

Chemistry 1506: Allied Health Chemistry 2

Section 8: Lipids

Biochemical Esters and Hydrocarbons

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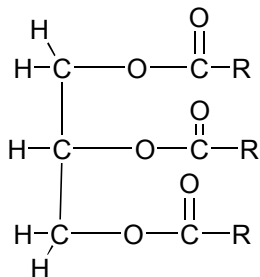
Section 8.1 Introduction

- Lipids
 - Defined by **solubility** rather than structure
 - Insoluble in water
 - Soluble in **low polarity solvents**
 - Includes both **Esters** and **Hydrocarbon like molecules**

- Uses
 - Energy Storage
 - 9 kcal/g vs. 4 kcal/g for **carbohydrates**
 - Cell Membranes
 - Regulatory

Section 8.2 Lipids

➤ Triglycerides

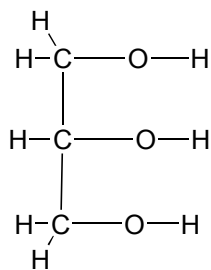


➤ Glycerol

➤ 1,2,3-propanetriol

➤ Liquid at room temperature

➤ Found in “glycerin soap”



➤ Fatty Acids

➤ Strait Chain Carboxylic Acids



➤ \approx 10 to 20 carbons in length

➤ Most in our bodies have 16 or 18 carbons

➤ All have an even number of carbons

➤ They have only C-C single bonds and C=C double bonds

➤ No other functional groups on chains

➤ Types of Triglycerides

➤ See Table in Text

- Saturated Fatty Acids
 - Solids at room temperature
 - Due to excellent packing of “tail” groups
 - Leads to fatty deposits on arteries

 - C14 example is Myristic Acid
 - Nutmeg
 - $\text{CH}_3\text{-(CH}_2\text{)}_{12}\text{-CO}_2\text{H}$

 - C16 example is Palmitic Acid
 - Palm oil
 - $\text{CH}_3\text{-(CH}_2\text{)}_{14}\text{-CO}_2\text{H}$

 - C18 example is Stearic Acid
 - Butter, animal fats
 - $\text{CH}_3\text{-(CH}_2\text{)}_{16}\text{-CO}_2\text{H}$

➤ Unsaturated Fatty Acids

- Found in **Vegetable Oils** and **Fish Oils**
- Natural compounds have **cis double bonds**
 - Thermodynamically disavored cis double bonds
 - **Monounsaturated** and **Polyunsaturated**
 - Cis bonds in **middle of chains**, **disrupt packing**
 - **Liquids at room temperature**
 - Much more **healthful**, don't **clog arteries**

➤ Oleic Acid

- C18, one cis **double bond**
- $\text{CH}_3-(\text{CH}_2)_7-\text{CH}=\text{CH}-(\text{CH}_2)_7-\text{CO}_2\text{H}$

➤ Linoleic Acids

- C18, two cis double bonds
- $\text{CH}_3-(\text{CH}_2)_4-\text{CH}=\text{CH}-\text{CH}_2-\text{CH}=\text{CH}-(\text{CH}_2)_7-\text{CO}_2\text{H}$

- Trans Unsaturated Fatty Acids
 - Man-made materials
 - Made from saturated fatty acids
 - By Dehydrogenation ($-H_2$, uses catalyst)

Saturated Fats - H_2 (Pt catalyst) \rightarrow trans-unsaturated Fats

- Produces the thermodynamically favored trans isomers
- Double bonds at many places in chain
- Common ingredients in margarine

- Have all trans Fatty Acids
 - These groups pack well
 - Solids at room temperature

➤ Dietary Fats

➤ Vegetable Fats (and Fish Oils)

➤ Cis unsaturated and polyunsaturated Fatty Acids

➤ Liquids at room temperature

➤ Best for you

➤ Animal Fats

➤ Saturated Fatty Acids

➤ Solids at room temperature

➤ Moderate-Poor for you

➤ Margarine

➤ Trans Fatty Acids

➤ Solids at room temperature

➤ Worst for you????

➤ Hydrogenation of Unsaturated Fats

- “Crisco” replaces lard in cooking
- Solid fat produced from vegetable sources



➤ Olestra

- See Text
- Produced by Proctor and Gamble
- Produced from natural ingredients
- Sucrose (table sugar)
- Fatty Acids (corn oil or soybean oil)
- Similar Flavor and “Mouth Feel” to saturated fats
- 7-8 Fatty acids join to sucrose by ester linkages

➤ Saponification

➤ See Text

➤ First Organic Synthesis

➤ Boil Fat with wood ashes

➤ wood ash solution

➤ Cleaning Agents

➤ Micelle formation

➤ Hydrophilic Heads and Hydrophobic Tails

- Commercial Soap
 - Fatty Acid salts
 - RCO_2^-
 - Na^+ salts are solids
 - K^+ salts are liquids
 - Other ingredients
 - Enzymes
 - pH modifiers
 - water softeners
 - surfactants
 - fragrances, colors

- Detergents
 - R-SO_3^- and/or R-Ar-SO_3^- instead of RCO_2^-
 - Don't react with metal ions in **hard water**

➤ Waxes

➤ Produced by **Plants, Insects**, etc.

➤ Box 17D, page 567

➤ Long chain **esters**

➤ **$R-CO_2-R'$**

➤ **Fatty Acids**

➤ **Alcohols**

➤ $\approx C_{30}$

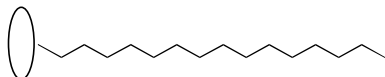
➤ **strait chain**

➤ properties comparable with **paraffin wax**

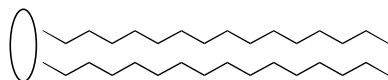
➤ exterior of molecules looks much like an **alkane**

Section 8.3 Membranes

- Reminder of Soap Micelles
 - Micelles and Fatty Acids
 - Hydrophilic heads
 - Hydrophobic tails
 - Dipole-Dipole and Hydrogen Bonding



- Lipid Bilayer
 - typically have two hydrophobic tails
 - Hydrophilic heads



- Fluid Mosaic Model
 - Rapid lateral diffusion
 - Little or no trans-membrane diffusion
 - “fluidizers”

➤ Diagram of **Cell Membrane**

➤ See Figure in Text

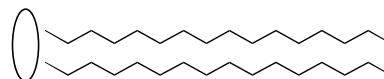
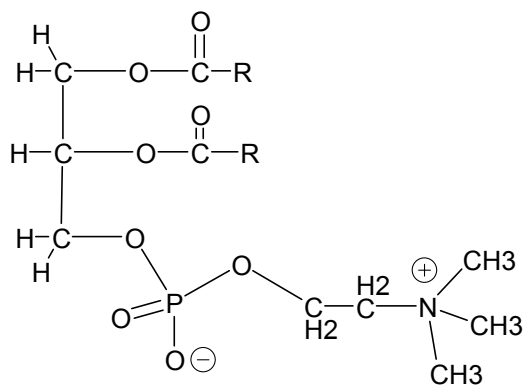
➤ **Lipids**

➤ **Proteins**

➤ **Carbohydrates**

Section 8.4 Membrane Components Related to Glycerides

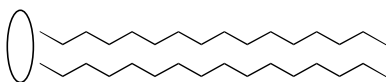
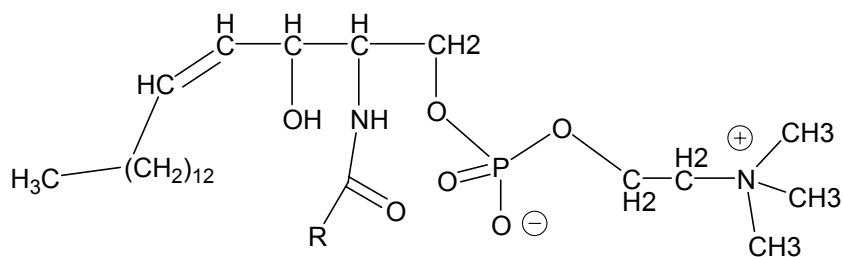
- Glycerophospholipids
 - Lecithin is common name
 - Choline
 - Hydrophilic group
 - $\text{HO-CH}_2\text{-CH}_2\text{-N(CH}_3)_3^+$
 - Two Fatty Acid hydrophobic groups
 - Glycerol linker
 - Phosphate linker hydrophilic group



- Often referred to simply as **phospholipids**

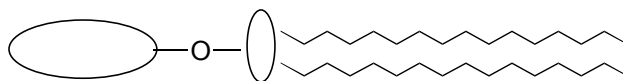
➤ Sphingolipids

- especially rich in **Myelin**
- **Sphingosine hydrophobic group and linker**
- **One Fatty Acid hydrophobic group**
- **Phosphate hydrophilic group**
- **Choline hydrophilic group**



➤ Glycolipids

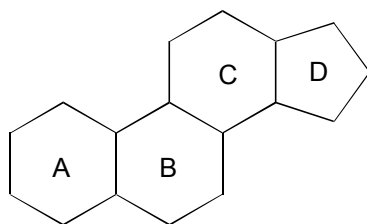
- **Lipid + carbohydrate**



Section 8.5 Steroids

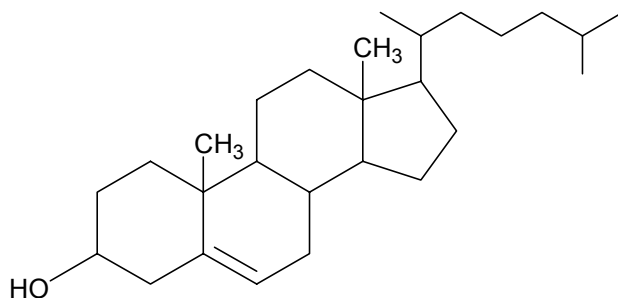
➤ Basic Steroid Ring Structure

- Three six membered and one five membered ring



➤ Cholesterol

- “Fluidizers” in cell membranes
- They are rich in animal fats
- Gall stones are almost pure cholesterol
- They come from both diet and biosynthesis



➤ Steroid Hormones

- Regulatory Functions
- Same basic steroid core structures
 - See figure in text
 - Testosterone
 - Estradiol
 - Progesterone
 - Anabolic Steroids
- Bile Salts
 - Charged steroids with extra OH groups
 - Used to dissolve fats in the intestines

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