

Some Carbohydrate Functions

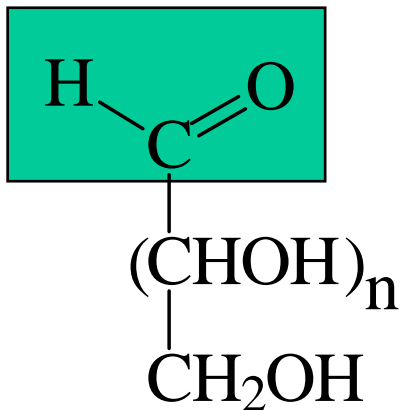
- Developmental processes
- Protein localization
- Regulation of activity
- Cell-cell interactions
- Structural integrity, e.g. cell walls
- Phytohormones
- Plant and animal defense
- Prevention of desiccation (bacteria)
- Adherence of bacteria to surfaces
- Bacterial resistance to host defenses
- Cell-cell recognition and signaling

Introduction to Carbohydrates

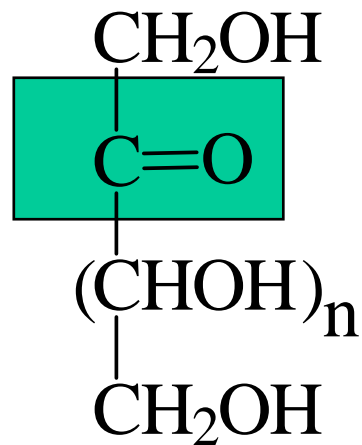
Biochemistry

Garrett & Grisham

Chapter 7, p. 209-237

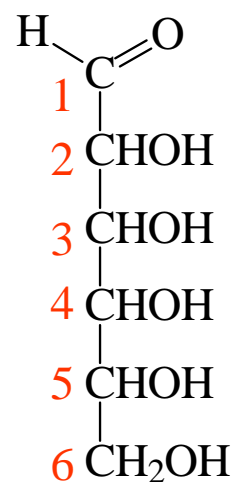
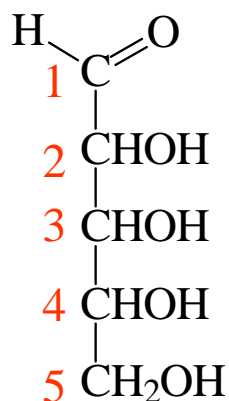
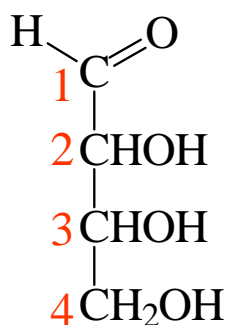
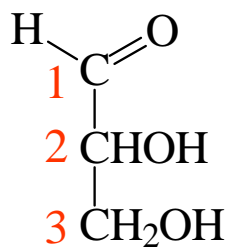


Poly-hydroxy-aldehyde

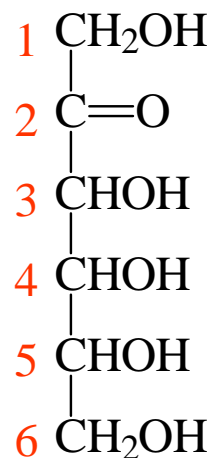
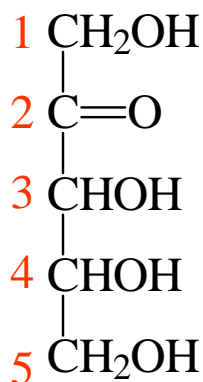
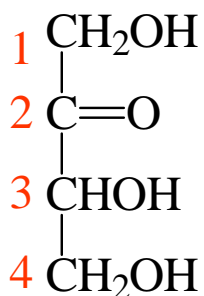
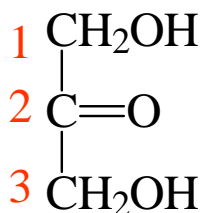


Poly-hydroxy-ketone

Monosaccharides

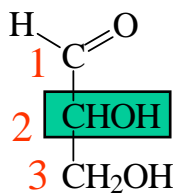


Aldose family

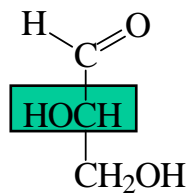


Ketose family

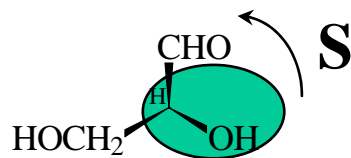
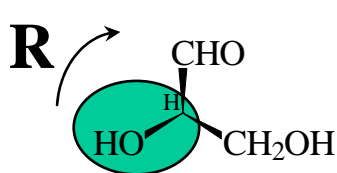
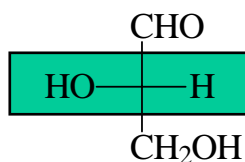
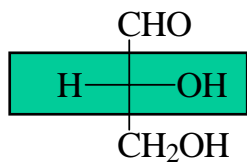
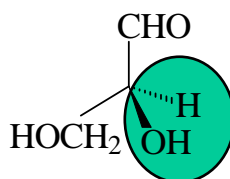
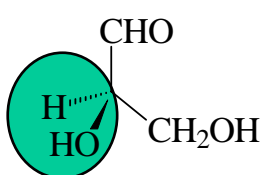
Stereo-isomerism



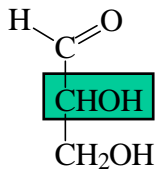
D-glyceraldehyde



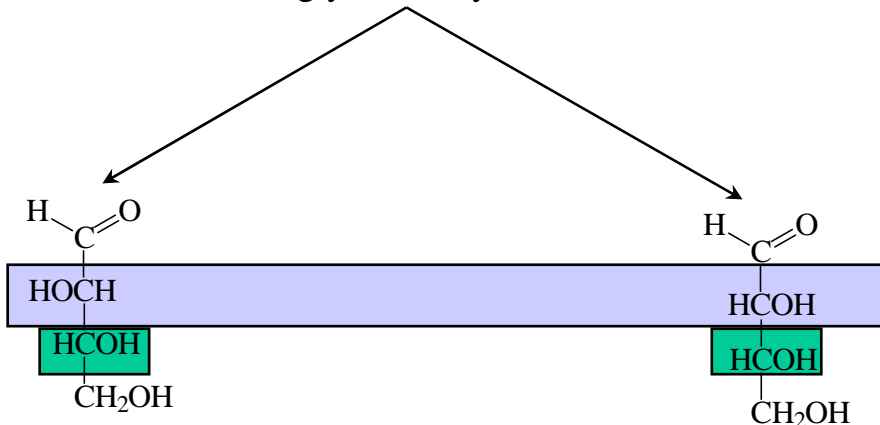
L-glyceraldehyde



D-Aldoses

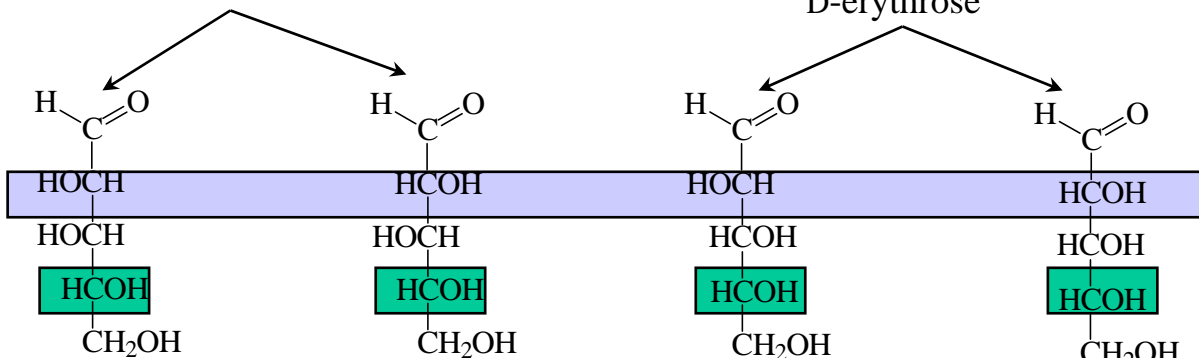


D-glyceraldehyde



D-threose

D-erythrose

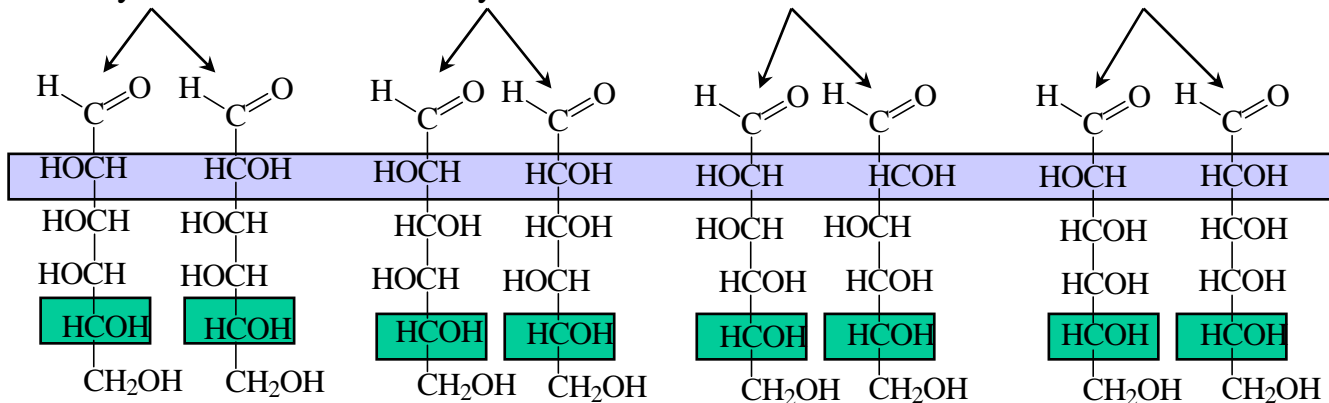


D-lyxose

D-xylose

D-arabinose

D-ribose



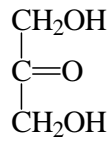
D-talose D-galactose

D-idose D-gulose

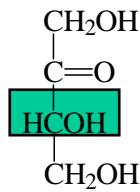
D-mannose D-glucose

D-altrose D-allose

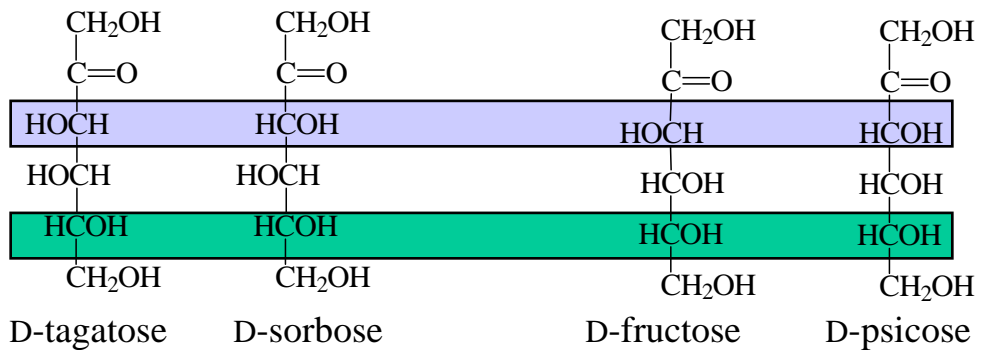
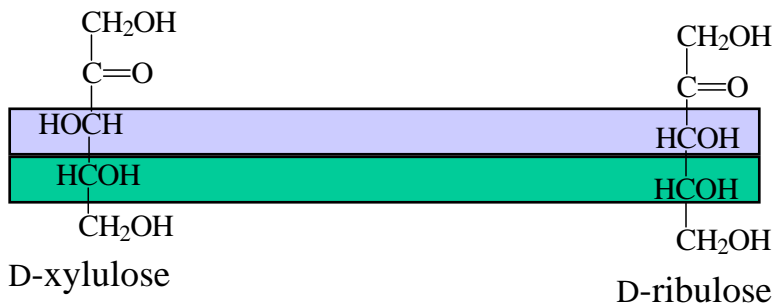
D-Ketoses



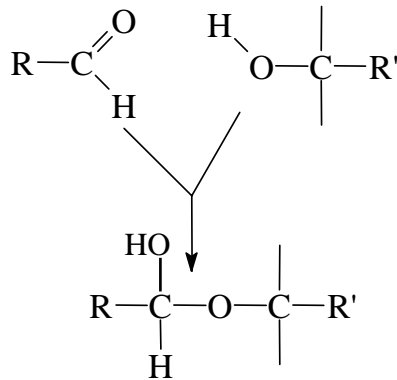
dihydroxyacetone



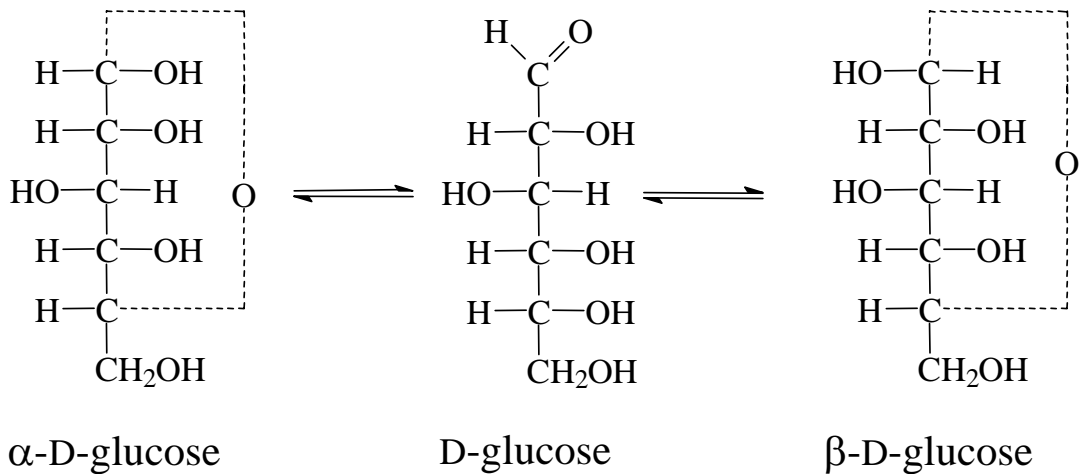
D-erythrulose



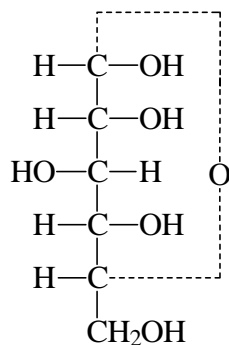
Hemi-acetal (ketal)



Anomers

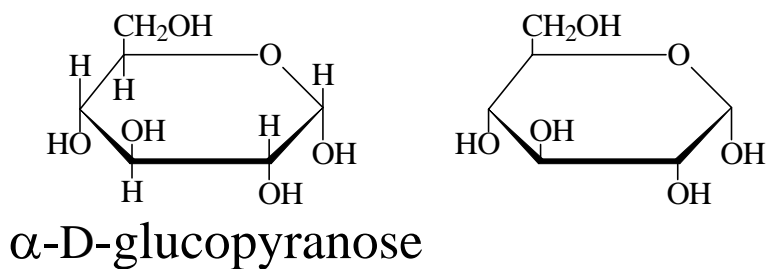


Haworth Structures



Fischer

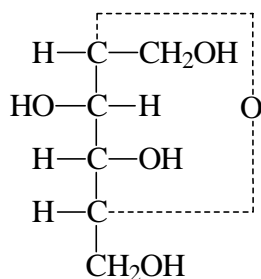
Haworth



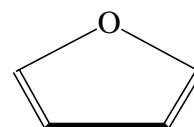
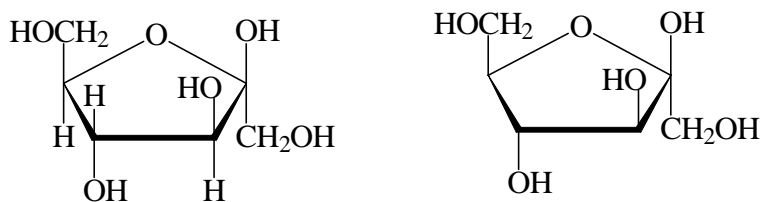
α -D-glucopyranose



pyran

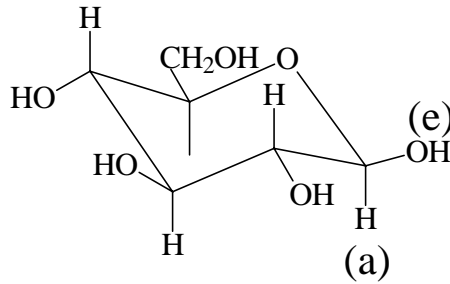
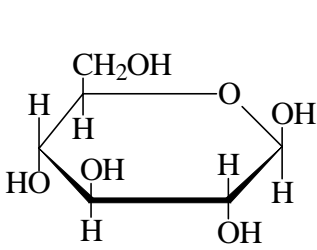


β -D-fructofuranose

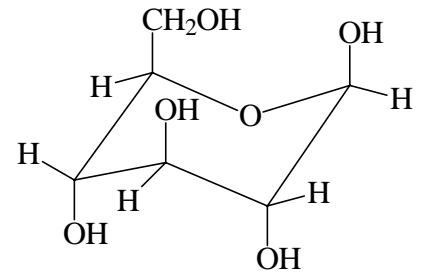


furan

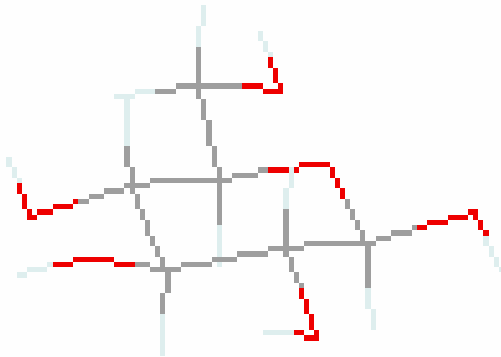
Conformations



$4C_1$



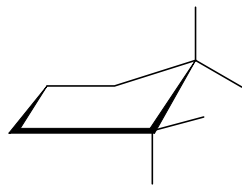
$1C_4$



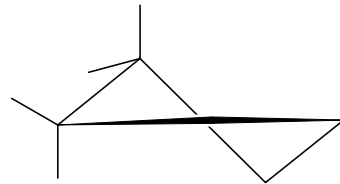
$4C_1$



$4C_1$

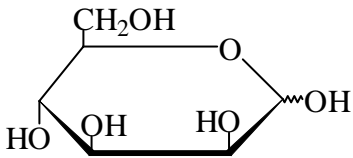


envelope (E)

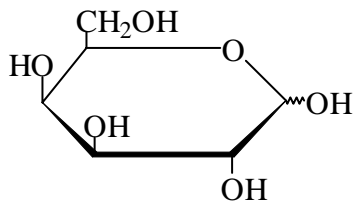


twist (T)

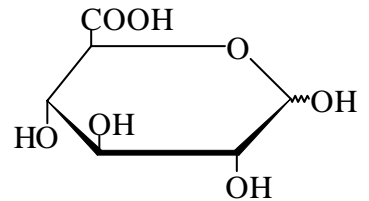
Various Glycosyl Residues



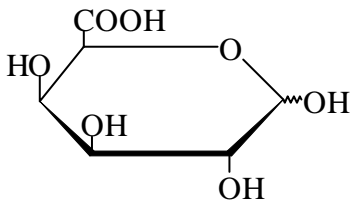
D-Mannose



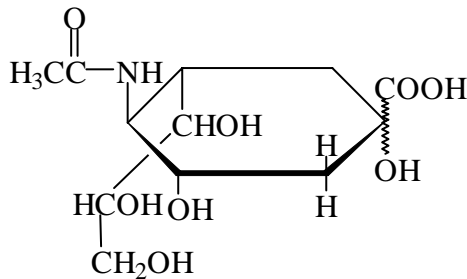
D-Galactose



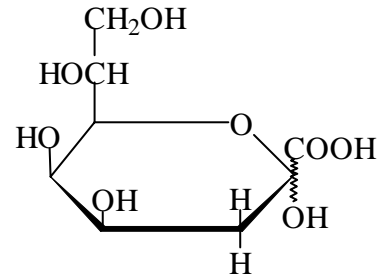
D-Glucuronic acid



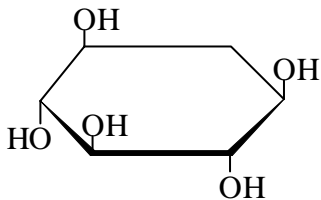
D-Galacturonic acid



N-Acetylneuraminic acid
(Sialic acid)

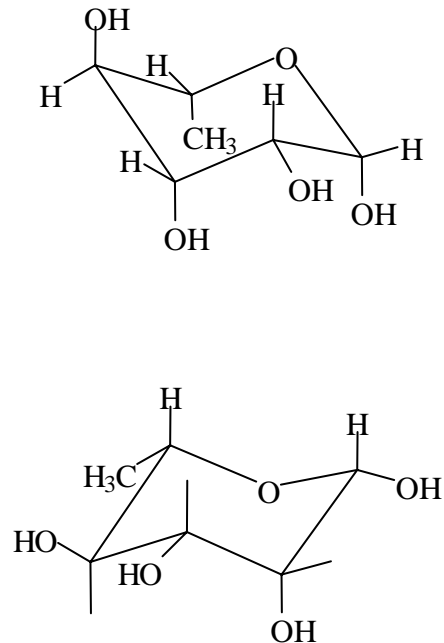
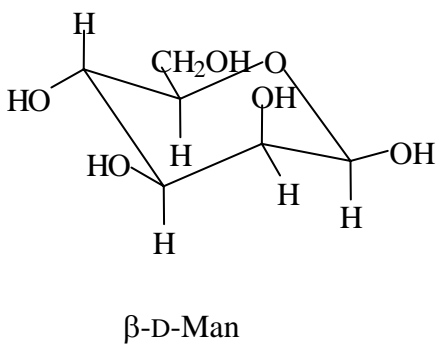
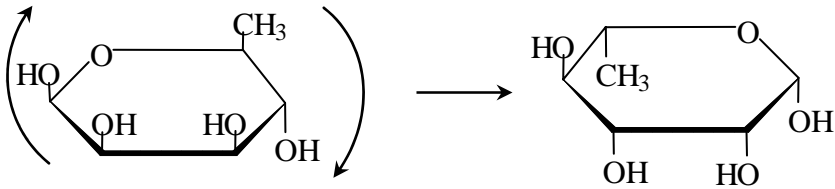
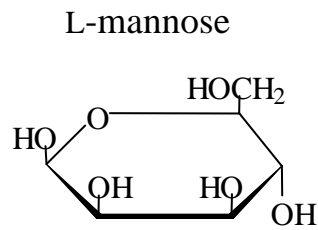
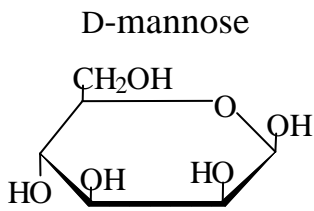
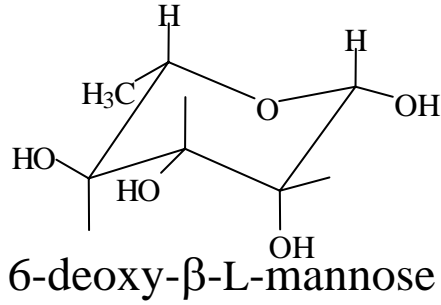


3-Deoxy-D-manno-2-octulosonic acid

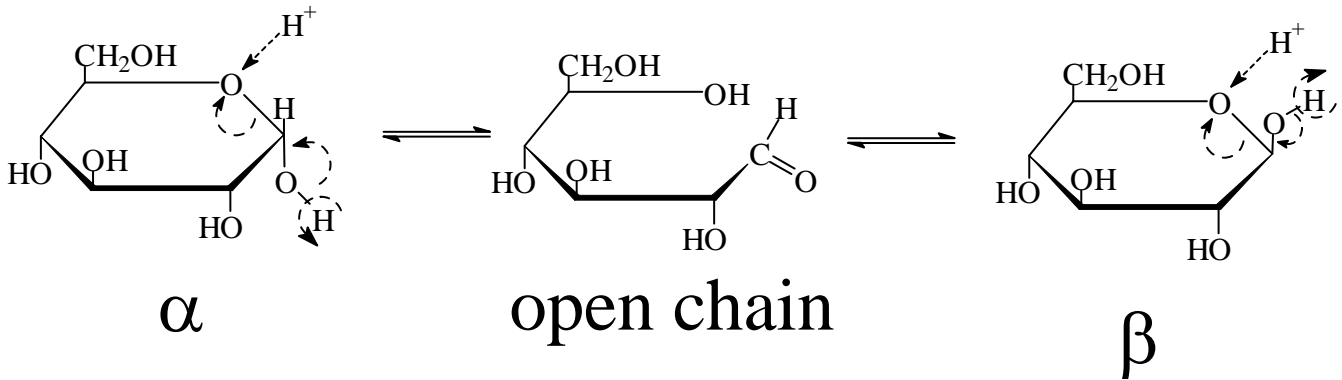


myo-inositol

β -L-Rhamnose



Mutarotation



Initial state 1

aqueous solution of
D-glucose with
X g/ml and a specific
rotation of $+112.2^\circ$



Final state for both

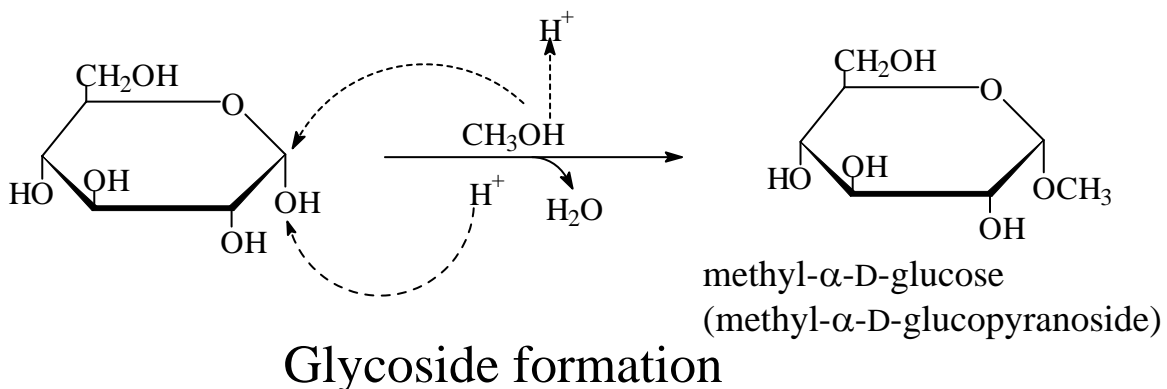
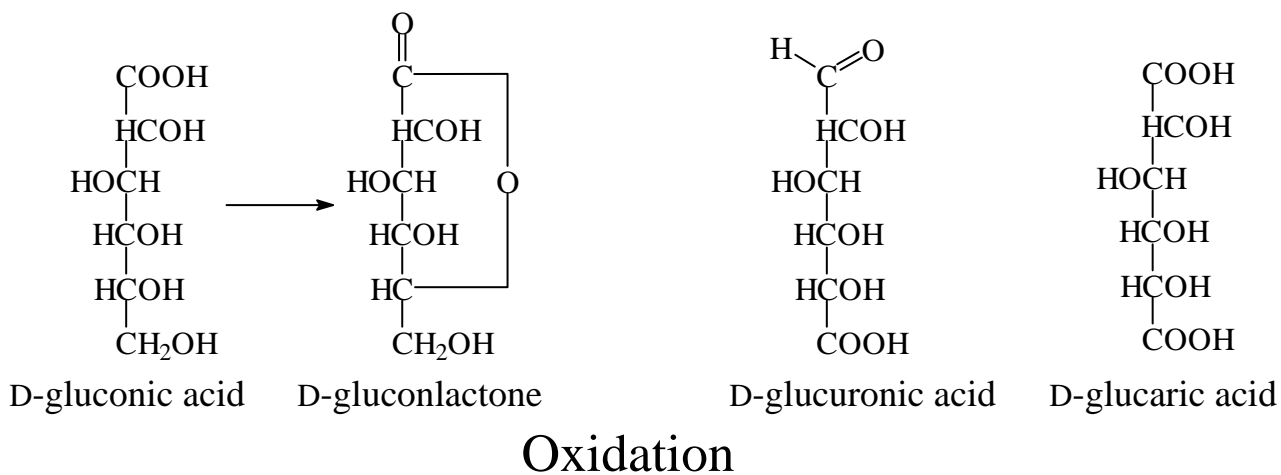
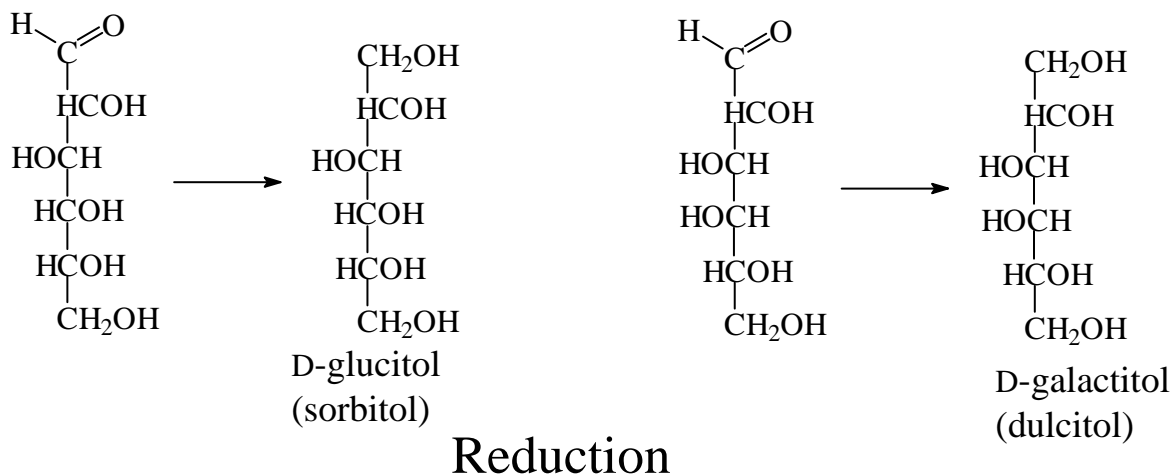
equilibrium solution
with a specific
rotation of $+18.7^\circ$



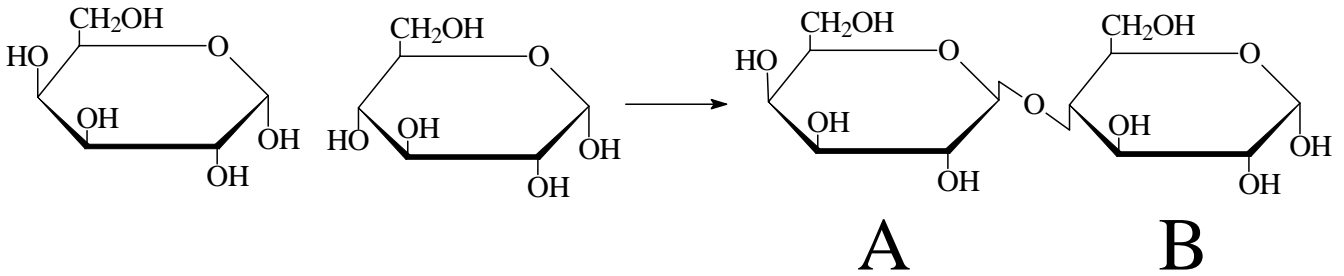
Initial state 2

aqueous solution of
D-glucose with
X g/ml and a specific
rotation of $+18.7^\circ$

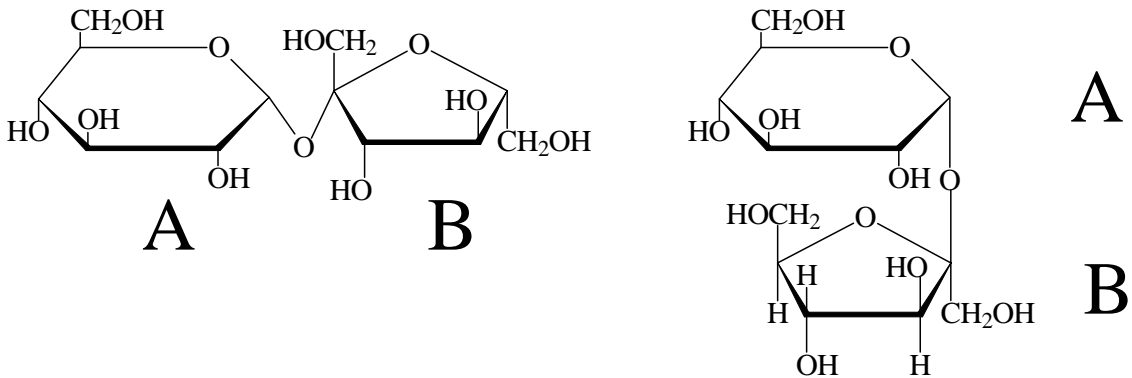
Some Reactions



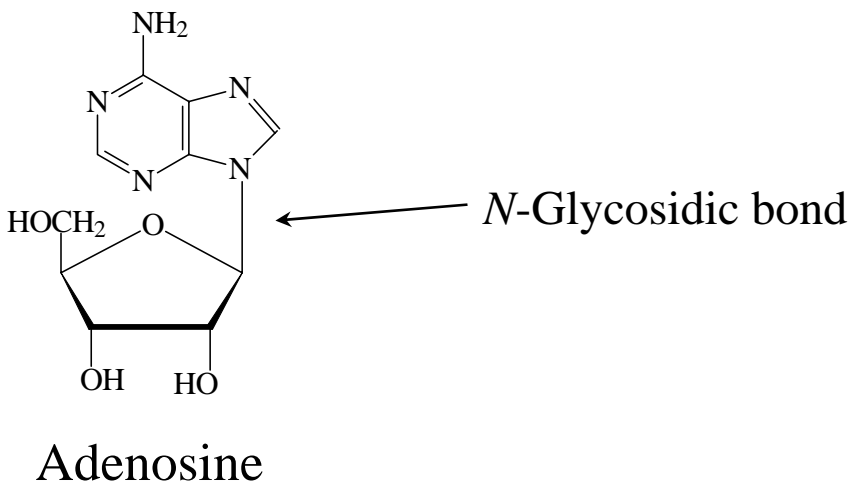
Oligosaccharides



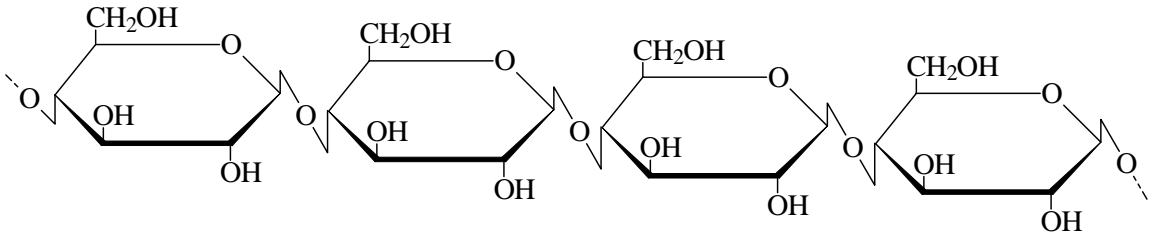
4-O- β -galactopyranosyl- α -D-glucopyranose(lactose)



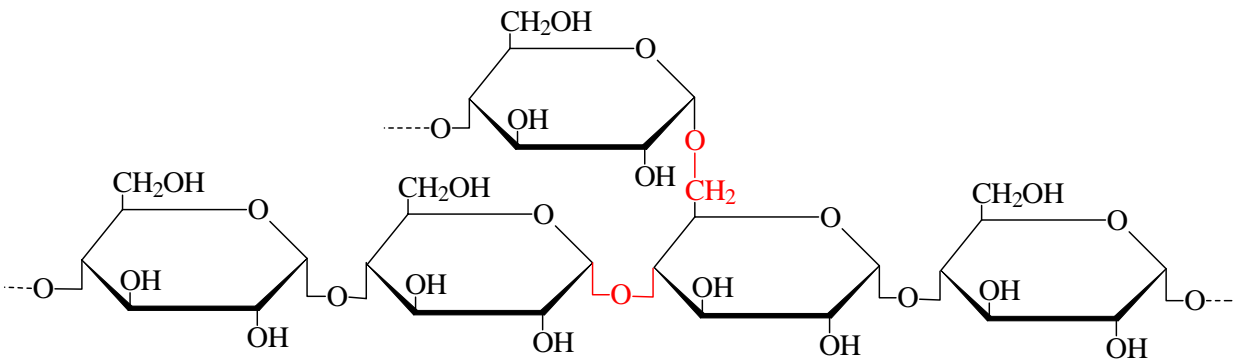
2-O- α -D-glucopyranosyl- β -D-fructofuranoside(sucrose)



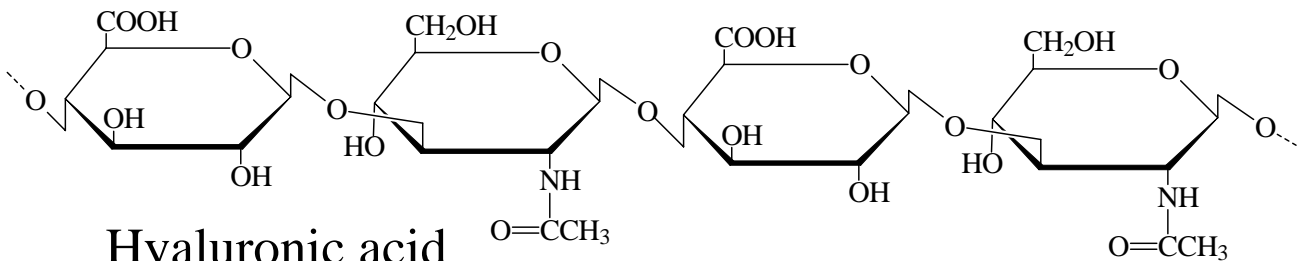
Polysaccharides



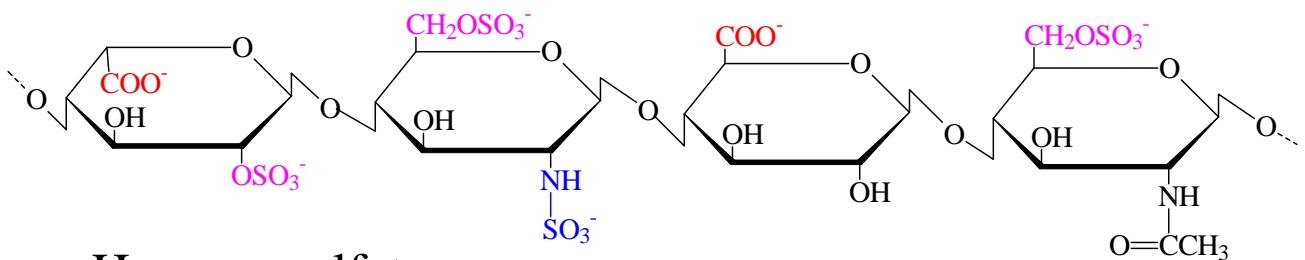
Cellulose (a homopolysaccharide)



Starch

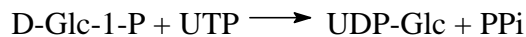
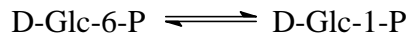
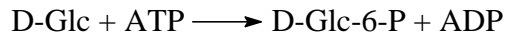


Hyaluronic acid
(a heteropolysaccharide)

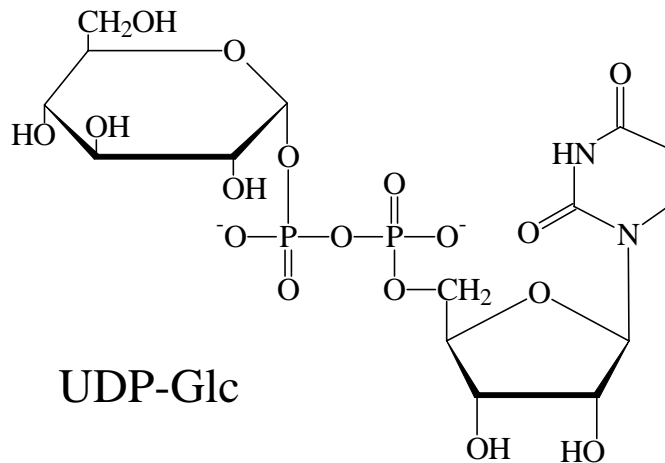


Heparan sulfate

“Activated” Sugar Donors



NDP-sugar pyrophosphorylase
(UDP-glucose pyrophosphorylase)



UDP-Gal

GDP-Fuc

dTDP-Rha

UDP-GlcA

UDP-GlcNAc

CMP-Kdo

UDP-GalA

dTDP-Glc

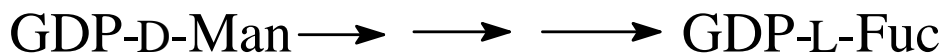
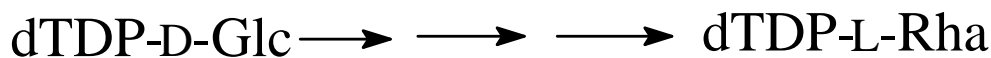
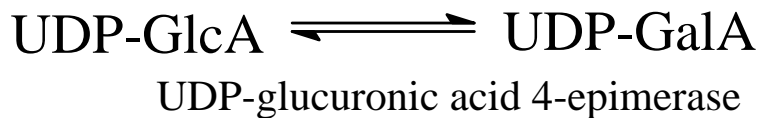
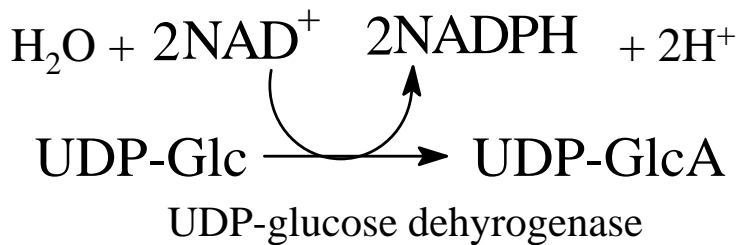
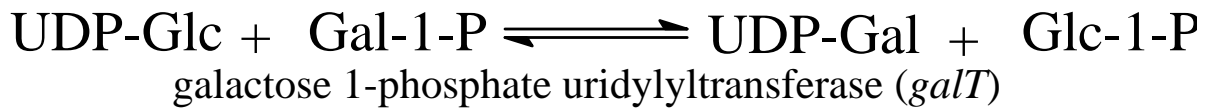
CMP-NeuNAc

GDP-Man

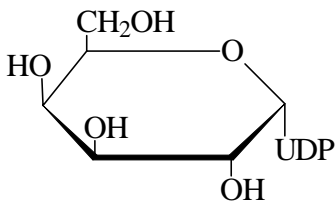
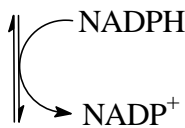
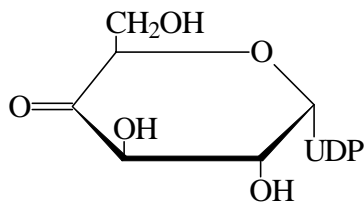
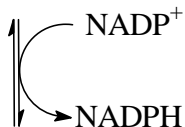
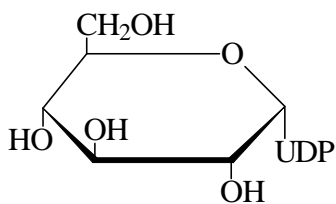
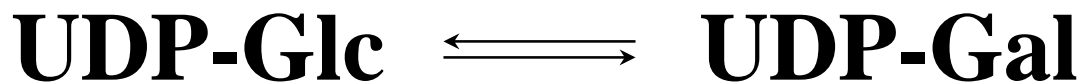
ADP-Glc

ADP-Hep

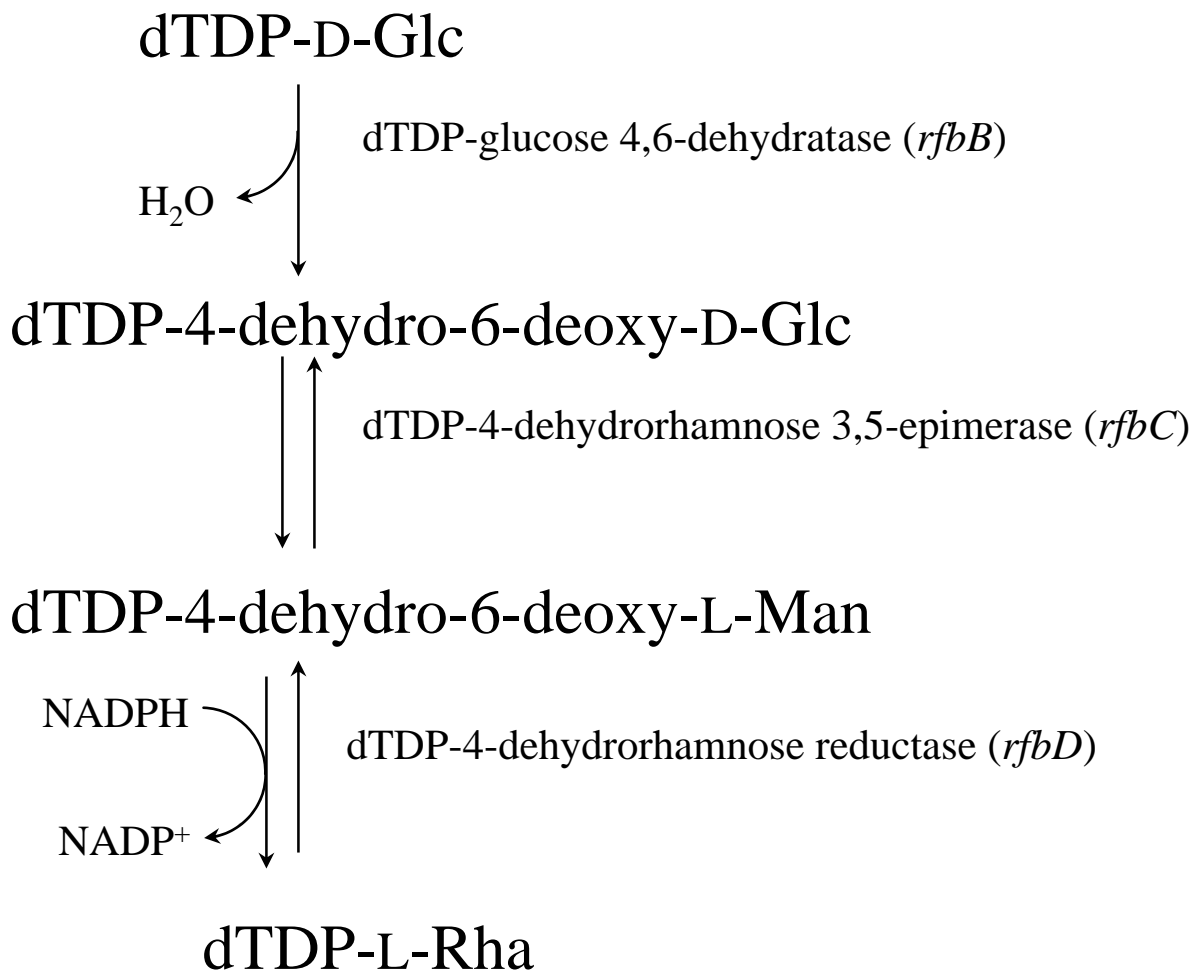
Sugar Nucleotide Biosynthesis



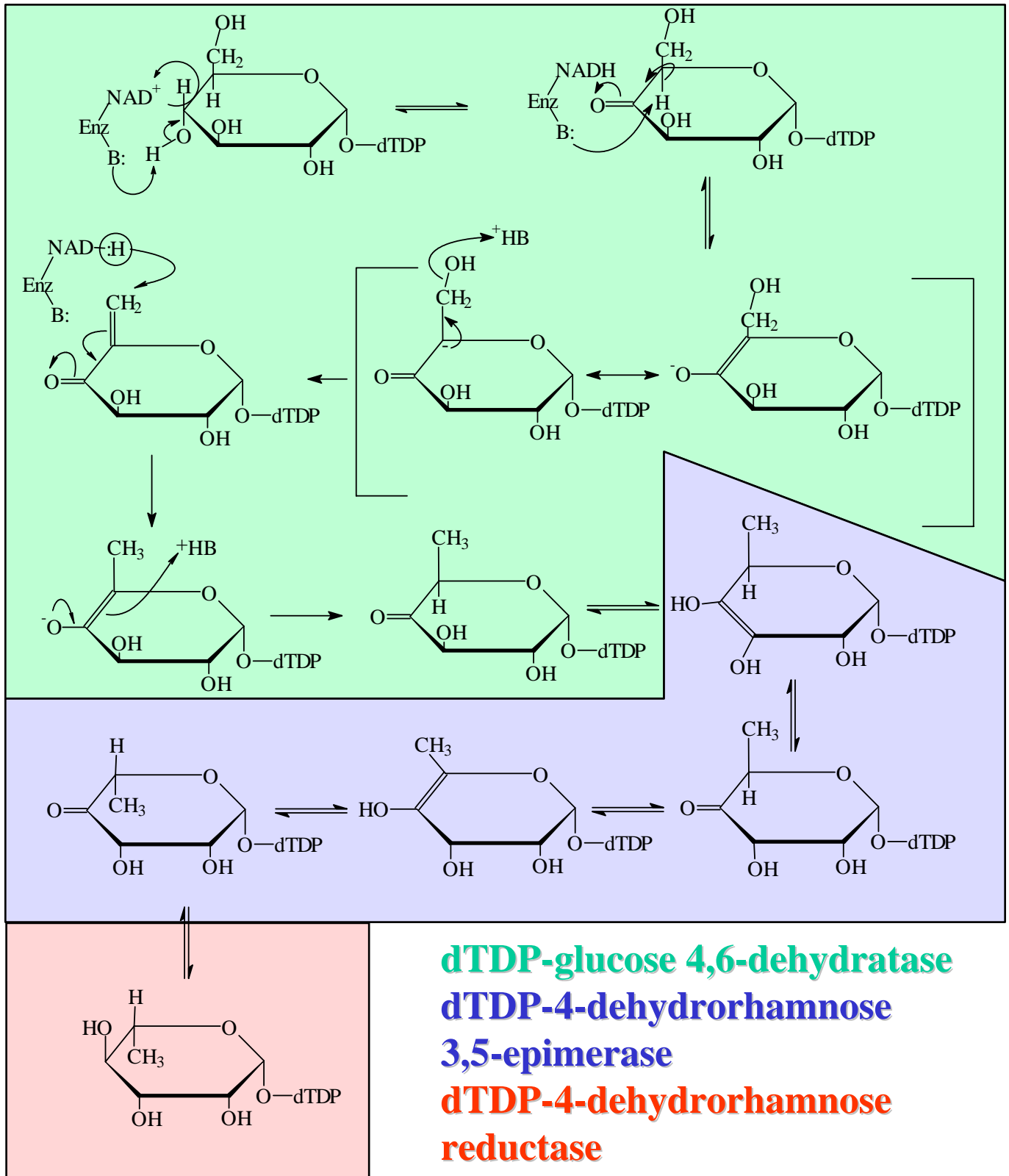
UDP-Glucose 4-Epimerase (*galE*)



dTDP-L-Rhamnose Biosynthesis

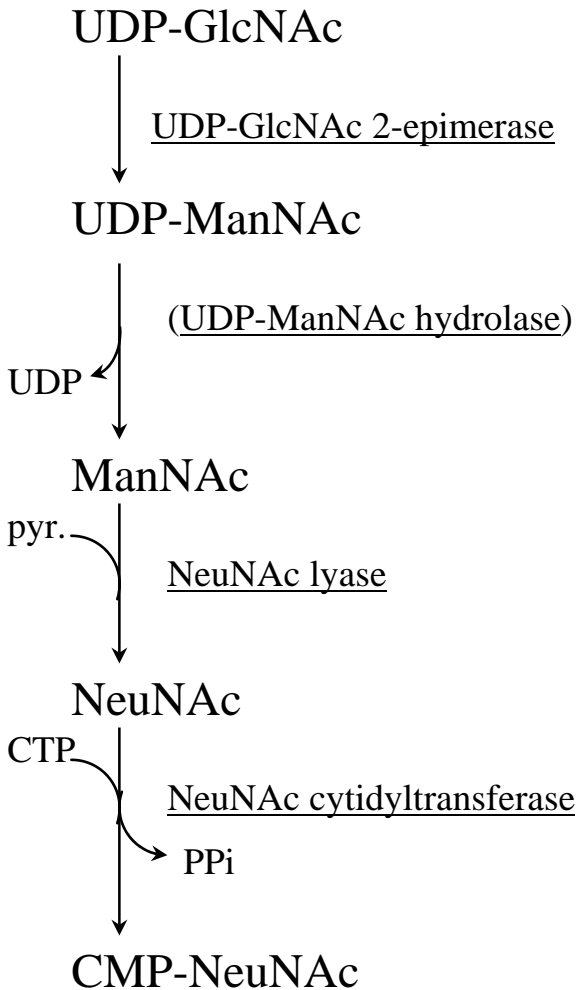


dTDP-Rhamnose Biosynthesis: Reaction Mechanism

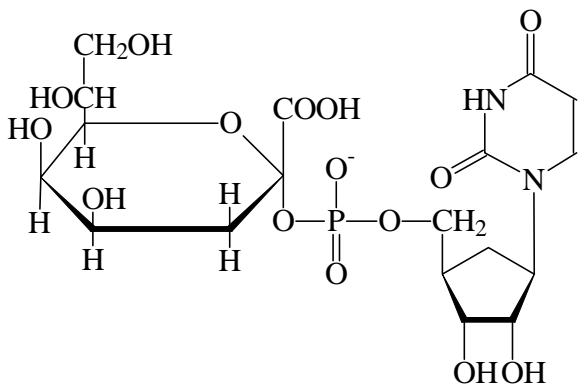
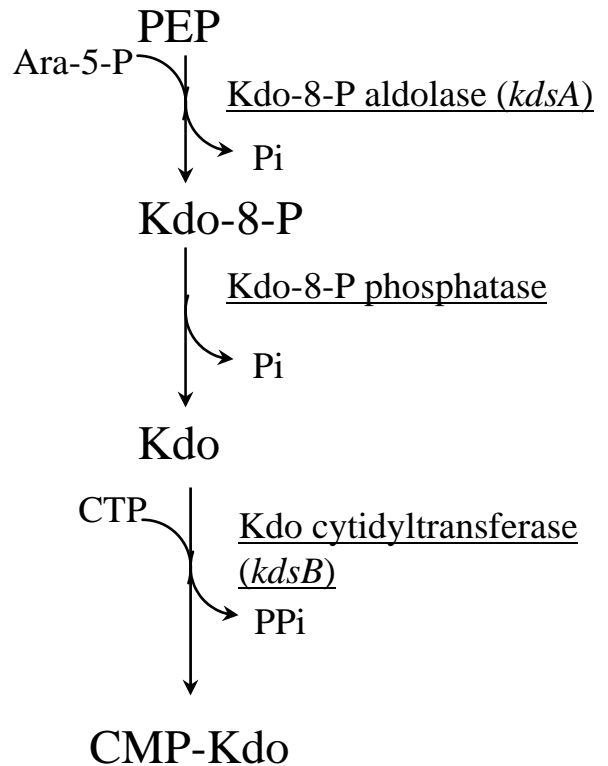


Biosynthesis of CMP-NeuNAc and -Kdo

CMP-NeuNAc

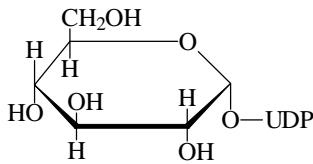


CMP-Kdo

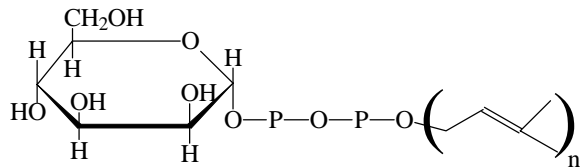


Kdo forms a high energy ketal bond making the CMP a very good leaving group.

Glycosyl Transferase Reactions

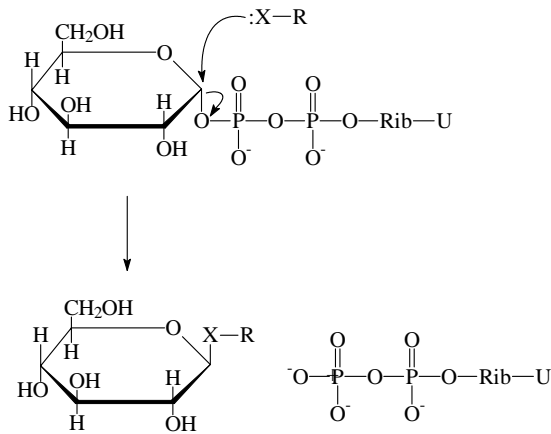


UDP-Glc

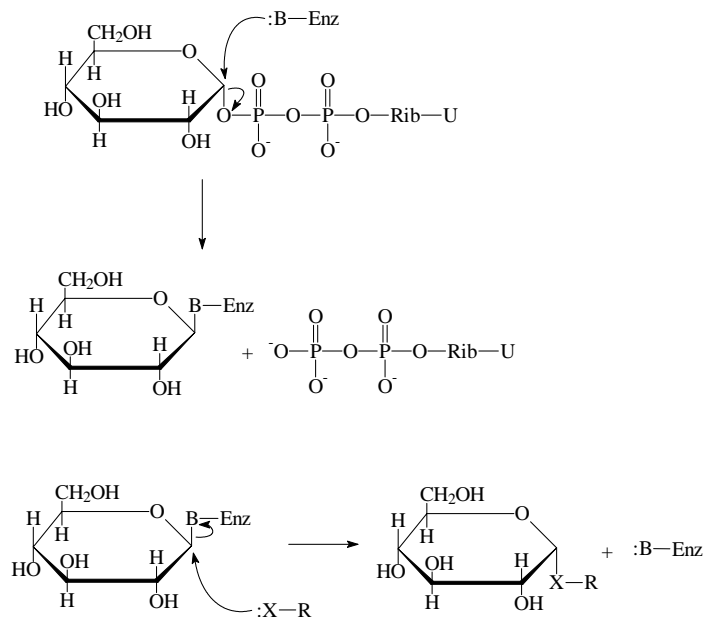


Man-Dol

Formation of β -linkages



Formation of α -linkages



:X-R where :X can be a hydroxyl, amine, amide, phosphate, and R can be a sugar, lipid, protein, etc.