RECALL

Carbohydrates (sugars and saccharides)

- Sugars are compounds that are composed of at least 3 carbons and has a formula of approximately $C_NH_{2N}O_N$
- D-Glucose an aldohexose



These sugars can cyclize (form rings)

- 6-ring sugar is a pyranose
- 5-ring sugar is a furanose

Hemiacetal Formation

Recall addition reaction across a double bond (i.e., ether formation)



H-O-R

Similarly, addition reactions can be done on carbonyls (Ketones and Aldehydes):







- This is a favored reaction. The sugar interconverts between the linear (or open) and ring form but the ring form (hemiacetal) is generally more favored.
- If OH at the anomeric carbon (C with 2 oxygens attached) is on same side of ring as CH₂OH then the configuration called β (beta) if on opposite side it is α (alpha)
- For glucose, the alpha and beta anomer are present in the same amount. However, for other sugars, the alpha anomer is generally more favored.
- 6-Membered sugar rings are called pyranose
- 5-Membered sugar rings are called furanose

Example 2 - Fructose



Acetal Formation

- Happens when there are more alcohols around



Example 1 - Glucose



Mixture of anomers

Example 2 - Table Sugar (Sucrose):



 α -D-Glucopyranosyl- β -D-Fructofuranoside

- Has 2 anomeric carbons
- Non-reducing sugar since it contains an acetal group and does not contain hemiacetals, aldehydes, or alpha-hydroxy ketone
- Can be broken down by the body to glucose and fructose monomers

Monosaccharides – simple sugars such as glucose and fructose – can't be converted to smaller sugars by chemical reaction (i.e., hydrolysis)

Polymers of Sugars

- Disaccharide: sugars that are composed of 2 monosaccharide units
- **Trisaccharide:** sugars that are composed of 3 monosaccharide units
- Tetrasaccharide: sugars that are composed of 4 monosaccharide units
- Oligosaccharides: sugars that are composed of 3 to 10 monosaccharide units
- **Polysaccharides:** long chain of carbohydrates containing more than ten (> 10) monosaccharide monomers.

Cellulose



β -(1 \rightarrow 4)-D-Glucopyranoside polymer (Cellulose)

- Cellulose is a polysaccharide composed of D-glucose monomers linked via β-1,4 glycosidic linkages.
- Cellulose is a main component of cotton
- Cellulose is also a raw material for producing cellulose nitrate which is the major component of smokeless powder used as a propellant in ammunition of firearms and artillery.
- β-linkages cannot be digested by most mammals

Starch (Amylose)



α -(1 \rightarrow 4)-D-Glucopyranoside polymer (Amylose)

- Amylose (accounts for 20% of the weight of starch) is a polysaccharide composed of D-glucose units linked via α-1,4 glycosidic linkages

Starch (Amylopectin)



-(1→4)-glycosidic linkage

Amylopectin: α -(1 \rightarrow 4) and α -(1 \rightarrow 6) linked D-glucopyranoside polymer

- Amylopectin is the main component of starch (80% dry weight)
- Amylopectin is characterized by branching via α -(1 \rightarrow 6)-glycosidic linkages in approximately every 25 glucose units along the main polymer chain.

Chitin



Other Examples and Information

Reducing Sugars

- Contains either an aldehyde, α -hydroxyketone, or a hemiacetal
- All aldoses are reducing sugars







Aldehyde

-Hydroxyketone

Hemiacetal

Non-reducing sugars

- Any sugars that do not contain any of the above functionality (i.e., glycerol) or an acetal group (i.e., sucrose)



Artificial Sweeteners

Sucralose



- Non-reducing sugar

Sodium Cyclamate



Saccharine



Aspartame

