

Chemistry 506: Allied Health Chemistry 2**Chapter 17: Lipids****Biochemical Esters and Hydrocarbons**

Introduction to General, Organic & Biochemistry, 5th Edition by
Bettelheim and March: Chapter 17, Pages 557-590

Outline Notes by Dr. Allen D. Hunter, YSU Department of
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Outline

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17A Section(s) 17.1

Introduction

➤ Lipids

➤ Defined by **solubility** rather than structure

➤ **Insoluble in water**

➤ Soluble in **low polarity solvents**

➤ Includes both **Esters** and **Hydrocarbon like molecules**

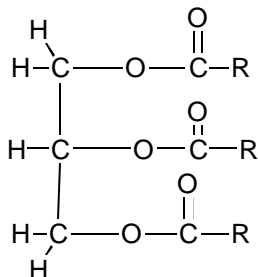
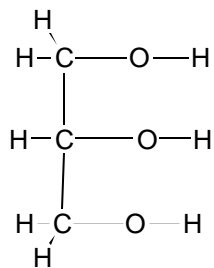
➤ Uses

➤ **Energy Storage**

➤ 9 kcal/g vs. 4 kcal/g for **carbohydrates**

➤ **Cell Membranes**

➤ **Regulatory**

17B Section(s) 17.2/3 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

➤ Table 17.1 on page 560

- 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** ($-\text{H}_2$, 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

- Box 17A on page 563
- 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

➤ Box 17C page 565

➤ 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**

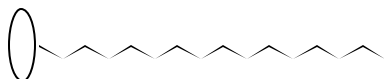
➤ properties comparable with **paraffin wax**

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

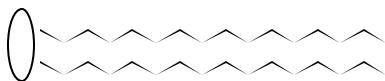
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17C Section(s) 17.5 Membranes

- 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**

➤ Figure 17.2 on page 568

➤ **Lipids**

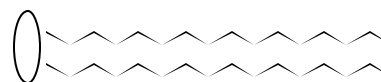
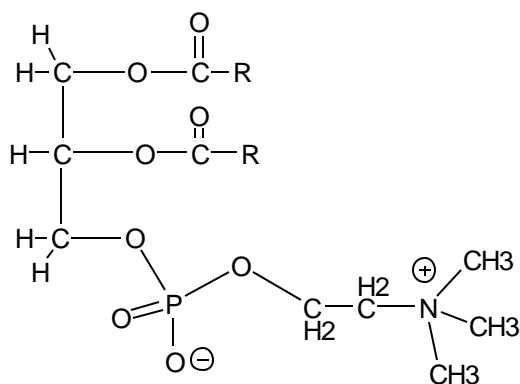
➤ **Proteins**

➤ **Carbohydrates**

17D Section(s) 17.6/7/8 Membrane Components Related to

Glycerides

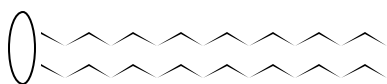
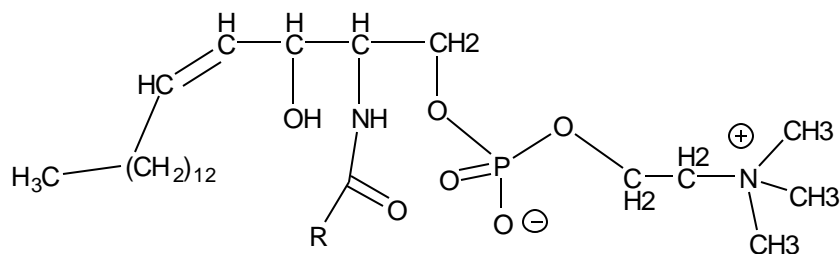
- Glycerophospholipids
 - Lecithin is common name
 - Choline
 - Hydrophilic group
 - $\text{HO-CH}_2\text{-CH}_2\text{-N(CH}_3)_3^+$
 - Two Fatty Acid hydrophobic groups
 - Glycerol linker
 - Phosphate linker hydrophilic group



- Often referred to simply as **phospholipids**

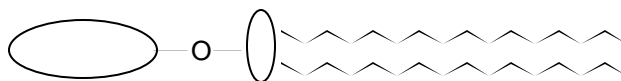
➤ Sphingolipids

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



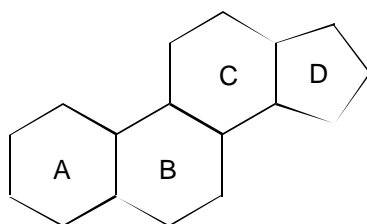
➤ Glycolipids

- Lipid + carbohydrate

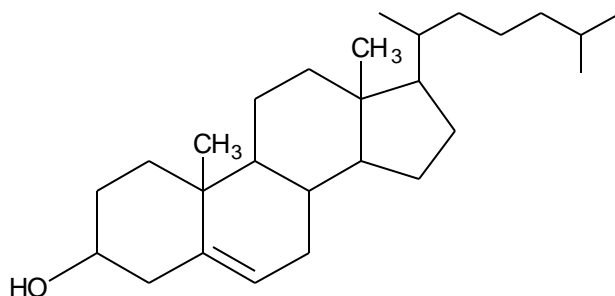


17E Section(s) 17.9/10/11 Steroids**➤ Basic Steroid Ring Structure**

- 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
 - Figure 17.6, page 580
 - Testosterone
 - Estradiol
 - Progesterone
 - Anabolic Steroids (Box 17H, page 581)

- Bile Salts
 - Charged steroids with extra OH groups
 - Used to dissolve fats in the intestines

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