8.1 Midterms Exam Coverage

Midterms BCHE102A - Exam Coverage

- Introduction ot Biochemistry
  - Basic Biology Concepts
  - Cell Biology
  - Water and Its Properties
- Carbohydrates
  - Structure
  - Classification
  - Biological Significance
- Lipids
  - Structure
  - Classification
  - Biological Significance

8.2 Water and Its Properties

May 26, 2022

Midterm exam review - Water and it's Properties

What is the Difference of Ionic and Covalent Bonding?

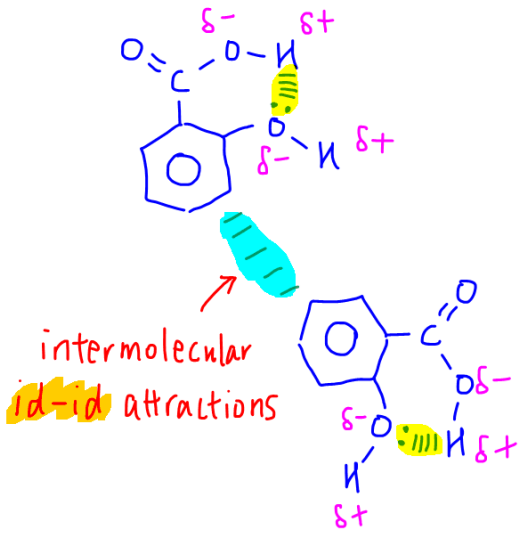
- Ionic
  - Transferring Electrons
  - Strong bond
  - Metal + Non metal
  - Cations + Anions
- Covalent
  - Non metal + non metal
  - Pure covalent (non polar)→ stronger than a polar covalent
  - Sharing of electrons
- Carbon is a non-metal

What is a Hydrogen Bond?

- Hydrogen atoms with strong electronegative atoms such as O and N
  - In the periodic table, the electronegativity increases going to the right
- Bond strength
  - stronger than other dispersion forces (Van der Waals)
  - stronger than dipole-dipole
  - Weaker than Ionic and Pure Covalent though

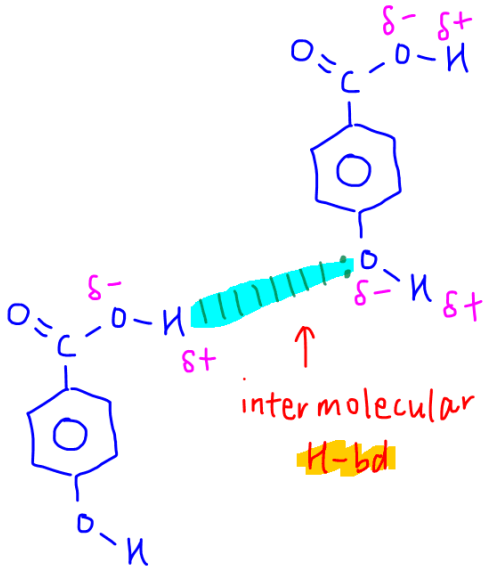
Intermolecular and Intramolecular H bond

2-hydroxybenzoic acid



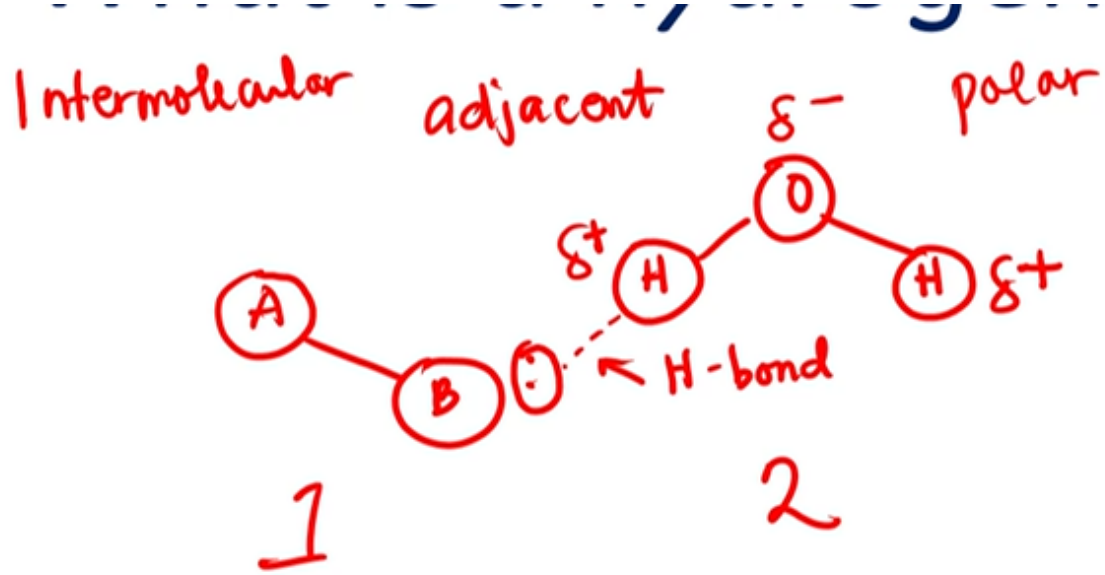
Intramolecular H-bd
weaker id-id attraction b/w molecules ∴ lower mp (158.6°C)

4-hydroxybenzoic acid



stronger H-bd b/w molecules ∴ higher mp (214.5°C)

- Intramolecular - within the molecule
  - When an H is connected to an O (for example) in a molecule, there is an unequal sharing of molecules. The O has a slightly negative charge because the electrons are mostly there. This is also why H becomes slightly positive.
  - Another atom that has a lone pair within the same molecule may be attracted to the slightly positive H atom the molecule has
- Intermolecular - between 2 or more molecules



- In water, Oxygen is slightly negative and each H is slightly negative. When there is another molecule that has an atom that has a lone pair it can get attracted to the slightly positive of H

Hydrogen Bonds happen in:

- H2O
- Proteins
  - Secondary structure
- Nucleic Acids
  - DNA and RNA
    - Nucleotide bases
- Both Proteins and Nucleic acids need H bonds for stability

Describe the water molecule

- Composition: 2 H and 1 O
- Formula: H2O

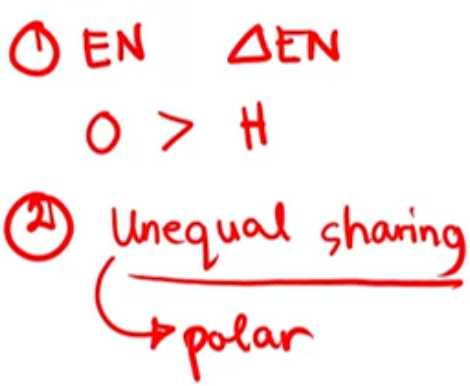
Properties of Water

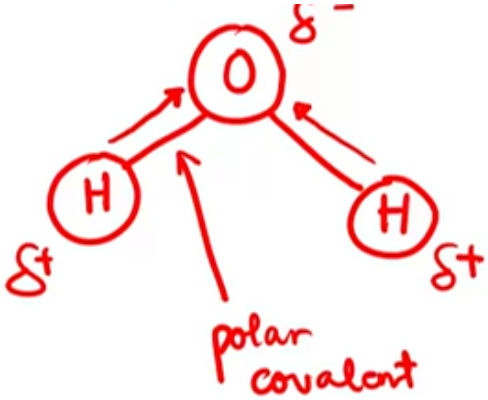
- Odorless, colorless, transparent, and tasteless

- Excellent Solvent
- Cohesion and Adhesion
  - Surface tension
  - Capillary Action
- High Specific Heat
- High Heat of Vaporization

Why is Water a Polar Molecule?

- Because there is an **Electronegativity Difference** beweeen the O and H atoms. O is more electronegative than H





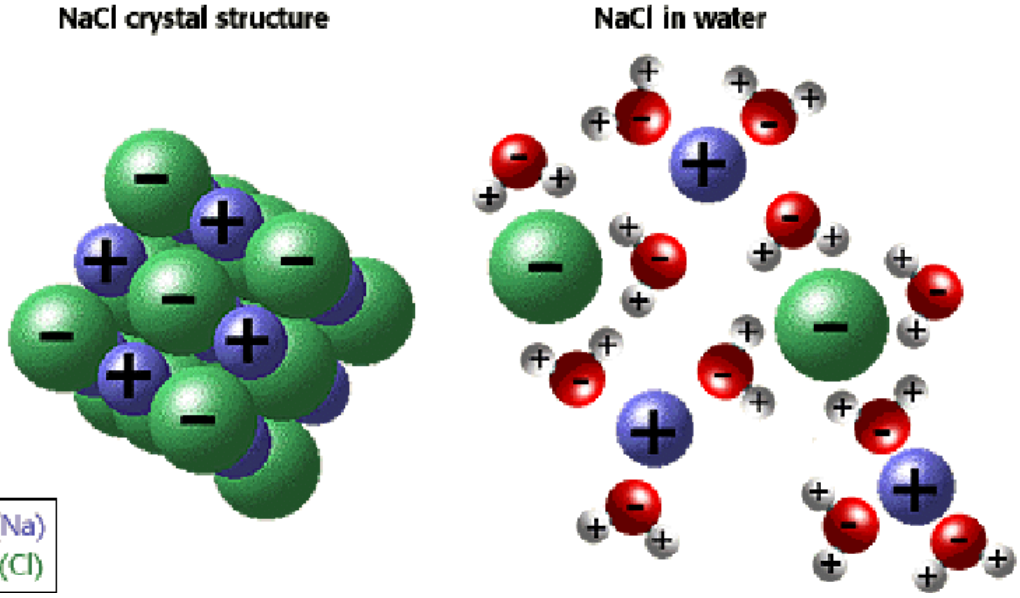
Why is Water an Excellent Solvent?

- **not universal**
- "like dissolves like"
  - Non-polar solutes need non-polar solvents
  - Polar solutes need polar solvents
- **This is attributed to its polarity**

1. Dissolution

- a physical change
- NaCl+H2O → NaCl(aq)
  - forms a hydration shell

- NaCl (s) - crystal lattice structure
  - In disolution the crystal lattice structure breaks down but the NaCl **ionic bond doesn't break**, just "embraced" by the water molecules

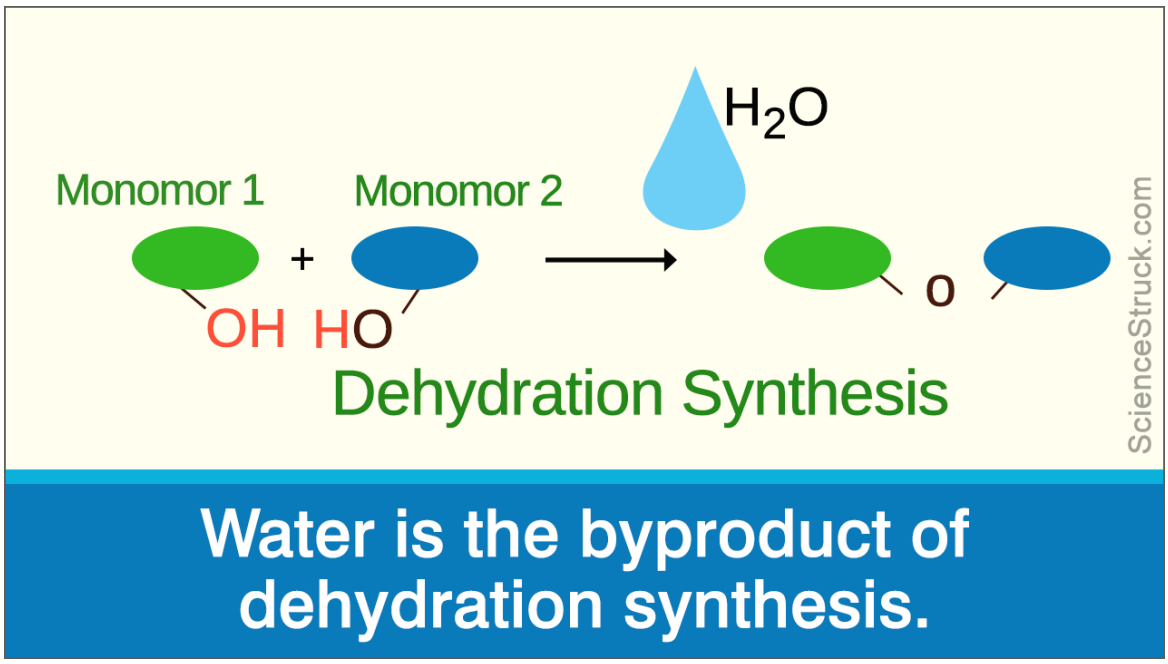


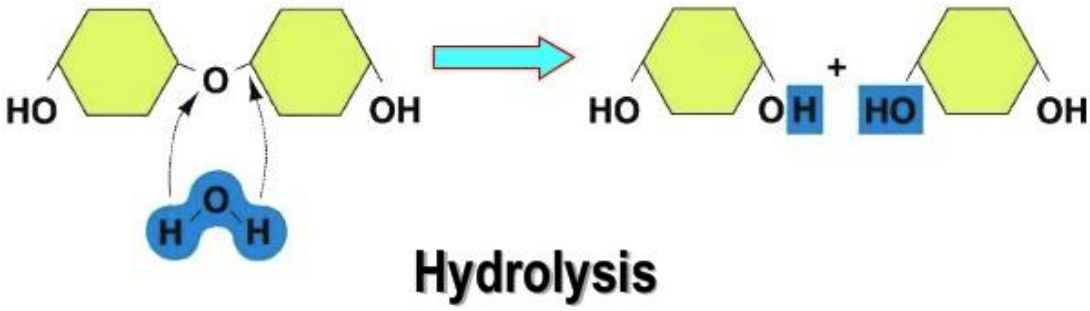
2. Dissociation

- also known as ionization → release of electrolytes
- When water molecules pull Na and Cl away from each other

Describe Water as a Reactant

- Dehydration Synthesis

    - 

    - removal of water
    - usually for building
        - Ex. Glucose (monosaccharide) → Glycogen (polysaccharide)
            - Glycosidic bonds between glucose units formed when removal of water
- Hydrolysis
    - 

    - Adding water to separate (lysis)

High Heat of Vaporization

- single drop of water to single drop of alcohol
- attributed to H bonds → needs high energy to break down (high heat)
    - single drop of water takes a long time to evaporate
- Application: in the body, we don't boil in our own skin

- Resistance of body to sudden temperature changes
- Why have to regulate aquarium temp?
    - Fish kill happens when sudden temperature changes → dissolved oxygen in water goes down in high heat
- Thermoregulation: evaporative cooling
    - Sweat is 90% water
    - Phase changes → energy to become gas

Cohesion and Adhesion

- Forces of Attraction
- Cohesion
    - same molecules
        - H2O to H2O
    - Water drops stacked on coin → dome shape
    - Surface tension
    - The more cohesive forces the higher the surface tension
    - Application - water strider and basilisk lizard
        - the surface of the water doesn't break easily
- Adhesion
    - H2O to different molecules
        - H2O to cell wall
    - Capillary Action
        - transport of water in plants
        - to do this, adhesive forces are stronger than the cohesive and also stronger than gravity
        - if high cohesive forces, it will keep water molecules together and not go up.
    -

8.3 Carbohydrates

Carbohydrates

Describe a Carbohydrate Molecule

- CnH2nOn
  - n is based on the number of carbons
- Functional Groups
  - OH (Hydroxyl)
  - Aldehydes
  - Ketones
- Covalent bond

A type of Monosaccharide that has 5 carbon atoms

- **Pentose**
- 3 C atoms
  - Triose
- 4 C atoms
  - Tetrose
- 6 C atoms
  - Hexose

A type of monosaccharide which has an aldehyde group attached to first carbon

- **Aldose**
- If put into C2 it is a ketose

A type of carbohydrate that has 3-10 monomeric units

- **Oligosaccharides**
- some references say 2-10 monomeric units
    - Disaccharides are therefore under oligosaccharides
- Mono → Di → Oligo → Poly

What is a chiral carbon

- Has 4 different groups/substituents connected to this C atom

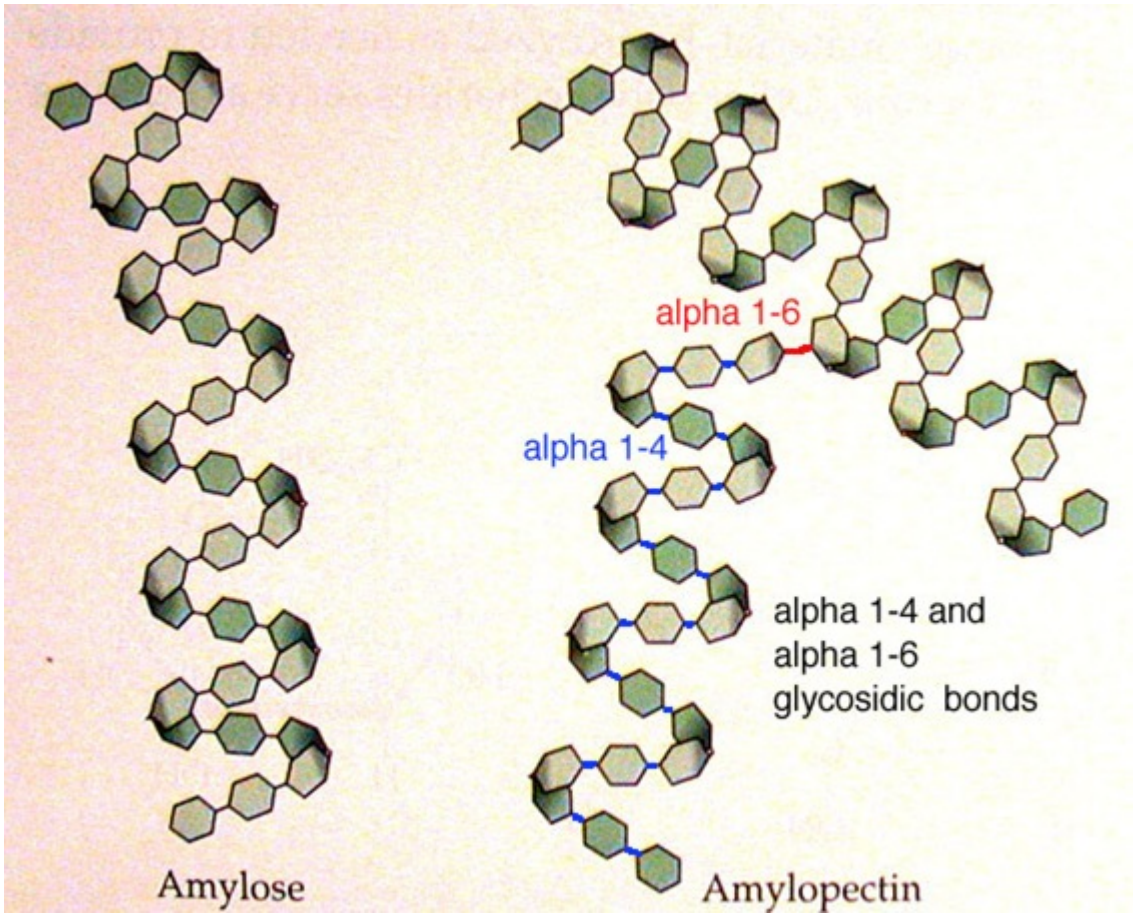
It refers to the stored form of carbohydrates in animals

- **glycogen**
- stored in the liver and muscles
- plants?
    - starch is the equivalent of glycogen in plants

Refers to the structural carbohydrate in the exoskeleton of arthropods

- **Chitin**
- Plants?
    - Cellulose

Two main components of starch

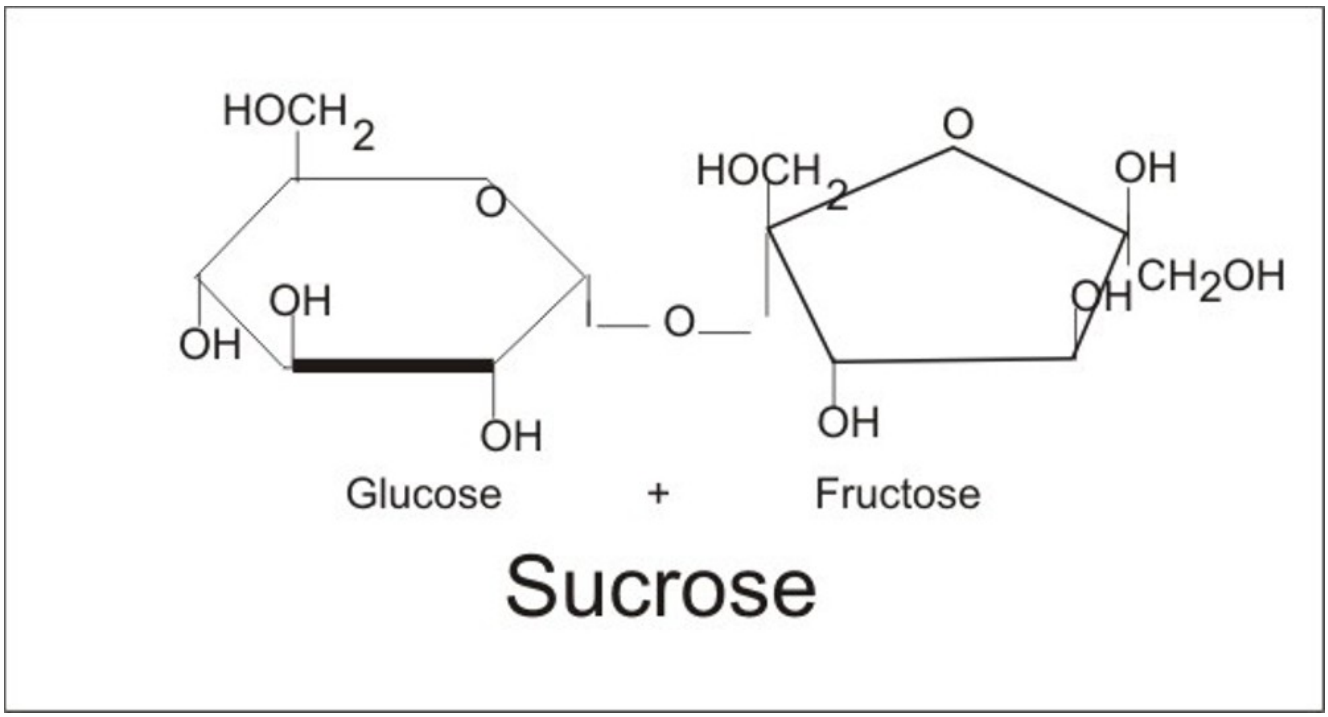


- amylose - 20%
  - H2O soluble
- amylopectin - 80%
  - H2O insoluble

Glucose + Galactose will yield

- Lactose

Glucose + Fructose will yield



- Sucrose
  - Glucose is 6 membered ring
  - Fructose is 5 membered ring

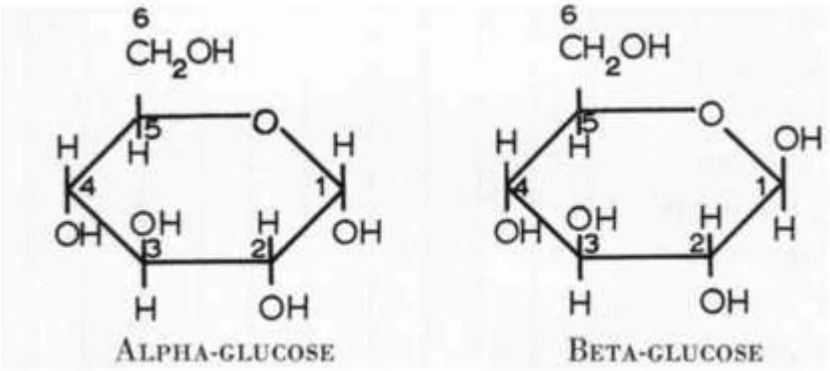
Stachyose and raffinose are disaccharides

- **False, oligosaccharides**
- Stachyose is a tetrose
- Raffinose is a triose

True or False: Polysaccharides include amylose, cellobiose, glycogen, and chitin

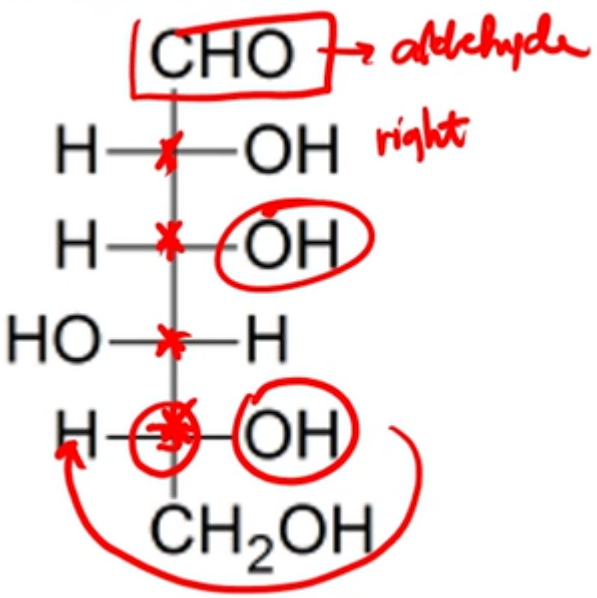
- **FALSE, cellobiose is a disaccharide**

How do you distinguish between the alpha and beta anomers?



- **Alpha anomer - opposite side, Beta anomer - same side**
- Pyranose
  - C1 - OH
  - C6 - CH2OH
- Furanose
  - C2 - OH
  - C6 - CH2OH

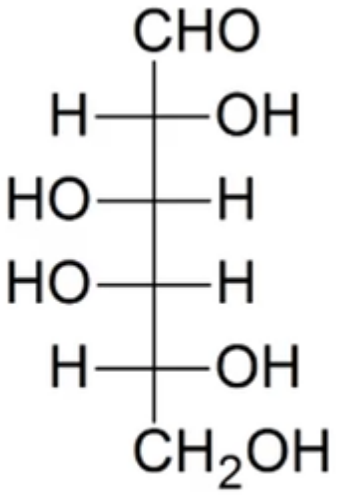
Examine the structure of this Fischer projection of monosaccharide gulose.



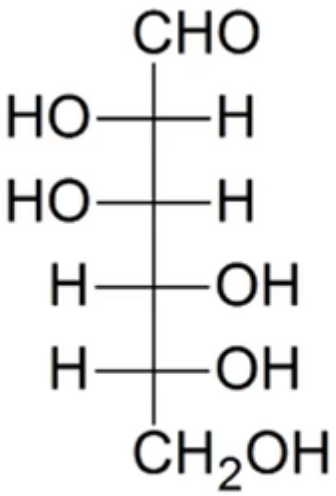
1. is it D or L sugar - D sugar
2. Aldose or Ketose? - Aldose
3. How many chiral centers? - 4 - C2-C5

4. Convert this to Haworth structure? (two structures alpha and beta)
    - Bond rotation of C5 to clockwise because D sugar, thus CH2OH is above
        - If L sugar, C5 bond rotation is counterclockwise

Study the Fischer Projections to Answer the Questions Below



galactose



mannose

1. Is Galactose D or L sugars
    - D Sugar
2. Is Mannose a D Sugar or L Sugar
    - D Sugar
3. Are these two Carbohydrates enantiomers? If not, how many places do they differ?
    - No. Enantiomers are mirror images
    - They differ at C2 and C4
4. What is the term that will describe the relationship between galactose and mannose?
    - Epimer - 1 Chiral Carbon difference

- Diastereomer - 2-3 Chiral Carbon Difference
    - thus, **Mannose and Galactose are Diastereomers**
    - Epimer is also a diasteriomer
