

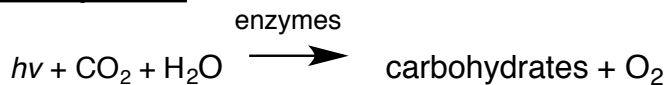
# Lecture 20- Carbohydrate chemistry

**Carbohydrates** - polysaccharides  
 -most abundant class of macromolecules

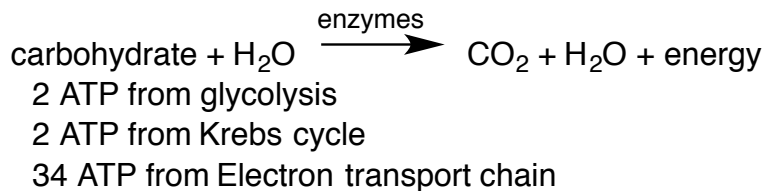
## Why are they understudied?

- 1) DNA → RNA → Protein → enzymes  
 carbohydrates
- 2) Biosynthesis & chemical synthesis is complex
- 3) Structural heterogeneity
  - the most common sugars in vertebrates, >15 million tetrasaccharides
  - many have the same mass (diastereomers)
  - even MS-MS analysis has difficulty distinguishing them

## Photosynthesis

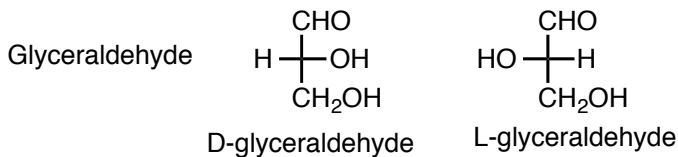


## Animals

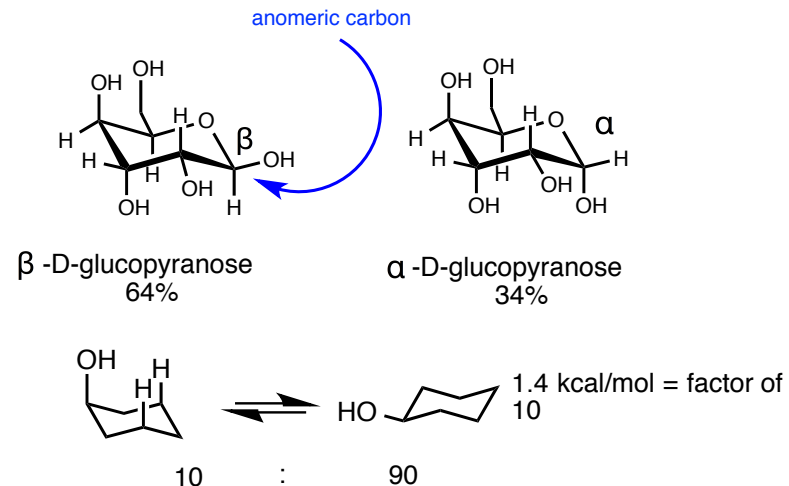
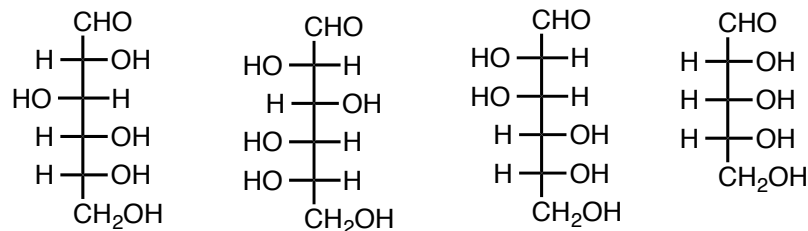


## Fischer projections and stereochemistry

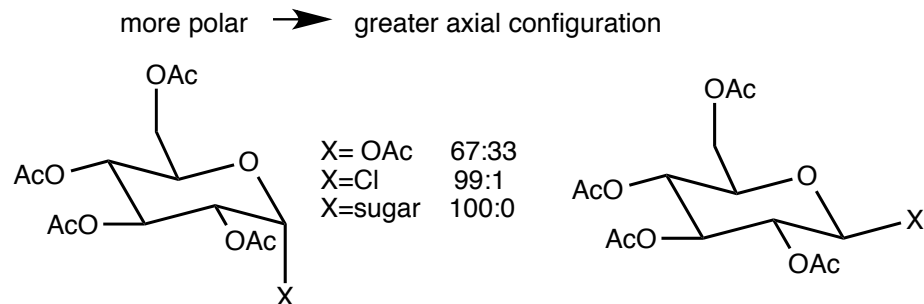
Literally  $(\text{C}\cdot\text{H}_2\text{O})_{n>3}$



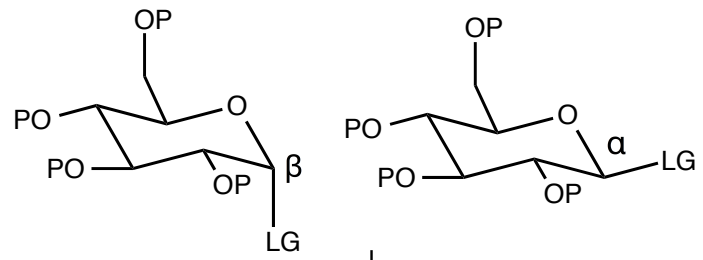
D-configuration is determined from the asymmetric carbon furthest from the carbonyl group



**Anomeric effect** - axial configuration is thermodynamically favored for certain polar groups

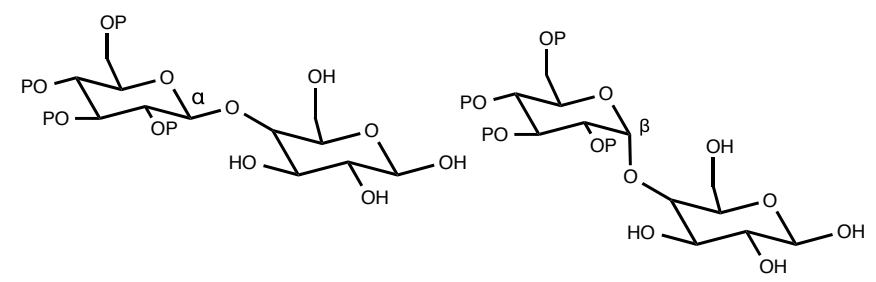


**Chemical glycosylation**

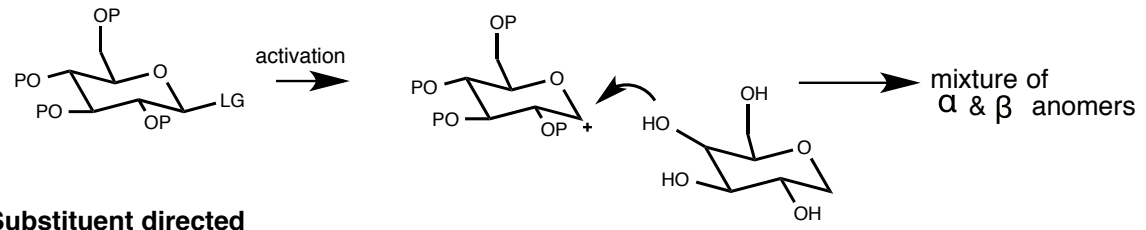


1. Promoter  
2. protecting group removal

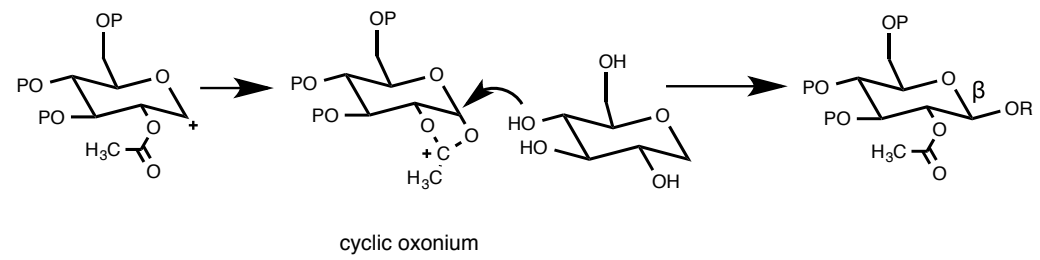
mixture of  $\alpha$  &  $\beta$  anomers



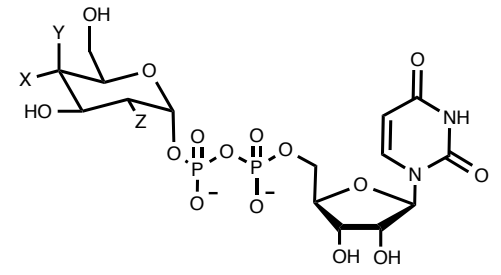
**S<sub>N</sub>1 Type mechanism**



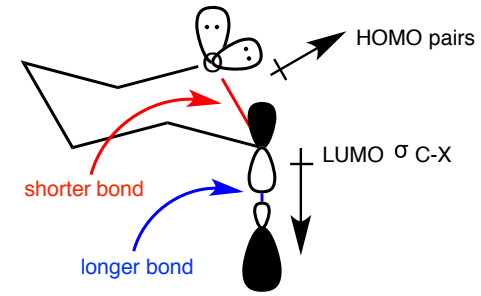
**Substituent directed**



Multiple glycosyl-transferases use the same donor and similar acceptors

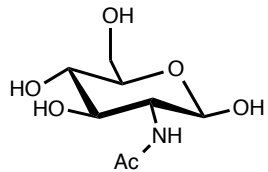


**Anomeric effect** - stereoelectronic effect (minimizing dipoles)



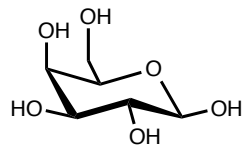
-dipoles interact favorably  
-also referred to as hyperconjugation

### D-Glucose (Glc)



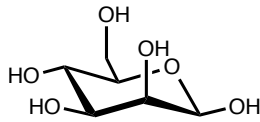
N-acetyl-D-glucosamine (GlcNAc)

### Galactose



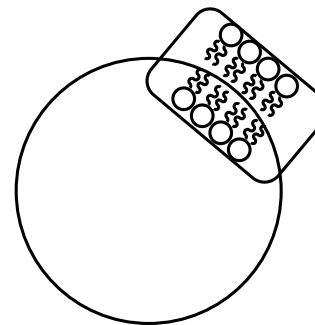
D-galactose (Gal)

### Mannose

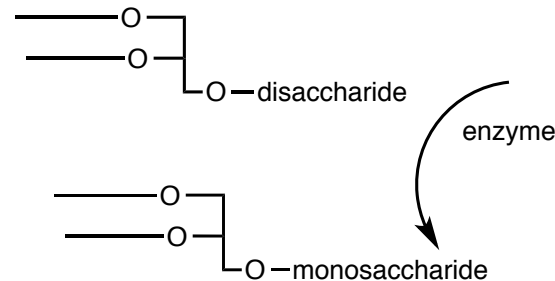


D-mannose (Man)

### O-glycosylation

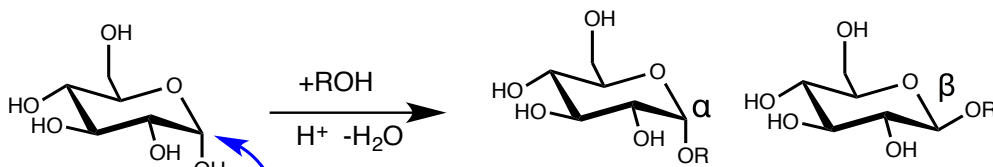


-monosaccharides, disaccharides (rare molecules, involved in signalling)  
 -polysaccharides - involved in molecular recognition



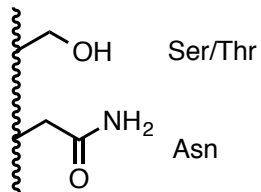
signalling molecule

### Glycosylation Reaction:



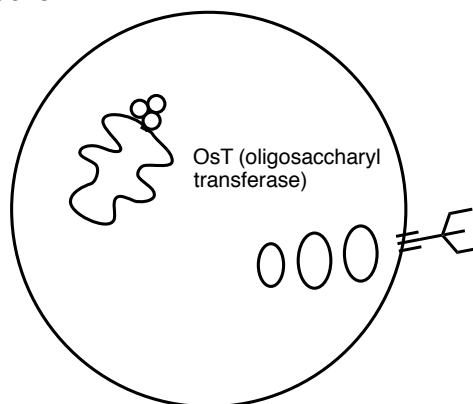
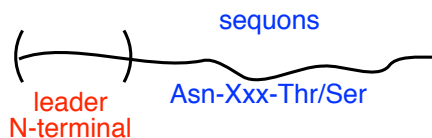
reducing end, in acyclic form this is the aldehyde

### Glycoconjugation

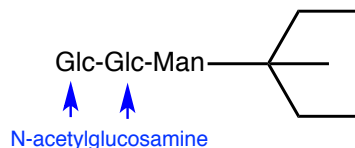


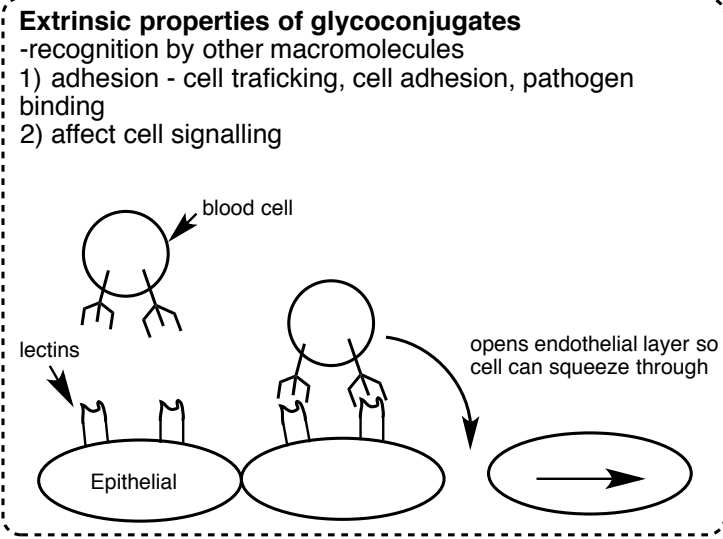
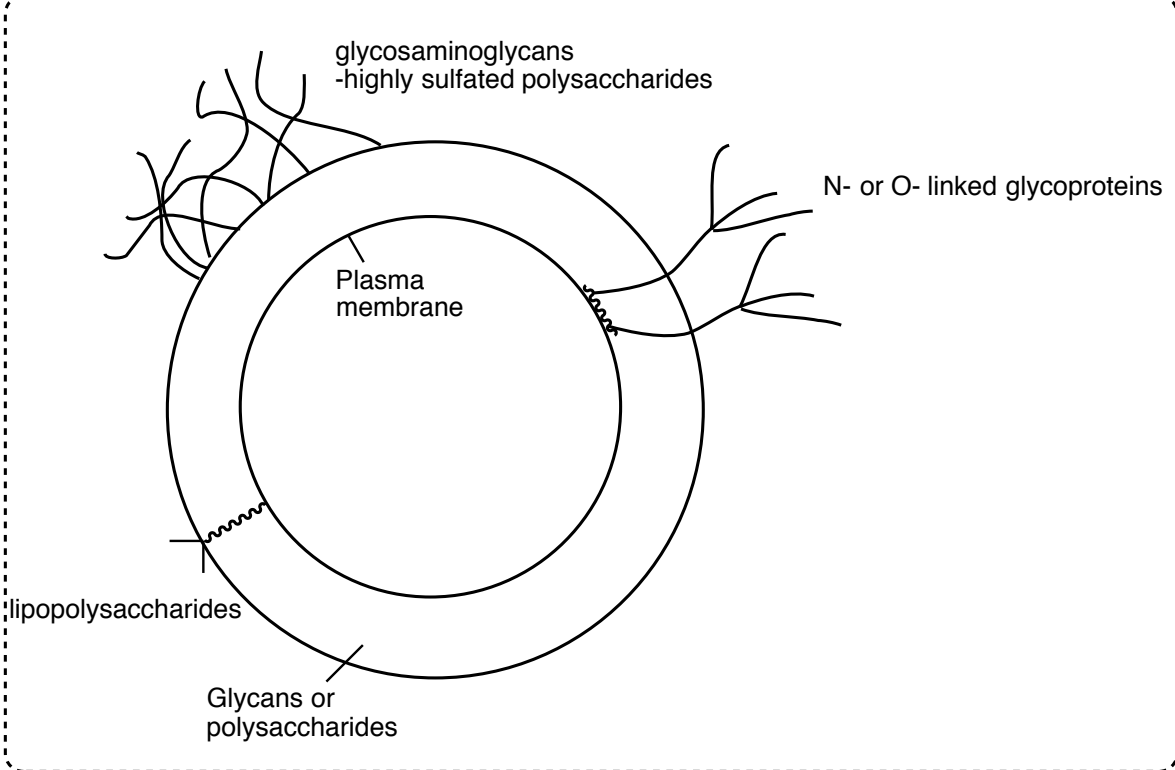
**Lectins** (carbohydrate binding proteins).  
 Lectin interactions with sugars contribute to protein folding and functions

### N-glycosylation (endoplasmic reticulum)



-When OsT (oligosaccharyl transferase) sees a sequon it attaches a 14 saccharide side chain onto Asn  
 ->70 enzymes in the golgi which remodel the three arms of the saccharide





**Intrinsic function**

Polysaccharides interact directly with the molecule they are conjugated to

- 1) affect solubility
- 2) affect half-life
- 3) affect protein folding
- 4) affect stability

Protein-carbohydrate  $K_d$ s =  $\mu$ M to mM range

