Number of Carbohydrate Units

Monosaccharides = single unit
Disaccharides = two units
Oligiosaccharide = 3-10 units
Polysaccharide = 11+ units

Bonus:

- Can you name the most common Mono (4), Di(3), and Poly(4)-saccharides

Number of Carbons

3C = Triose
4C = Tetrose
5C = Pentose
6C = Hexose
7C = Heptose

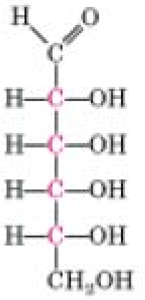
Most common are 5 and 6 Carbon Carbohydrate

Bonus:

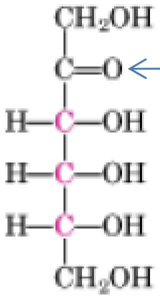
- Can you name the most common pentose?
- Can you name the most common hexoses?

Functional Group

Aldose = aldehyde



Ketose = ketone

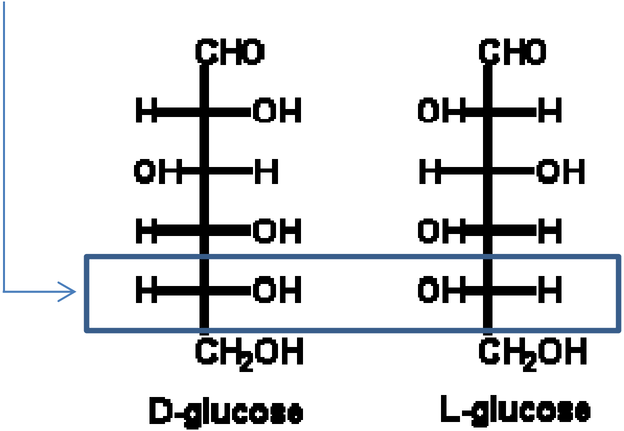


Bonus:

- Can you name a common example of each?

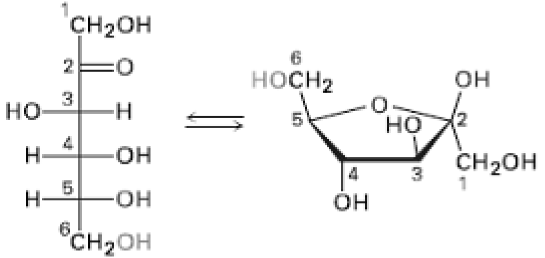
D or L Isomer

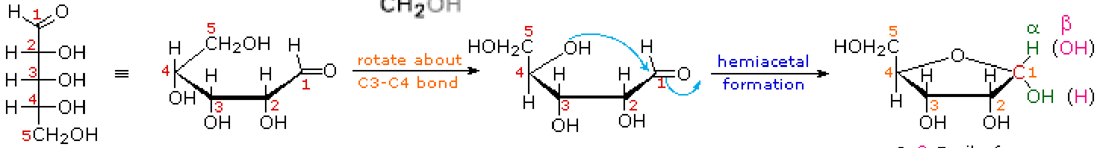
- The orientation of the OH group furthest from the most oxidized end of a carbohydrate.
- The bottom OH on a properly drawn Fischer Projection



Size of Ring

Furanose = 5 member ring - Ald/Ket + OH 4 carbons a way

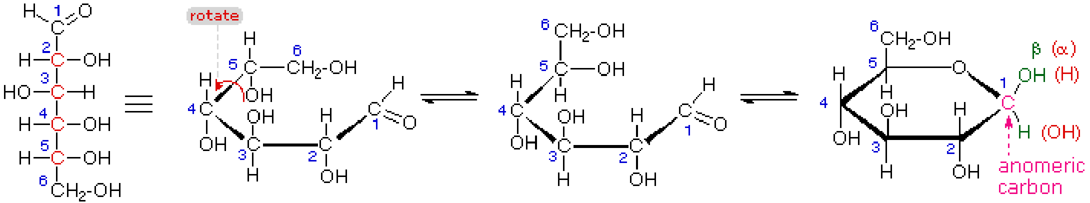




D-ribose

α & β-D-ribofuranose

Pyranose = 6 member ring - Ald/Ket + OH 5 carbons away



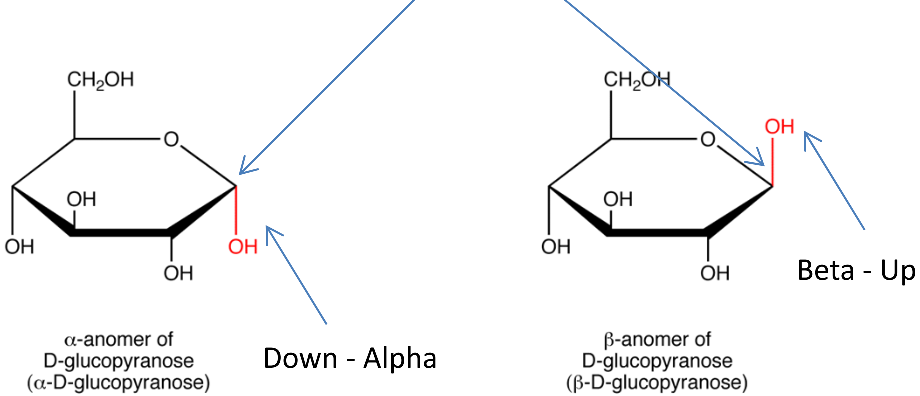
D-(+)-glucose

D-glucopyranose

Anomers

Definition:

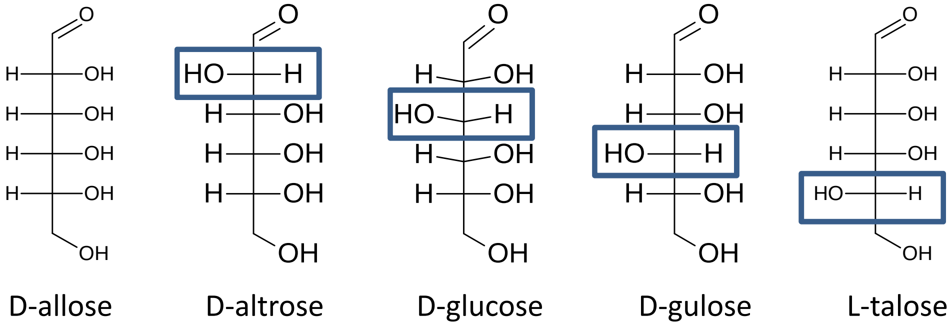
- Diastereomers that differ in the configuration/orientation around the OH group on the carbon capable of mutarotation (hemiacetal or hemiketal carbon)
- BUDA (Beta Up, Down Alpha)



Epimers

Definition:

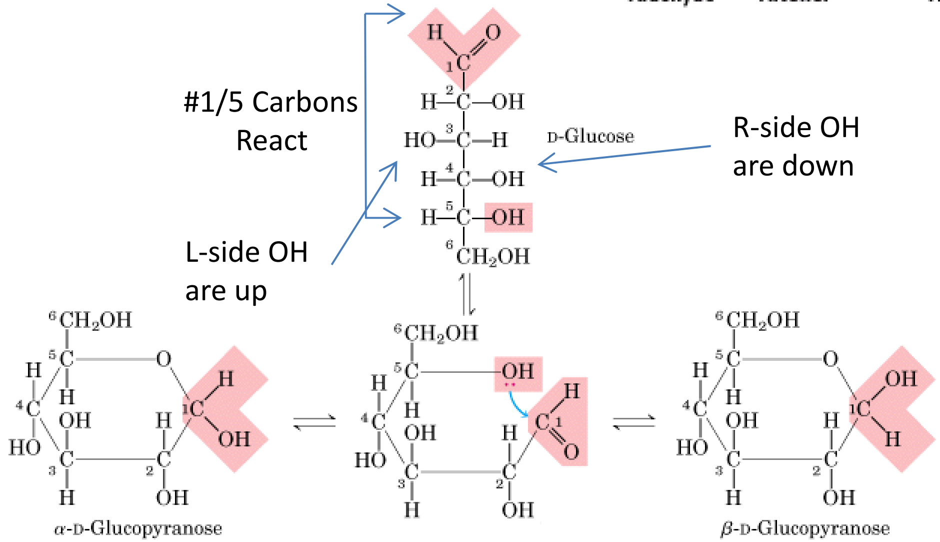
Two monosaccharide's that differ in the configuration around a single carbon.



Drawing Pyranose Rings

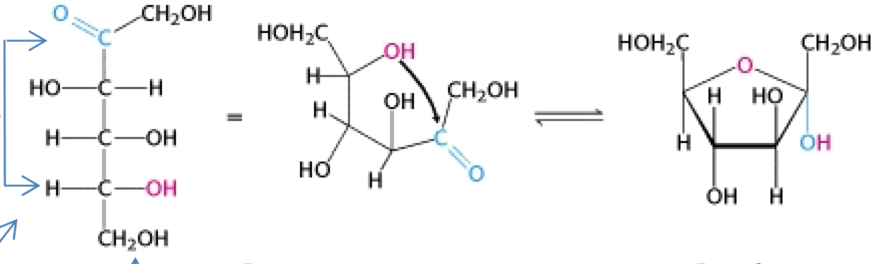
- Number the chain to decrease mistakes
- Left OH's Up
- Right OH's Down
- #6 - CH_2OH group up for D-isomers

Hemiacetal reaction



Drawing Furanose Rings

#2/5 Carbons React



D-Fructose
(open-chain form)

α-D-Fructofuranose
(a cyclic form of fructose)

L-side OH are up

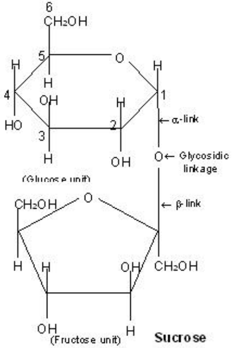
R-side OH are down

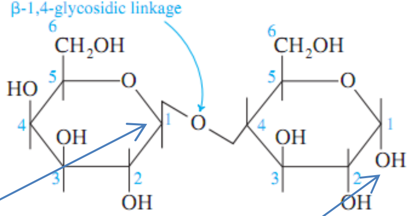
Drawing Disaccharides

- Formed by a dehydration reaction
- Draw a disaccharide given two monosaccharide's and the linkage
- Name disaccharides
- First ring (yl ending), Second normal

"Sucrose"

α-D-glucopyranosyl-(1,2)-β-D-fructofuranose

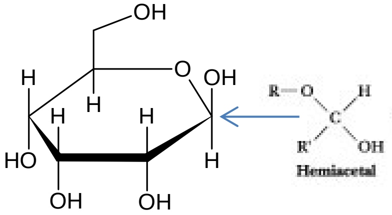




"Lactose"

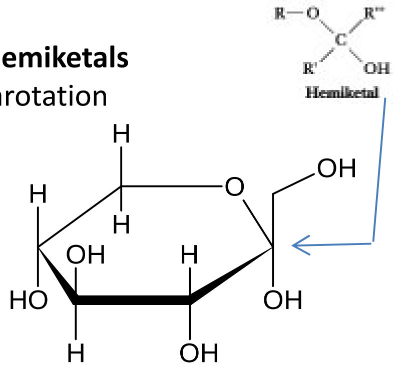
β -D-galactopyranosyl-(1,4)-α-D-glucopyranose

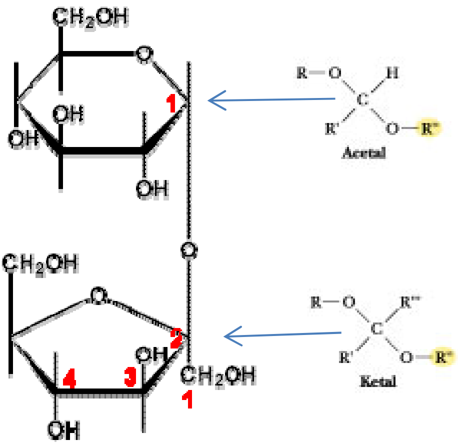
Hemiacetals, Acetals, Hemiketals, and Ketals



Hemiacetals and Hemiketals

- Capable of mutarotation
- React easily
- Reducing sugars



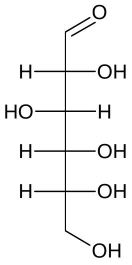


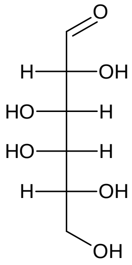
Acetals and Ketals

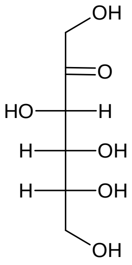
- Not Capable of mutarotation
- Not Reactive (hydrolysis)
- Not Reducing sugars

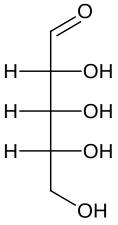
Monosaccharide’s

	4 Most Common Monosaccharide's			
Structural Isomers	D-Glucose	aldohexose	pyranose	bloodsugar, cellular respiration
	D-Galactose	aldohexose	pyranose	milk, yogurt, cell membranes
	D-Fructose	ketohexose	furanose	honey, sweetest sugar
	D-Ribose	aldopentose	furanose	DNA









Disaccharides

3 Most Common Disaccharides			
Maltose	α-D-Glucose + α-D-Glucose	α-1,4	beer, starch breakdown product
Lactose	β-D-Galactose + α-D-Glucose	β-1,4	milk sugar
Sucrose	α-D-Glucose + β-D-Fructose	α-β-1,2	table sugar

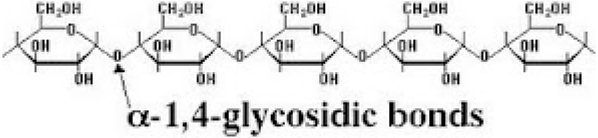
Polysaccharides

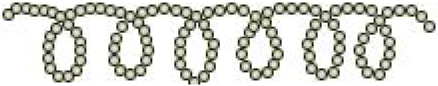
	4 Most Common Polysaccharide's			
Starch	Amylose	α-1,4	helix	plant energy storage
	Amylopectin	α-1,4 (main) α-1,6 (side)	treelike	plant energy storage
	Glycogen	similar to amylopectin	treelike	animal energy storage
	Cellulose	β-1,4	linear/ sheets	plant structural storage

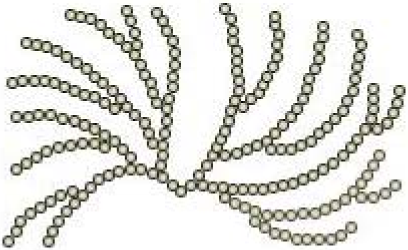
Starch

Amylose:

- 25-1300 α-D-Glucose units
- α-1,4-glycosidic bonds
- Forms coils/helical/telephone structure
- Energy storage for plants

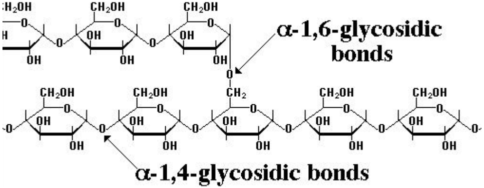






Amylopectin:

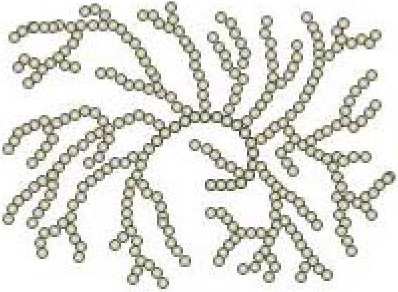
- 25-1300 α-D-Glucose units
- α-1,4-glycosidic bonds, branched every 25 glucose with a α-1,6-glycosidic bond
- Forms tree like structure
- Energy storage for plants



Glycogen

Glycogen:

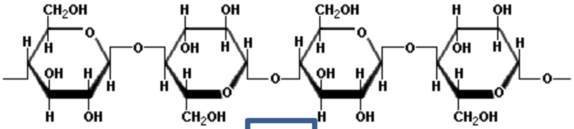
- 25-1300 α-D-Glucose units
- α-1,4-glycosidic bonds, branched every 12-18 glucose with a α-1,6-glycosidic bond
- Forms tree like structure
- Similar to amylopectin, but more branched
- Energy storage for animals



Cellulose

Cellulose:

- 25-1300 β-D-Glucose units
- β-1,4-glycosidic bonds
- Forms linear chains, strong H-bonds leads to the formation of sheets
- Resistant to hydrolysis, indigestible by humans
- Most abundant organic substance in nature
- Chief structural component of plants and wooc



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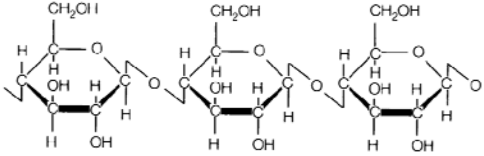
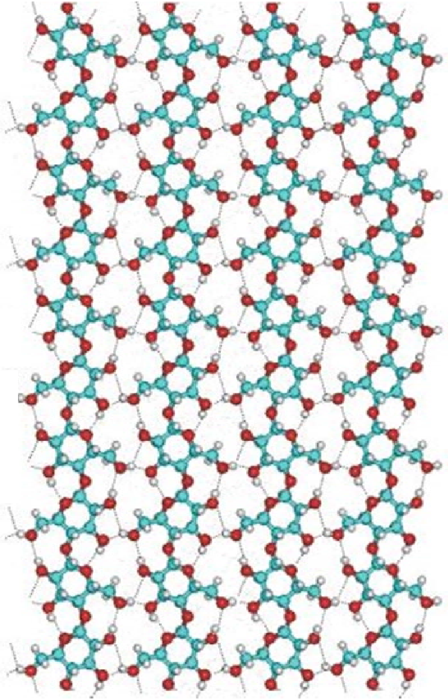
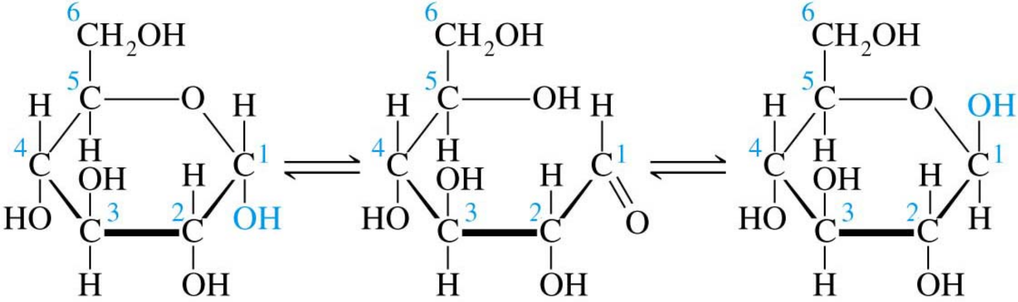




Mutarotation

- Process by which anomer’s are interconverted
- Equilibrium between cyclic and chain form.
- Occurs because hemiacetal carbon can open/close

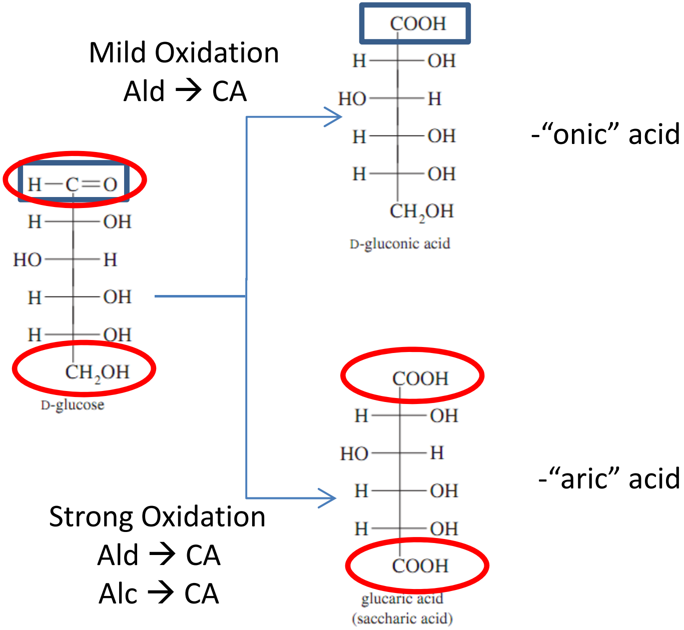


α-D-(+)-glucopyranose

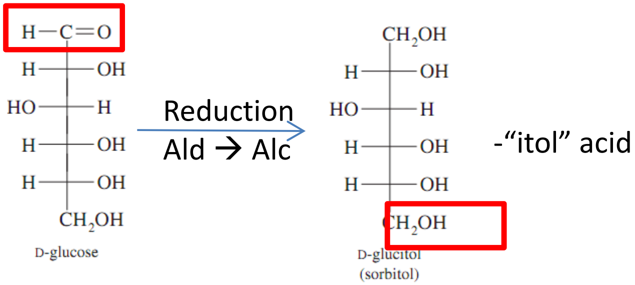
D-(+)-glucose (open-chain form)

β-D-(+)-glucopyranose

Oxidation Reactions

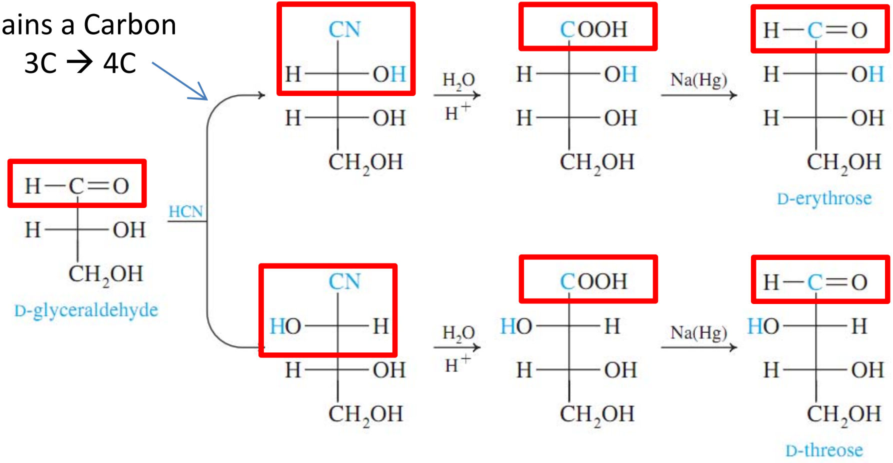

Mild Oxidation
Ald → CA
Strong Oxidation
Ald → CA
Alc → CA
D-glucose
D-gluconic acid
-"onic" acid
glucaric acid
(saccharic acid)
-"aric" acid

Reduction Reaction


H—C=O
H—OH
HO—H
H—OH
H—OH
CH2OH
D-glucose
Reduction
Ald → Alc
CH2OH
H—OH
HO—H
H—OH
H—OH
CH2OH
D-glucitol
(sorbitol)
-"itol" acid

Kiliani-Fischer Reaction

Carbon Chain
Gains a Carbon
3C → 4C



Aldehyde → Cyanohydrin → Carboxylic Acid → Aldehyde

Cyanohydrin Rxn | Hydrolysis Rxn | Reduction Rxn

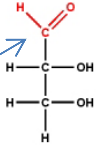
Redox Tests

Redox Tests for Carbohydrates:

- Benedicts/Fehling/ Barfoeds – Cu^{+2} → Cu_2O (s) "Blue → Brick Red ppt

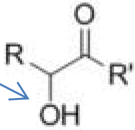
  general tests → mono/di

- Tollens – Reduce Ag^{+} → Ag (s) "Silver Mirror"
- Sugar is Oxidized, Metals are Reduced

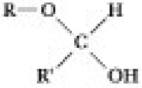


Functional Groups:

- Free Aldehydes
- α-hydroxyketones
- Hemiacetal



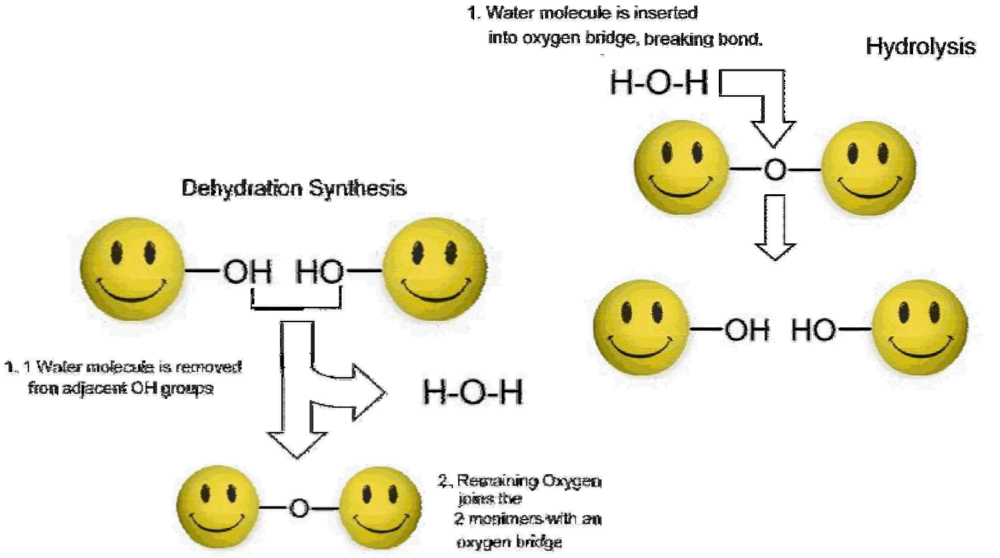
α-hydroxy ketone



Hemiacetal

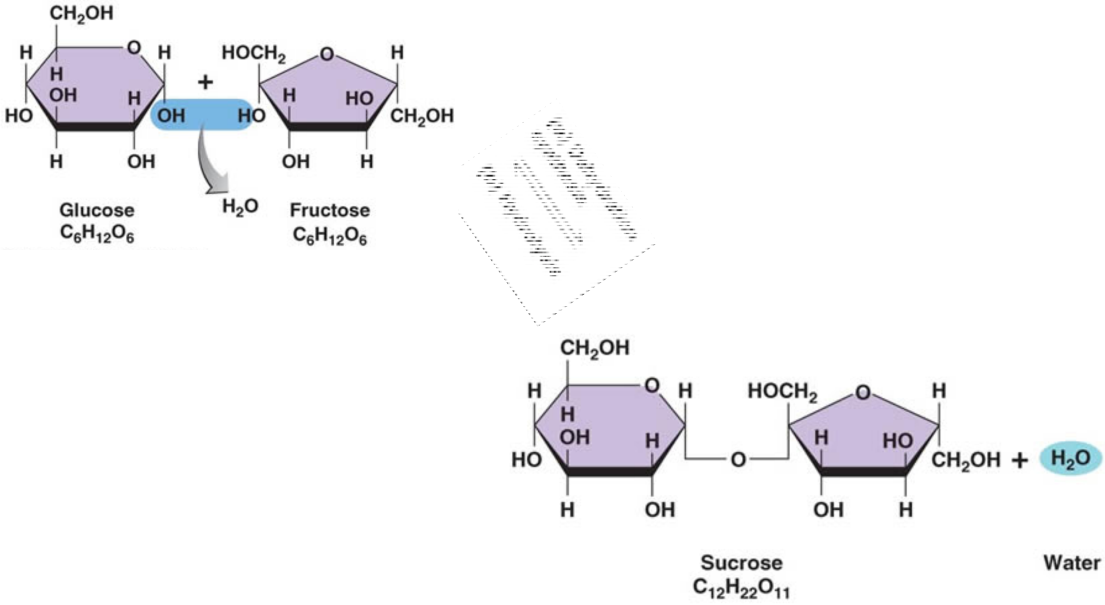
Dehydration/Hydrolysis

Carbohydrate molecules are joined by Dehydration Reactions (-H_2O)
Di/Oligio/Polysaccharides are broken apart by Hydrolysis Reactions (+H_2O)



Dehydration/Hydrolysis

Carbohydrate molecules are joined by Dehydration Reactions (-H_2O)
Di/Oligio/Polysaccharides are broken apart by Hydrolysis Reactions (+H_2O)



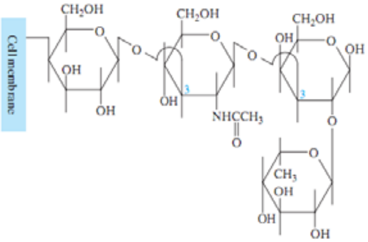
Miscellaneous Applications

Sweeteners

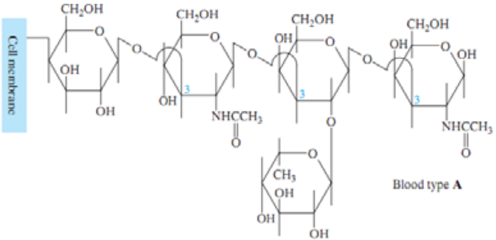
TABLE 27.1 | Relative Sweetness of Sugars and Sugar Substitutes (based on fructose = 100)

Sugars	Relative sweetness	Sugar substitutes (common brand names)	Relative sweetness
Fructose	100	Sucralose (Splenda)	3.5×10^4
Invert sugar	75	Saccharin (Sweet 'N Low)	1.7×10^4
Sucrose	58	Acesulfame potassium (Sunette, Sweet One)	1.2×10^4
Glucose	43	Aspartame (Equal, NutraSweet)	1.0×10^4
Maltose	19	Rebiana (Truvia, PureVia)	1.2×10^4
Galactose	19	Neotame	4.1×10^5
Lactose	9.2		

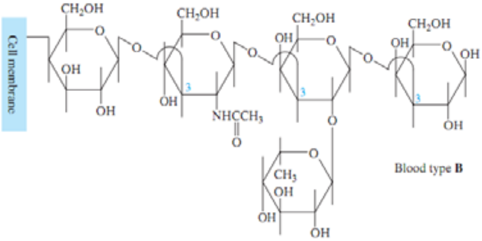
Antigens / Blood Types



Blood type **O**



Blood type **A**



Blood type **B**