

Chemistry 1506: Allied Health Chemistry 2

Section 7: Carbohydrates

Biochemical Alcohols and Ethers

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Section 7.1 Introduction

➤ Carbohydrates

➤ Functions

➤ Energy Storage

➤ Structure

➤ Immune Response

➤ Regulation of Cell Biochemistry and **Physiology**

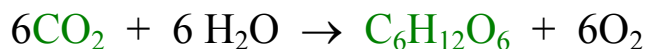
➤ Typical carbohydrate formula

➤ $\approx C_nH_{2n}O_n$

➤ Molecules from $n \approx 4 =$ millions

- Typical **Structural Elements of Carbohydrates**
 - Multiple **OH groups**
 - **Rings**
 - **Ether Linkages**
 - Within rings
 - Between rings (**Glycosidic Bonds**)
 - Derived from poly-OH **Aldehydes** and **Ketones**

- **Formation of Carbohydrates**



- **Photosynthesis** (plants, algae, etc.)
- **Chemosynthesis** (bacteria)
- **Biosynthesis** (all living things)

Section 7.2 Enantiomers and Chirality

➤ Enantiomers

- non-superimposable mirror images

➤ Chiral atoms

- for Chemistry 1506: have four different groups on a central atom

- Exercise: Practice identifying chiral atoms in molecules

➤ **Physical Property and Chemical Property Differences**

➤ Almost all are the same

➤ **Rotation of plane of polarized light**

➤ Polarized light

➤ Polarimeter

➤ Optical Activity

➤ **Reactions with other chiral molecules**

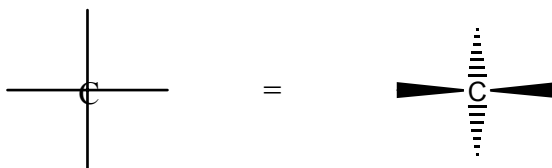
➤ **Racemic Mixture**

➤ 50:50 mixture of opposite enantiomers

➤ no net rotation of light

➤ Fischer Projection

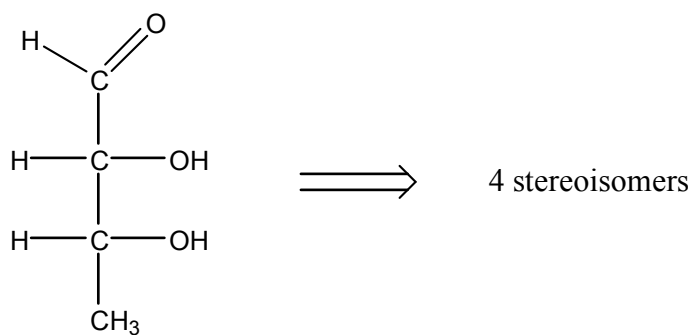
➤ “cross”



➤ Multiple Chiral Centers

➤ 2^n stereoisomers for n chiral centers

➤ examples of sugars



Section 7.3 Glucose

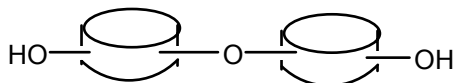
➤ Monosaccharides

- Normally 5 or 6 carbons
- Normally $C_5H_{10}O_5$ or $C_6H_{12}O_6$
- Alcohol groups and ether groups
- “cartoon picture”

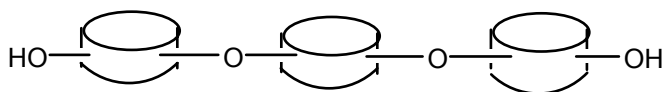


➤ Glycosidic Bonds (i.e., ether linkages)

➤ Disaccharides



➤ Trisaccharides



➤ Oligosaccharides

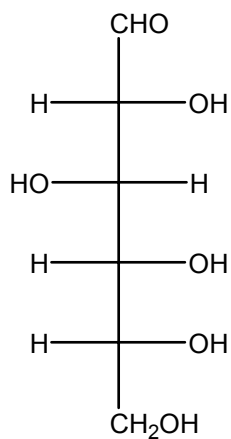
- Common on **membrane surfaces** and **protein surfaces**
- Used for **signaling**
- Typically have **complex branched structures**

➤ Polysaccharides

- Used for **Structural Strength** and **Energy Storage**
- Typically have **highly repetitive structures**

- D-Glucose
 - Most abundant molecular fragment in biosphere
 - Aldohexose
 - $C_6H_{12}O_6$
 - Exists in 3 **interconverting forms**
 - Favored form depends on solvent, temperature, etc.
 - **D-Glucose, α -D-Glucose, and β -D-Glucose**

➤ Fischer Projection of D-Glucose



➤ Cf. L-Glucose

➤ Wedges and hatches

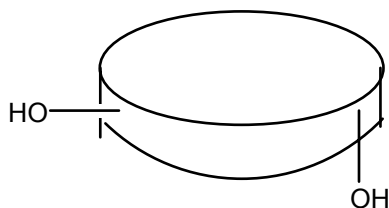
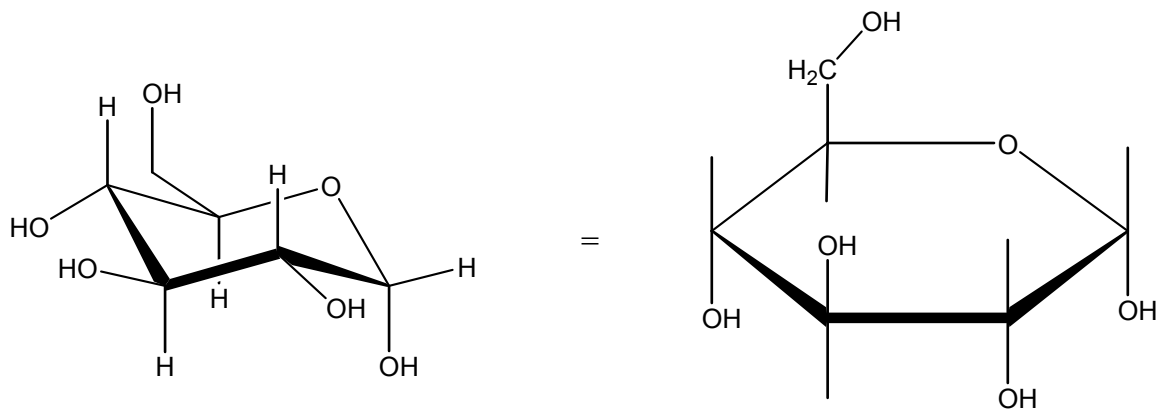
➤ C1 is Anomeric Carbon

➤ Ring Formation via intramolecular attack by OH #5

➤ Cyclization

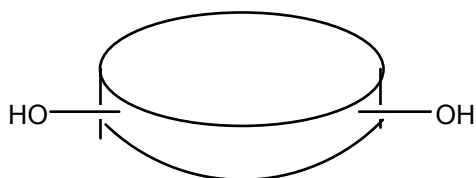
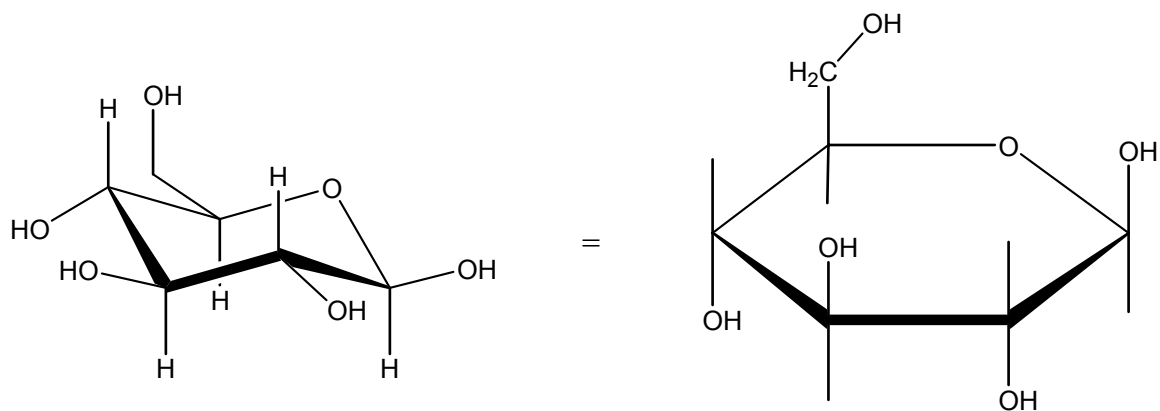
➤ Structure of α -D-Glucose

➤ “bent”



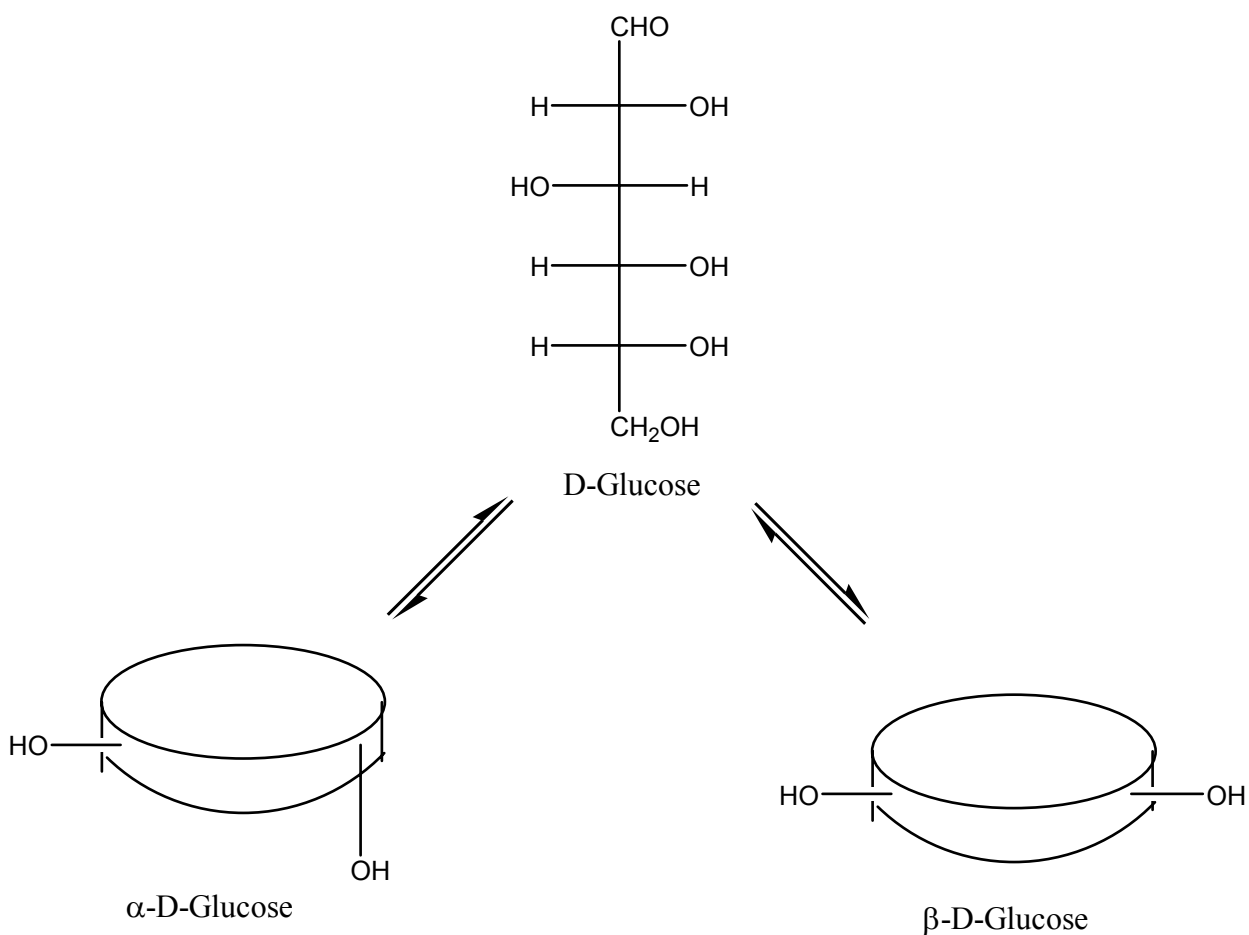
➤ Structure of β -D-Glucose

➤ “flat”



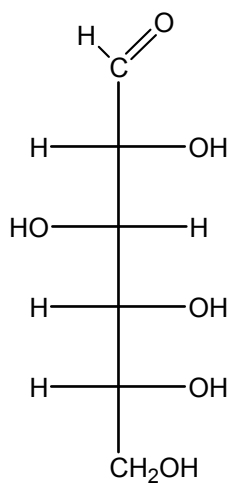
➤ Interconversion of D-Glucoses

- each form has different **physical properties** and **chemical properties**
- **α forms** and **β forms** give different **saccharide products**



Section 7.4 Monosaccharides

- Structures: Figure in text
- **Aldohexoses**
 - 6 carbon **aldehydes**
 - 4 **chiral centers** \Rightarrow 16 **stereoisomers**
 - only the 8 "D" forms common in nature
 - **D-Glucose** most common



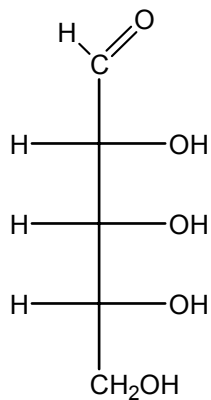
➤ Aldopentoses

➤ 5 carbon aldehydes

➤ 3 chiral centers \Rightarrow 8 stereoisomers

➤ only the 4 "D" forms common

➤ Example is D-Ribose (in RNA)

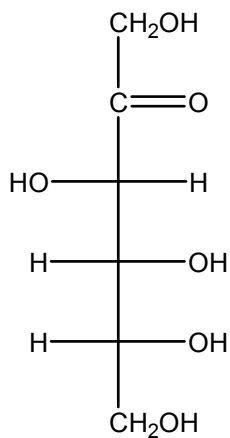


➤ **Ketohexoses**

➤ 6 carbon **ketones**

➤ 3 **chiral centers** \Rightarrow 8 **stereoisomers**

➤ Only **D-Fructose** is important



➤ Other **Aldo*oses** and **Keto*oses**

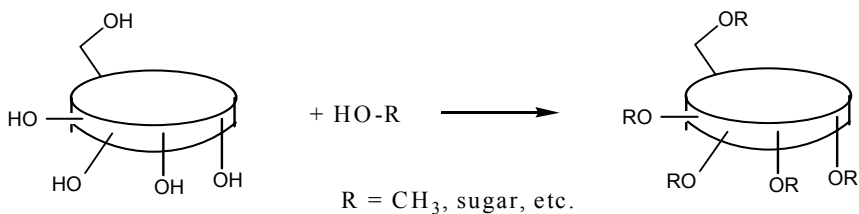
➤ Don't need to memorize

Section 7.5 Physical and Chemical Properties of Monosaccharides

- Sweetness
- Solubility
 - Bond polarity
 - Hydrogen bonding
- Optical Activity
 - Multiple chiral centers
- Solvent and temperature dependent equilibria
- Predominantly cyclic rather than linear Aldo or Keto forms in solution

➤ Glycosidic Bond Formation

- ether linkages from carbohydrate OH groups



- Highly specific in biological systems
- Often get mixtures in chemical syntheses

16.9 Skip

Section 7.6 Disaccharides

- Sucrose
 - Beet Sugar and Cane Sugar
 - α -D-Glucose and β -D-Fructose

- Maltose
 - Malt Sugar

- Lactose
 - Milk Sugar

Section 7.7 Polysaccharides

➤ Starch

- Energy storage molecule
- Referred to as **Glycogen** in mammals
- Poly(α -D-Glucose), 1,4-Glycosidic Linkages
- Primary structure is **Kinked chain**
 - Easy to break/digest
 - Water soluble

➤ Cellulose

- Plant **structural molecule**
 - Single most common **polymer**/material in nature
 - **Wood** is formed from **Cellulose** and **Lignin**
- Poly(β -D-Glucose)
- Primary structure is **Strait chain**
 - Hard to break/digest (**bacteria can**)
 - **Wettable** but not **water soluble**

➤ **Structural Variations in Polysaccharides**

➤ **Chain Length**

➤ **Branching**

➤ **Crosslinking**

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