

Organic Molecules

- Organic molecules contain C & H atoms bonded to other atoms.
- 4 types (**biomolecules**) in organisms: carbohydrates, lipids, proteins, & nucleic acids.

Carbon Atom

- C atom forms covalent bonds with up to 4 other elements (generally with CHNOPS).
- Hydrocarbons:** chains of C atoms bonded to H atoms; branched or ringed (**cyclic**).
- C atoms can form double or triple bonds with certain atoms (carbon, nitrogen).

Carbon Skeleton & Functional Groups

- Skeleton/backbone:** C chain of organic molecule

Functional groups

- Clusters of specific atoms bonded to the C skeleton with characteristic structure & functions.
 - ✓ Addition of -OH (hydroxyl group) to C skeleton turns molecule into an **alcohol**.
 - ✓ Nonpolar organic molecules are **hydrophobic** unless they contain a polar functional group (ex. ethane).
 - ✓ **Hydrophilic** compounds (e.g. ethanol) can dissolve in H_2O b/c the -OH (hydroxyl) functional group is polar.
 - ✓ Organic molecule may be both **acidic** & hydrophilic depending on functional groups:

Biomolecules of Cells

- ✓ e.g. hydrocarbon that contains a carboxyl group; carboxyl groups ionize in solution by releasing hydrogen ions, becoming both polar and acidic.

- Isomers** are molecules with identical molecular formulas but different arrangements of their atoms.

Biomolecules of Cells

- Cellular enzymes carry out **dehydration** reactions to synthesize biomolecules, H_2O molecule is removed & covalent bond is made between 2 atoms of the monomers.
- Hydrolysis reactions** break down polymers; hydroxyl (-OH) group from H_2O attaches to 1 monomer & hydrogen (-H) attaches to other.
- Enzymes:** molecules that speed up chemical reactions by bringing reactants together.

Polymers

- Constructed by linking many of the same type of **monomers**, e.g. amino acids/ protein, many nucleotides/ nucleic acid.
- In a **dehydration reaction**, a hydroxyl (-OH) group is removed from one monomer & a hydrogen (-H) is removed from the other.; produces H_2O .

Carbohydrates

Monosaccharides

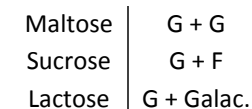
- Simple sugars with a backbone of 3 – 7 C atoms.*
- Hexoses**
 - Glucose & fructose are **hexoses** & isomers of one another; formula ($\text{C}_6\text{H}_{12}\text{O}_6$) but differ in arrangement of the atoms.
 - Glucose found in blood of **animals**; source of **biochemical energy** (ATP) in \approx all organisms.

Pentoses

- Ribose & deoxyribose:** 5-carbon sugars, contribute to backbones of RNA & DNA.

Disaccharides

- Contain 2 monosaccharides joined by a dehydration reaction



- ✓ **Maltose** forms in the digestive tract of humans during starch digestion.
- ✓ **Sucrose** (table sugar): used to sweeten food
- ✓ **Lactose:** found in milk.

Polysaccharides

- Energy storage molecules.*
- Polymers** of monosaccharides.
- Not soluble** in H_2O .
- Do not pass through cell plasma membrane.

Polysaccharides

1. Starch

- Straight chain of glucose molecules with **relatively few** side branches.
- *Amylose* and *amylopectin* found in plants.

2. Glycogen

- Highly branched polymer of glucose with many side branches.
- **Storage** form of glucose in animals.

3. Cellulose

- Polymer of glucose: forms **microfibrils**, the primary constituent of plant cell walls.
- **Indigestible** by humans due to the unique bond b/w glucose molecules.

4. Chitin

- Polymer of glucose with an **amino group** attached to each glucose.
- Primary constituent of the **exoskeleton** of crabs, lobsters, insects, etc.
- Not digestible by humans.

5. Peptidoglycan: polymer of glucose derivatives found in bacteria.

Lipids

- **Lipids:** hydrocarbons that are insoluble in H₂O because they lack polar groups.
- **Fat** provides insulation & energy storage in animals.
- **Phospholipids** form plasma membranes.
- **Steroids:** important cell messengers.
- **Waxes:** protective functions in organisms.

Lipids

1. Triglycerides

- *Long term energy storage.*
- **Fats** and **oils** contain glycerol + fatty acids.
- **Fatty acid:** long hydrocarbon chain with a carboxyl (acid) group at one end.
 - ✓ Most fatty acids in cells contain 16–18 C atoms per molecule.
 - ✓ **Saturated fatty acids:** no double bonds b/w C atoms.
 - ✓ **Unsaturated fatty acids:** double bonds in the C chain where there are less than 2 hydrogens per C atom.
- **Glycerol:** water-soluble compound with 3 hydroxyl groups.
- **Triglycerides:** glycerol joined to 3 fatty acids by dehydration reactions.
- **Fats** contain saturated fatty acids; solid at room temperature (e.g. butter).
- **Oils** contain unsaturated fatty acids; liquid at room temperature.
- **Animals** use fat for long-term energy storage; fat stores more energy.

2. Phospholipids

- *Membrane components.*
- 3rd fatty acid is replaced by a polar (hydrophilic) phosphate group, which usually bonds to another organic group (designated by *R*).

Lipids (2)

- **Hydrocarbon** chains of fatty acids become nonpolar (hydrophobic) tails.
- **Phospholipids** arrange themselves in a double layer in water, so polar heads face toward H₂O molecules & nonpolar tails face toward one other, away from H₂O molecules.
- Thus phospholipids form a separation b/w 2 solutions (e.g., interior + exterior of cell).

3. Steroids

- *4 fused rings.*
- **Skeletons** of 4 fused C rings; vary according to attached functional groups which determine the biological functions.

Cholesterol

- Component of animal cell's plasma membrane.
- Precursor of steroid hormone (aldosterone, testosterone, estrogen, etc.).
- Diet high in saturated fats + cholesterol can lead to circulatory disorders.

Waxes

- Long-chain fatty acids bonded to **long-chain** alcohols.
- High melting point, **waterproof** & resist degradation.
- Form a **protective** covering in plants that retards water loss in leaves and fruits.
- In **animals**, maintain animal skin and fur, trap dust and dirt, and form the **honeycomb**.