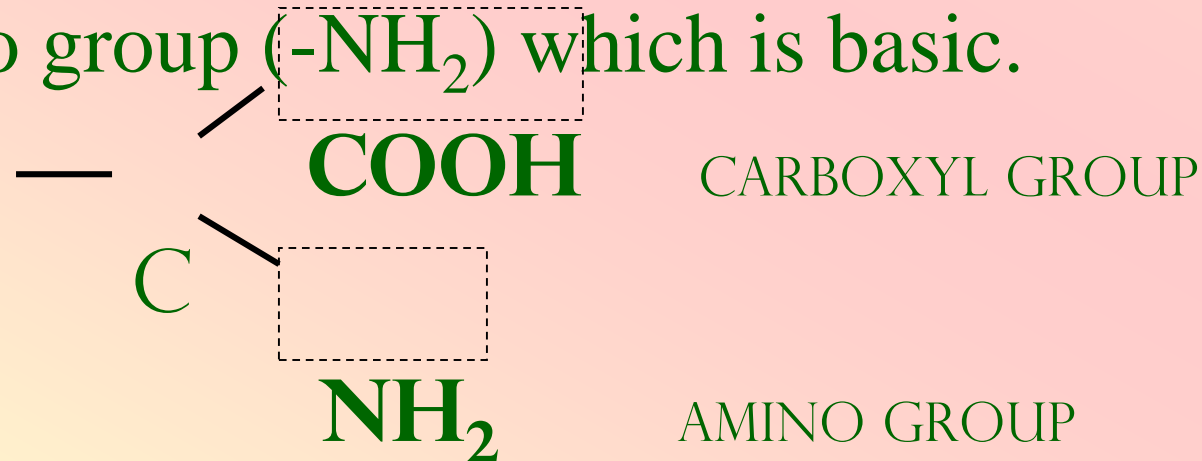
1. Proteins are compounds of these element: carbon, hydrogen, oxygen, nitrogen sulphur and phosphorus.

2. **Amino acids** are the subunits of all proteins.

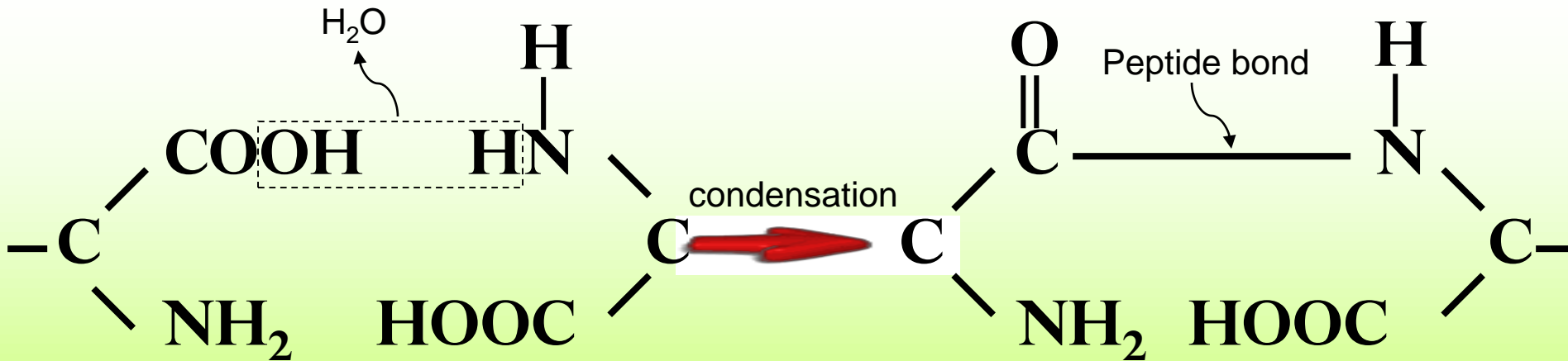
3. Each amino acids carries two functional group:

a) A carboxyl group (- COOH) which is acidic and

b) An amino group (-NH<sub>2</sub>) which is basic.



- Two amino acids can combine together to form a **dipeptide** by a condensation reaction between the carboxyl group of one and the amino group of the other. The resulting a bond linking the two amino acids that is called a **peptide bond**.



- *Long chains of amino acids are called polypeptides.*
- *A polypeptide is formed by the condensation reaction of many amino acids, with the removal of water.*
- *A polypeptide chain can also be hydrolyzed, with the addition of water molecules to form individual amino acids.*

### *PROTEIN STRUCTURE*

- *Primary-linear sequence of amino acids*
- *Secondary structure- forming a helix or pleated sheet.*
- *Tertiary structure- compact structure*
- *Quaternary structure- 2 or more tertiary structure*