Carbohydrates

Pratt and Cornely, Chapter 11

Objectives

• Recognize and draw particular carbohydrate structures
• Know general structural elements of cyclic monosaccharides and disaccharides, and their implications for structure/function
• Predict the products of condensation reactions and hydrolysis
Straight-chain Monosaccharides

- Aldose/ketose terminology
- Triose, tetrose, pentose, hexose
- Recognize isomerization
  - Review mechanism from chapter 6

Stereochemistry

- D/L designation
- Fisher Projections
- **Problem 6**: How many stereoisomers are possible for a ketopentose, ketohexose, and ketoheptose?
Structures to Know

- D-glucose
- D-glyceraldehyde
- D-Ribose
- D-Galactose
- D-fructose
- dihydroxyacetone

Cyclic Monosaccharides

- Pyranose
- Haworth Projection
- Anomeric carbon
- Alpha and beta anomers
Problem 14

• Carry out a cyclization reaction with D-galactose and draw the 2 possible products.

Cyclic Monosaccharides

• Furanose
• Just focus on what is commonly observed
  – Pyranoses: glucose, galactose
  – Furanoses: ribose, fructose
Conformations

• Haworth and chair (no envelopes, etc)

Mutarotase

• Reaction of cyclic carbohydrates which equilibrates anomers
Derivatives: Sugar Phosphates

- Dihydroxyacetone phosphate
- D-Glyceraldehyde 3-phosphate

Other Derivatives

- **Problems 27-28:** Draw these products: a. gluconate (oxidation product of the aldehyde of glucose); b. sorbitol (reduction product of glucose)
Structure of Disaccharides

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

\[
\text{Glucose} + \text{CH}_2\text{OH} \rightarrow \text{H}^+ \rightarrow \text{α-Glucoside} \quad \text{glycosidic bonds}
\]

Structure of Disaccharides

- Nomenclature of linkage
  - Find the acetal!
  - Number and linkage
- Reducing sugar
  - Find the hemiacetal!
- Lactose
Sucrose

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

Polysaccharides

<table>
<thead>
<tr>
<th>Polysaccharide&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Component(s)&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Linkage(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage homoglycans</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Starch</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amylose</td>
<td>Glc</td>
<td>α (1 → 4)</td>
</tr>
<tr>
<td>Amylopectin</td>
<td>Glc</td>
<td>α (1 → 4), α (1 → 6) (branches)</td>
</tr>
<tr>
<td>Glycogen</td>
<td>Glc</td>
<td>α (1 → 4), α (1 → 6) (branches)</td>
</tr>
<tr>
<td>Structural homoglycans</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cellulose</td>
<td>Glc</td>
<td>β (1 → 4)</td>
</tr>
<tr>
<td>Chitin</td>
<td>GlcNAc</td>
<td>β (1 → 4)</td>
</tr>
<tr>
<td>Heteroglycans</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glycosaminoglycans</td>
<td>Disaccharides (amino sugars, sugar acids)</td>
<td>Various</td>
</tr>
<tr>
<td>Hyaluronic acid</td>
<td>GlcUA and GlcNAc</td>
<td>β (1 → 3), β (1 → 4)</td>
</tr>
</tbody>
</table>

<sup>a</sup>Poly saccharides are unbranched unless otherwise indicated.
<sup>b</sup>Glc, Glucose; GlcNAc, N-acetylglicosamine; GlcUA, β-glucuronate.
Starch and Glycogen

- Compact storage

Cellulose

- Watch structure carefully!

Function: structural support
Glycoproteins

- Protection and Recognition
- N-linked—Asn
  - Processed
  - Glycosidases, glycotransferase
- O-linked—Ser, Thr
  - Very large (80% of mass)

Proteoglycan

- Mostly carbohydrate
- Highly charged
- Acts as sponge in joints
Peptidoglycan

- Bacterial cell wall
- Target for penicillin