Carbohydrates

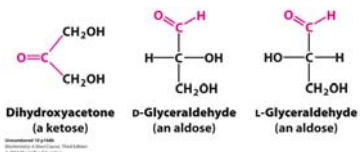
Chapter 10, Stryer Short Course

Basics of Carbs: Discussion Section

- Recognize and draw particular carbohydrate structures
- Know general structural elements of straight chain and cyclic monosaccharides
- Draw and name disaccharides
- Understand structure/function relationships of polysaccharides
- Predict the products of glycoside formation and breakdown

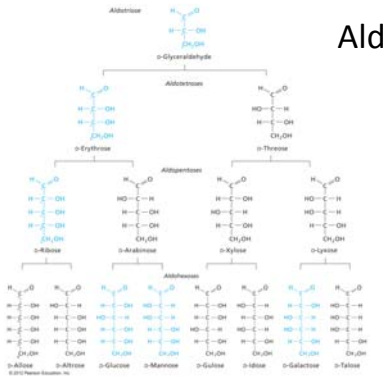
Straight-chain Monosaccharides

- Aldose/ketose terminology
- Triose, tetrose, pentose, hexose
- Stereochemistry: D, L designation
  - Fisher Projection



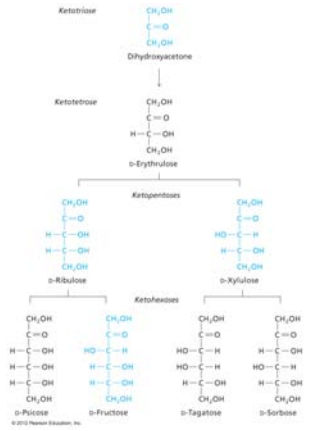
Dihydroxyacetone (a ketose) | D-Glyceraldehyde (an aldose) | L-Glyceraldehyde (an aldose)

Aldose Tree



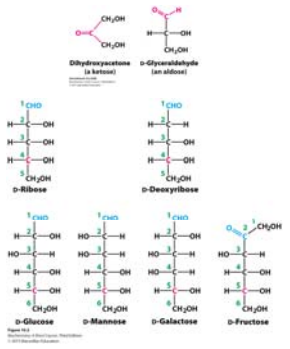
Epimers

Ketose Tree



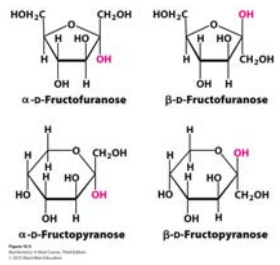
Structures to Know

- Dihydroxyacetone
- D-glyceraldehyde
- D-ribose
- D-glucose
- D-galactose
- D-fructose
- D-mannose



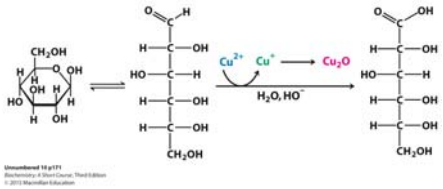
Cyclic Monosaccharides

- **Pyranose and furanose**
- Haworth Projection
- Anomeric carbon
- Alpha and beta anomers



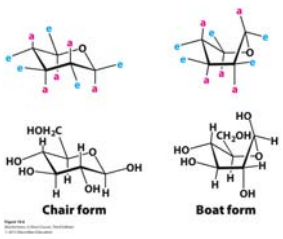
Reducing Sugars

- Test for free aldehyde
- Cyclic/acyclic equilibrium

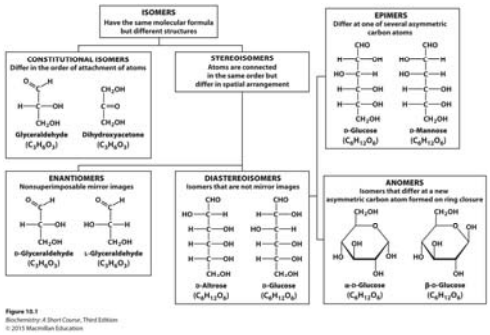


Conformations

- Haworth and chair commonly drawn
- boats, envelopes, etc

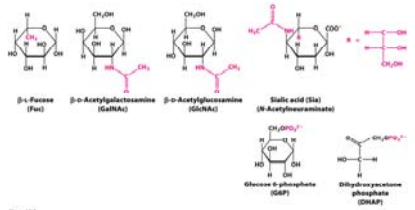


Summary of Terms



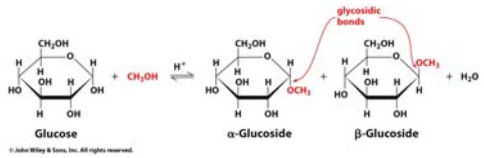
Sugar Derivatives

- Phosphate esters, aminosugars
- Acylation



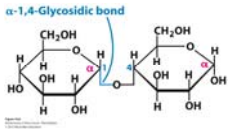
Structure of Disaccharides

- Condensation of Monosaccharides
  - Loss of anomeric hydroxyl group and proton of nucleophilic alcohol
  - Glycosidic Bond



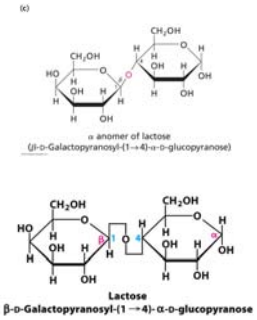
Structure of Disaccharides

- Nomenclature of linkage
  - Find the acetal!
  - Number and linkage
- Reducing sugar
  - Find the hemiacetal!
- Identity of disaccharide based on sugars and linkage



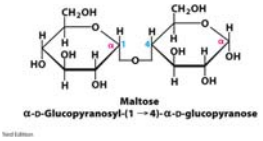
Lactose

- Lactose is a galactose unit with a β(1→4) linkage to glucose
- Milk sugar
- Basis of lactose intolerance: lactase
- Notice the strange glycosidic bond drawing convention



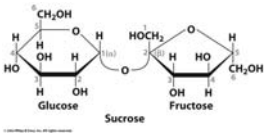
Maltose

- Glucose linked through an α(1→4) linkage to another glucose
- Breakdown product of starch
- Maltase
- Reducing sugar



Sucrose

- Non-reducing sugar
  - No hemiacetal
  - Notice that fructose is upside down
- Table sugar
- Sucrase



Glycosyltransferase

- Condensation is opposite of hydrolysis
- Glycosidic bond formation catalyzed by many enzymes
- Activated monosaccharide

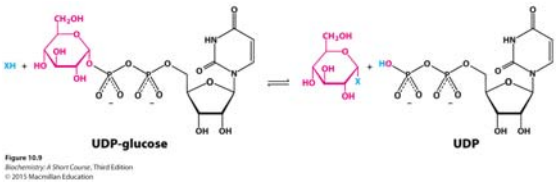


Figure 10.9
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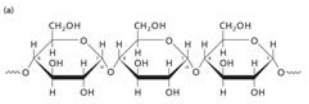
Polysaccharides

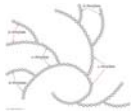
Table 8.2 Structures of some common polysaccharides

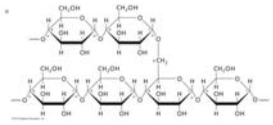
Polysaccharide[a]	Component(s)[b]	Linkage(s)
Storage homoglycans		
Starch		
Amylose	Glc	α-(1 → 4)
Amylopectin	Glc	α-(1 → 4), α-(1 → 6) (branches)
Glycogen	Glc	α-(1 → 4), α-(1 → 6) (branches)
Structural homoglycans		
Cellulose	Glc	β(1 → 4)
Chitin	GlcNAc	β(1 → 4)
Heteroglycans		
Glycosaminoglycans	Disaccharides (amino sugars, sugar acids)	Various
Hyaluronic acid	GlcUA and GlcNAc	β(1 → 3), β(1 → 4)

[a]Polysaccharides are unbranched unless otherwise indicated.
[b]Glc, Glucose; GlcNAc, *N*-acetylglucosamine; GlcUA, D-glucuronate.

Starch and Glycogen



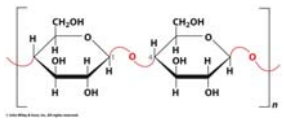


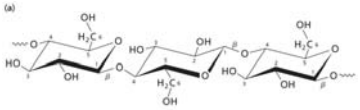


Compact storage

Cellulose

- Watch structure carefully!

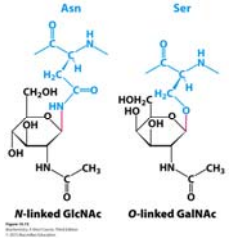




Function: structural support

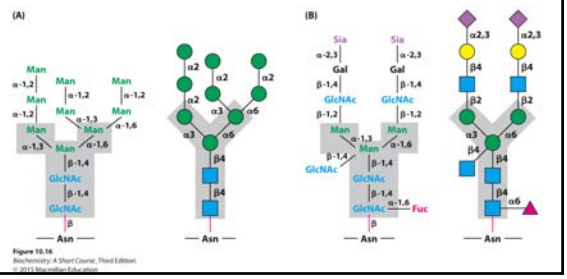
Glycoproteins

- Many proteins are highly modified by addition of carbohydrates
- Structure and Recognition
- N-linked—Asn
- O-linked—Ser, Thr



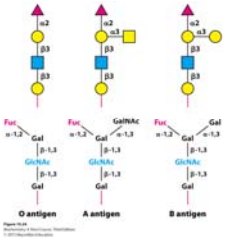
Modification of N-Linked Carbs

- Glycosyltransferases

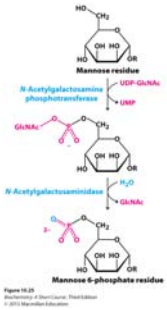


Blood types

- Genes for different glycosyltransferases
- Blood type: difference in antigen on surface of red blood cells
- Transfusions



Congenital Disorders of Glycosylation



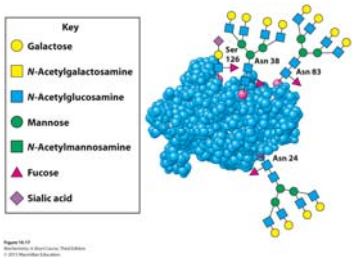
- Lysosyme digestive enzymes are marked for delivery by mannose-6-P
- A **lectin** (protein that selectively recognizes a glycan) on the lysozyme surface directs delivery
- If not phosphorylated, enzymes sent to wrong place
- Lysozymes cannot degrade glycosaminoglycan
- Buildup leads to skeletal and psychomotor retardation

Glycoproteins

- Glycoproteins
  - Structural diversity
  - Many functions—based on recognition
- Proteoglycans
  - Bulk is carbohydrate
  - Linked to glucosaminoglycan
  - Structural, protective functions
- Mucoproteins
  - Lubricants, predominately carbs

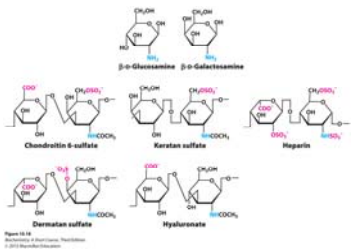
Example: Erythropoietin

- EPO-hormone
- Glycoprotein
- Recombinant form used to treat anemia



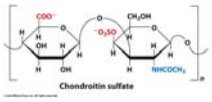
Proteoglycans

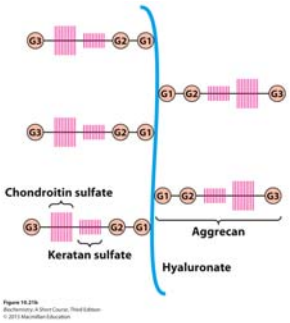
- Up to 95% carbs
- Cell adhesion
- Highly negatively charged
- Heparin: anticoagulant



Example: Cartilage

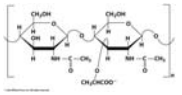
- Shock absorber

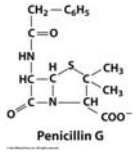


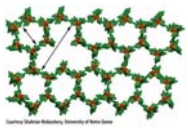


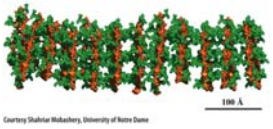
Peptidoglycan

- Bacterial cell wall
- Target for penicillin

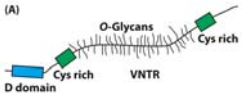


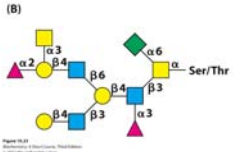






Mucoproteins





- Variable number of tandem repeats
- Function to protect cells
- Overexpressed in cystic fibrosis