BIOMOLECULES

Biomolecules are the chemical compound found in living organism, involved in the maintenance and metabolic process of living organism.

Cells are basic structural and functional units of living organisms, are highly organized and constant source of energy, required to maintain the life.

Biochemical organization of Cell: Atoms are organized into molecules, molecules into organelles, organelles into cells, cell organized to form tissue, tissue organized to form organ, organ to organ system and organ system organized to form organism.

Biomolecules are defined as any organic molecule present in a living cell. Biomolecules are mainly composed of major six elements, **carbon, hydrogen, oxygen and nitrogen, sulphur and phosphorus**. The next major elements are sodium, chlorine, potassium, calcium and magnesium. These make up to 3-5 % of living thing. Trace elements present at low level (1%) of living cell includes iron, iodine, manganese, molybdenum, selenium, silicon, tin, vanadium, boron, chromium, cobalt, copper and fluorine.

Each Biomolecules is essential for body functions. They have wide range of size, structure and perform various types of function.

The four major types of Biomolecules are:

1. **CARBOHYDRATES**
2. **LIPIDS**
3. **PROTEIN**
4. **NUCLEIC ACID**

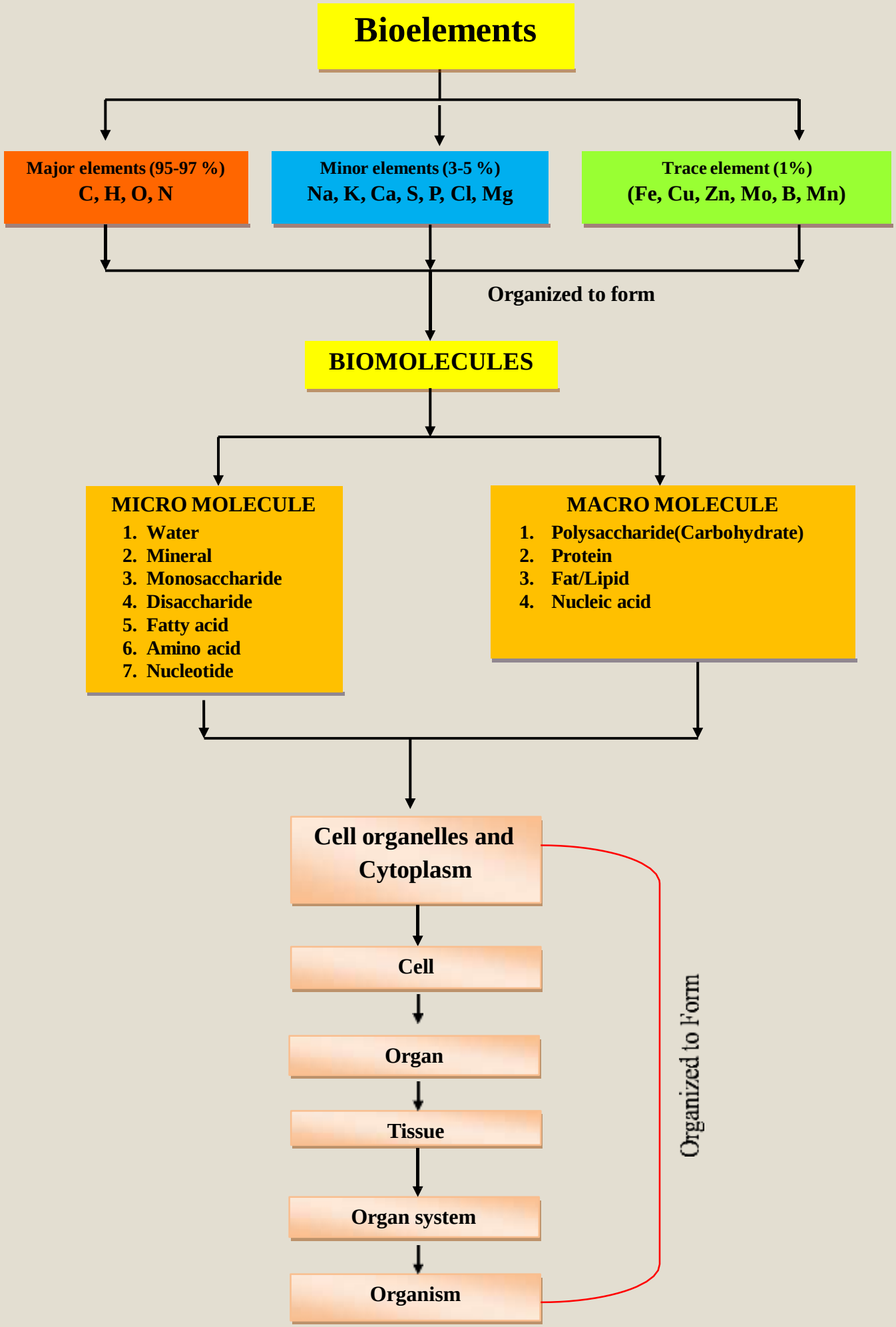


Figure1: Biochemical organization of cell

CARBOHYDRATE

Carbohydrate are hydrate of carbon contain C, H, O. Chemically Carbohydrates are Polyhydroxy aldehyde or Polyhydroxy ketone

Carbohydrates are naturally occurring organic compounds containing carbon, hydrogen, oxygen elements. Chemically Carbohydrates are Polyhydroxy aldehyde or Polyhydroxy ketones or the compounds that produce these on hydrolysis. Carbohydrates are also referred as saccharide.

On the basis of sugar unit carbohydrate are classified into three major classes:

1. **Monosaccharides**
2. **Oligosaccharides**
3. **Polysaccharides**

1. Mono saccharides:

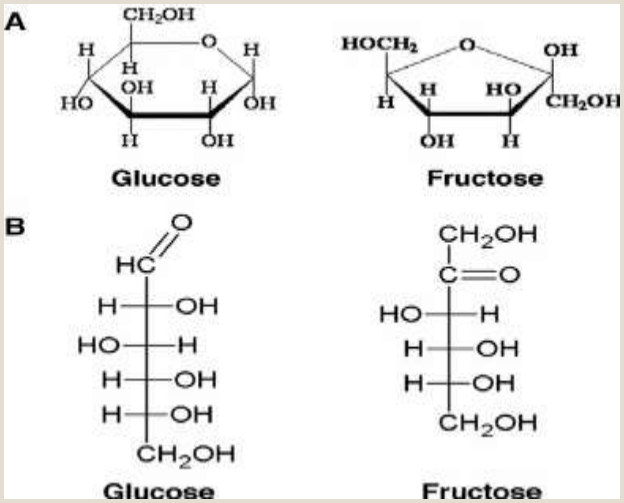
Mono saccharides contain Single sugar unit. Also called simple sugars, cannot be hydrolyzed into smaller units. Depending upon no. of carbon in a unit, mono saccharides are subdivided into a dioses to decoses. More common subclasses of mono saccharides are:

Aldoses: Contain aldehyde as Funtional group

a. Aldotrioses e.g. Glycerose,
b. Aldotertroses e.g. Erythrose,
c. Aldopentoses e.g. Ribose,
d. Aldohexoscs e.g. Glucose (dextrose), Galatose (present in milk)
e. Aldoheptose e.g. Glucoheptose.

Ketoses: Contain Ketone as functional group

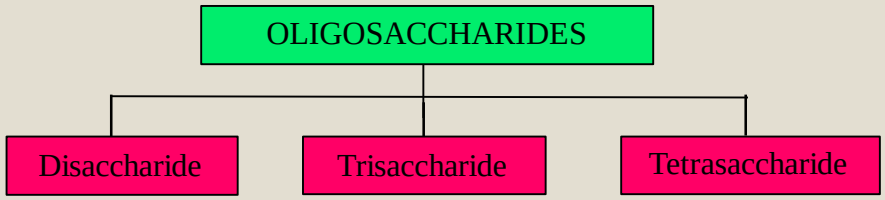
a. Ketotrioses e.g Dihydroxyacetone,
b. Ketotetroses e.g Erythrulose,
c. Ketopentoses e.g Ribulose,
d. Ketohexoses e.g. Fructose present in fruits honey
e. Ketoheptose e.g. Scdoheptulose.



Properties of Mono saccharides:

1. Muta-rotation
2. Glycoside Formation
3. Reducing Power
4. Reduction
5. Oxidation with mild and strong oxidizing agent
6. Methylation / Esterification
7. Dehydration
8. Form osazone with phenyl hydrazine

2. Oligosaccharide: Oligosaccharides are polymers of mono saccharides containing two to ten mono saccharides:



1. **Disaccharides:** Yield two mono saccharides on hydrolysis.

   a. Reducing Disaccharides: Contain hemiacetal or hemiketal group
   Example: Maltose (Glucose + Glucose) Germinating grain (used to make beer)
   Lactose (Galactose + Glucose), other examples are Isomaltose.

   b. Non Reducing Disaccharides: Contain no hemiacetal groups
   Example: Sucrose (Glucose + Fructose)

2. **Tri saccharides:**
   Example: Raffinose (Glucose + Fructose + Galactose) found in cotton seed and sugar beet.

3. **Tetra saccharides:** Yield 4 mono saccharides on hydrolysis.
   Example: Stachyose (Glucose + Fructose + Galactose + Galactose) (only tetra saccharide known to exist in plant e.g. Whole grains, peas, lentils)

3. Polysaccharides: Polysaccharides are polymer of monosaccharides. The long chain polymers are either straight chain or branched. They are also called glycanes**.** On hydrolysis produces monosaccharides. They are Nonsugar and tasteless. General formula $(C_6H_{10}O_5)_n$ Insoluble in water and form colloids with water.
Example: Starch, Cellulose, Pectin

Classification of Polysaccharides:

On the Basis of Function**:**

a. Storage
   Example: Starch, Plant store glucose as starch. The cereal grain (wheat, rice, corn, oat, barley) as well as tuber (potato) rich in starch. Glycogen storage form of glucose in animal and human which is analogous to the starch in plant. Glycogen is synthesized and stored mainly in the liver and muscles.
b. Structural
   Example: Cellulose, Pectin

On the basis of composition**:**

a. Homo polysaccharides
b. Hetero polysaccharides.

a. Homo Polysaccharides: On hydrolysis gives single monosaccharide units
   Pentosan: Contains pentoses
   Hexosans: Contains hexoses subdivided in to
   Glucosans: Polymer or glucose e.g. Starch, Glycogen
   Fructosans: Polymer or fructose e.g. Inulin
   Galactans: Polymer of galactose e.g. Galactan
   Mannans: Polymer of mannose e.g. Mananas.

b. Hetero Polysaccharide: e.g. Hyaluronic acid, Chondroitin sulphates.
   Gum: Consist of arabinose, rhamnose, galactose and glucoronic acid.
   Agar: The sulphuric acid esters of galactans consists of galactose, galactouronic acid.
   Pectins: Fundamental unit is pectic acid, consist of arabinosc, galactose, galactouronic acid.

Functions of Polysaccharides:

1. They serve as structural components of the cells
2. They serve as stored form of energy.
3. They serve as nutrient.

BIOLOGICAL ROLE OF CARBOHYDRATE

1. Most abundant dietary source of energy (4cal/g).
2. Serve as storage form of energy (glycogen) to meet the immediate energy demand of the body.
3. Precursor for synthesis of many compounds (Fatty acid and Amino acid).
4. Glycolipid and Glycoprotein participate in structure of cell membrane and cell function, cell growth, adhesion (cell to cell attachment), fertilization.

5. Structural component of many organisms. Cellulose in plant cell wall. Chitin in Exoskeleton of some insects. Cell wall of microorganism
6. Structural component: Pentose sugar (Deoxy ribose and ribose sugar) in DNA and RNA

CLASSIFICATION OF CARBOHYDRATE (CHEMICAL NATURE)

- **MONOSACCHARIDES**
  - Contain only one sugar molecule
  - Cannot be hydrolyzed
    - Aldoses
      - Contain Aldehyde
        - E.g. Galactose Ribose, Glucose
    - Ketoses
      - Contain Ketone
        - E.g. Ribulose, Fructose
- **OLIGOSACCHARIDES**
  - Polymers of monosaccharide contain 2-10 sugar units (molecules)
    - Disaccharide
      - Yield two monosaccharide on hydrolysis
        - E.g. Maltose (Glucose + Glucose), Sucrose (Glucose + Fructose)
    - Trisaccharide
      - Yield three monosaccharide on hydrolysis
        - E.g. Raffinose (Glucose + Fructose + Galactose)
    - Tetrasaccharide
      - Yield four monosaccharide on hydrolysis
        - E.g Stachyose (Glucose + Fructose + Galactose + Galactose)
- **POLYSACCHARIDES**
  - Long chain polymer of monosaccharide either straight chain or branched
    - Homo polysaccharide
      - On hydrolysis gives single monosaccharide unit
        - E.g. Starch, Glycogen
    - Hetero polysaccharide
      - On hydrolysis gives multiple monosaccharide unit
        - E.g. Hyaluronic acid

CLASSIFICATION OF PROTEIN (Physical and chemical nature)

- **SUGAR**
  - Reducing sugar
    - Sweet and soluble in water. Reduce Fehling and Benedict reagent.
      - E.g. Glucose, Fructose, Lactose, Maltose
  - Non reducing sugar
    - Sweet and soluble in water. Donot Reduce Fehling and Benedict reagent.
      - E.g. Sucrose
- **NON SUGAR**
  - Non sweet and insoluble in water. Donot Reduce Fehling and Benedict reagent.
    - E.g. Starch, Glycogen, Cellulose