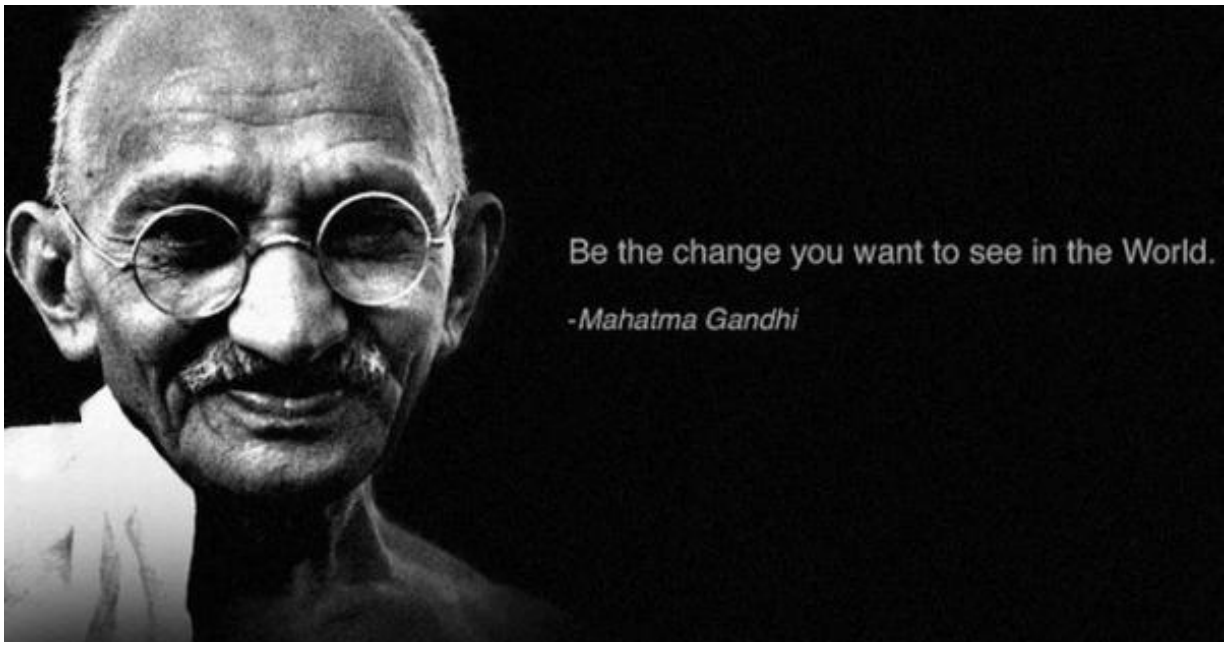
Molecular Biology 1

Lecture #5.



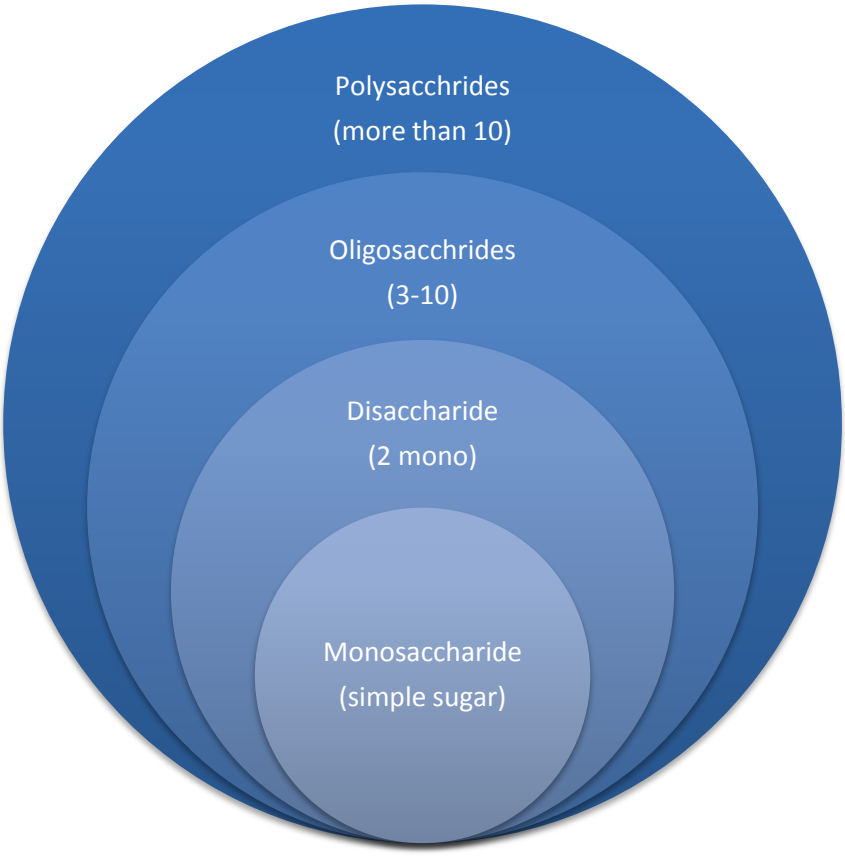
433 Biochemistry Team

✓ **Carbohydrates:** the most abundant organic molecules in nature. The empiric formula is (**CH_2O**). It provides important part of energy in diet. Acts as the storage form of energy in the body are structural component of cell membrane.

✓ **Diseases caused by disorders of carbohydrate metabolism:**

- Diabetes mellitus
- Galactosemia.
- Glycogen storage disease.
- Lactose intolerance.

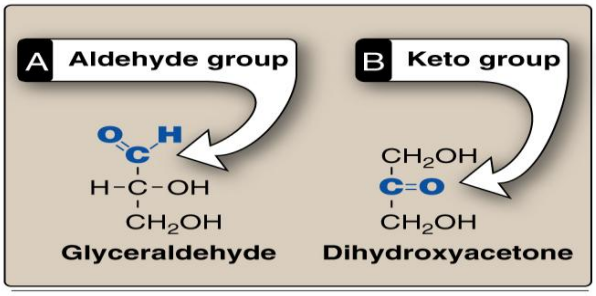
✓ **Classification:**



Monosaccharide classified based on:

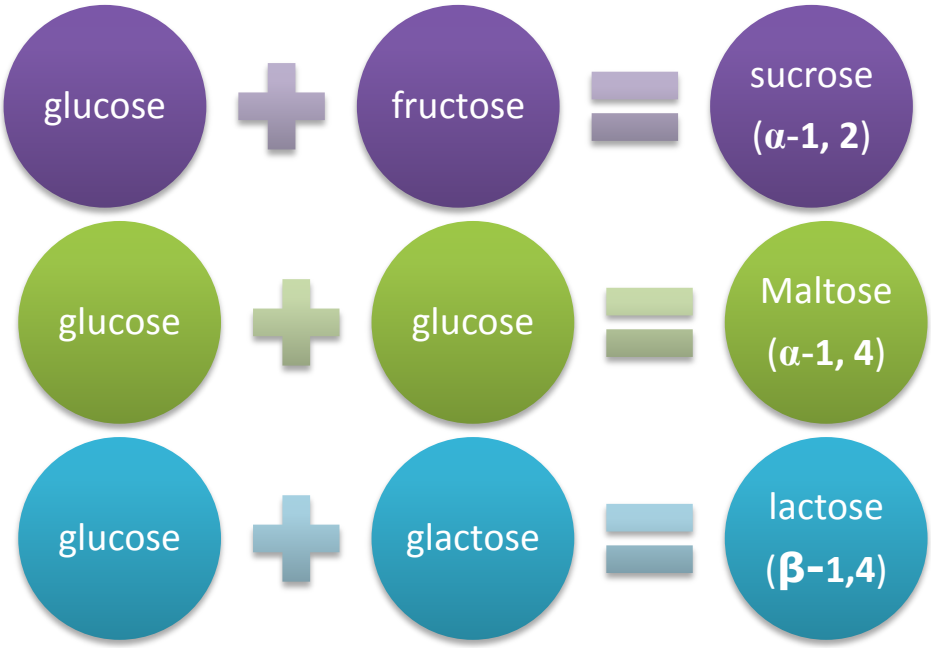
1) Number of carbon atoms.
2) Functional group (either Aldehyde group ALDOSES, or ketone group KETOSES).

Generic names	Examples
3 carbons: trioses	Glyceraldehyde
4 carbons: tetroses	Erythrose
5 carbons: pentoses	Ribose
6 carbons: hexoses	Glucose
7 carbons: heptoses	Sedoheptulose
9 carbons: nonoses	Neuraminic acid



	Aldose	Ketose
Triose	Glyceraldehyde	Dihydroxyacetone
Pentose	Ribose	Ribulose
Hexose	Glucose	Fructose

Disaccharides: Joining of 2 monosaccharaides by O-Glycosidic bond.



Polysaccharides:

- Homopolysaccharides:
  - Branched:
    Glycogen and starch (**α-glycosidic polymer**)
  - Unbranched:
    Cellulose (**β-glycosidic polymer**)
- Hetropolysaccharides:
  - E.g., glycosaminoglycans (GAGs)

* Homo-: means same; it has just C,O and H

* Hetro- : means different; it has other component with C. e.g. Sulfate (SO_4)

Isomers: compounds have the same formula but different structure formula. And the number of isomers depends on the number of asymmetric C.

Aldo-Keto isomers

- Ex: Glucose(aldose) and Furctose(Ketose)

Epimers

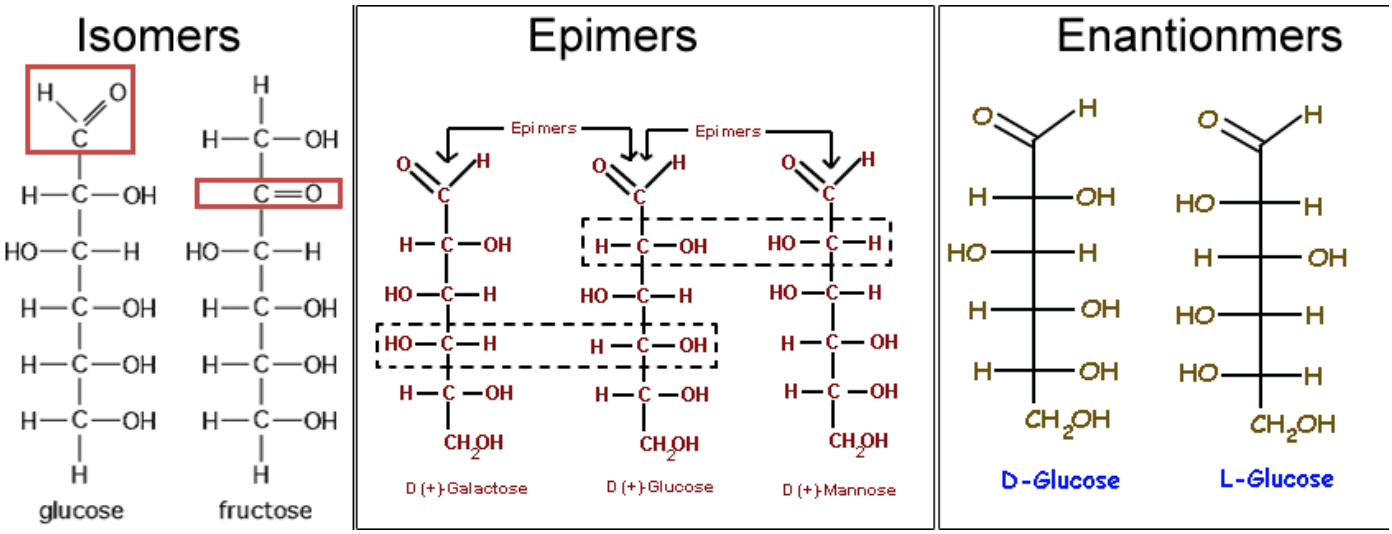
- CHO differ around only one specific carbon atom.
- Ex: Glucose and Galactose C4. Glucose and Mannos C2.
- Galactose and mannose are not epimers.

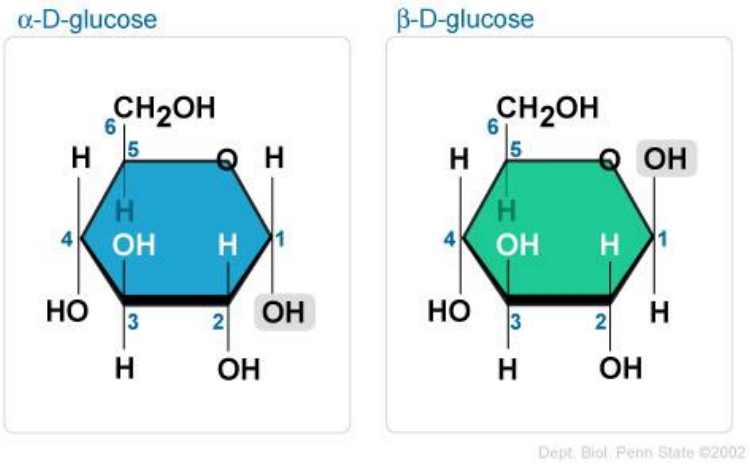
Enantiomers (D- and L-Forms)

- Structures that are **mirror images** of each other are designated as D- and L- sugars based on the position of –OH grp on the **asymmetric carbon farthest from the carbonyl carbon**
- Majority of sugars in humans are **D-sugars**

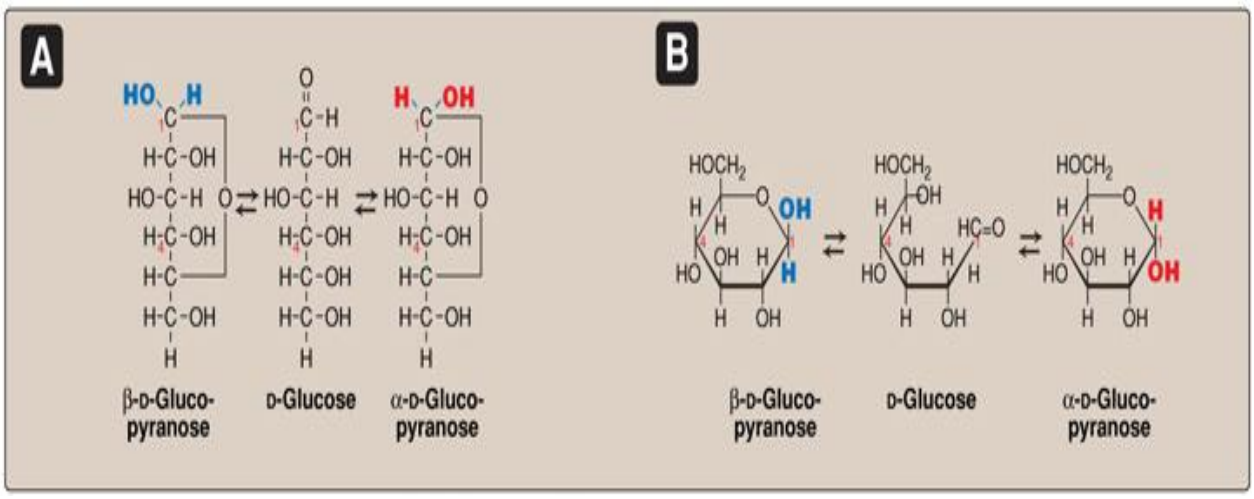
α- and β-Forms

- Monosaccharides with 5 or more carbon are predominantly found in the ring form. Cyclization creates an **anomeric carbon** (former carbonyl carbon) generating the α and β configurations.





Mutarotation: In solution, the cyclic α and β anomers of a sugar are in equilibrium with each other, and can be interconverted spontaneously.



Reducing Sugars: If the O on the anomeric C of a sugar is not attached to any other structure (Free), that sugar can act as a reducing agent.

- ✓ **R**educing sugars reduce chromogenic agents like Benedict's reagent or Fehling's solution to give a colored periceptate.
- ✓ **U**rine is tested for the presence of reducing sugars using these colorimetric tests.
- ✓ Ex. : Monosaccharides, Maltose and Lactose. Not Sucrose because all glucose's anomeric (Functional) C is attached to furctose's anomeric C.

Complex Carbohydrates: it is carbohydrates attached to non-carbohydrate structures by glycosidic bonds (O- or N- type). For example:

- Purine and Pyrimidine bases (DNA).
- Bilirubin.
- Protein in glycoprotein and proteoglycan.
- Lipids found in glycolipids
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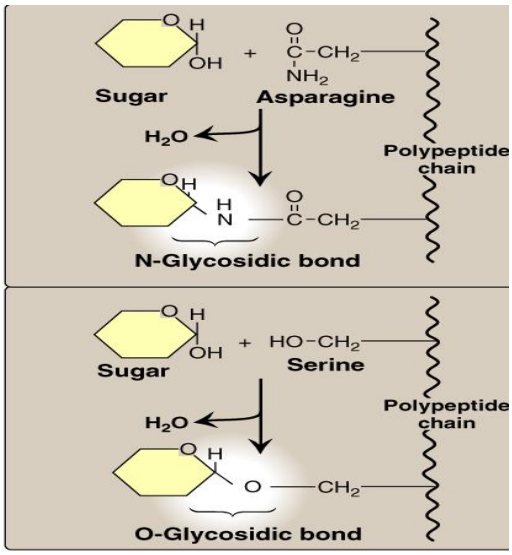
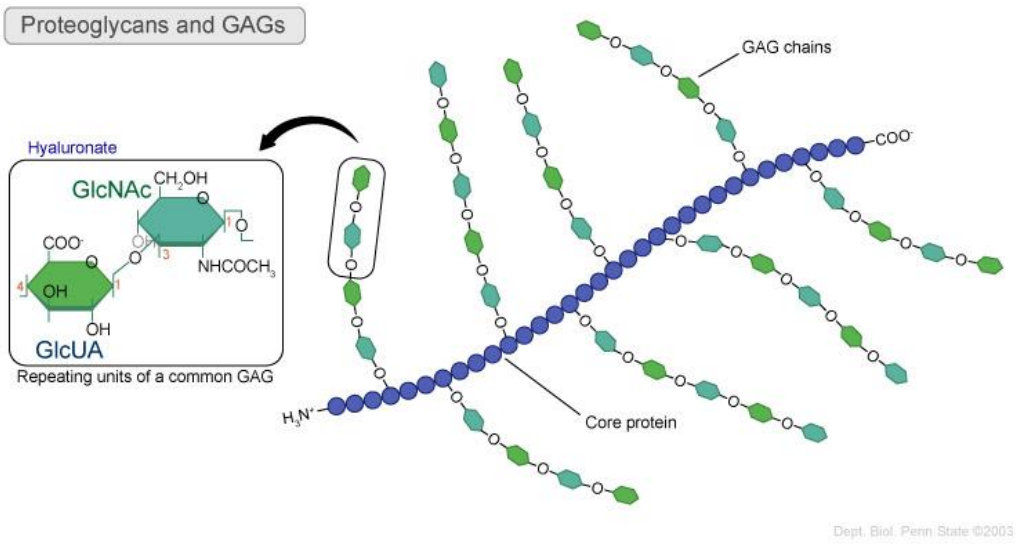
Glycosidic bonds:

- N-glycosidic: reference to the glycosidic Nitrogen.
- O-glycosidic: reference to the glycosidic oxygen.



Glycosaminoglycans (GAGs):

- Glycosaminoglycans (GAGs) are large complexes of negatively charged **hetero**polysaccharide chains.
- They are associated with a small amount of protein, forming **proteoglycans**, which consist of over 95 percent carbohydrate.
- They bind with large amounts of water, producing the gel-like matrix that forms body's ground substance.
- The viscous, lubricating properties of mucous secretions also result from GAGs, which led to the original naming of these compounds as mucopolysaccharides.
- **GAGs** are linear polymers of **repeating disaccharide** units.
- The amino sugar (usually sulfated) is either **D-glucosamine or D-galactosamine.**
- The acidic sugar is either **D-glucuronic acid or L-iduronic acid**
- GAGs are strongly negatively-charged because **carboxyl groups of acidic sugars and Sulfate groups.**



Relationship between glycosaminoglycan structure and function:

- ☐ Because of negative charges, the GAG chains tend to be extended in solution and repel each other and when brought together, they "slip" past each other This produces the **"slippery" consistency of mucous secretions and synovial fluid**
- ☐ When a solution of GAGs is compressed, the water is "squeezed out" and the GAGs are forced to occupy a smaller volume. When the compression is released, the GAGs spring back to their original, hydrated volume because of the repulsion of their negative charges. This property contributes to the **resilience of synovial fluid and the vitreous humor of the eye.**

Examples of GAGs are:

1. Chondroitin sulfates: Most abundant GAG
2. Keratan sulfates: Most heterogeneous GAGs
3. Hyaluronic acid: Compared to other GAGs, it is unsulfated and not covalently attached to protein
4. Heparin: Unlike other GAGs that are extracellular, heparin is intracellular and serves as an anticoagulant

Some extra link:

- Carbohydrates in general.