CHE 102 – Study Guide – Chapter 28-30

Overall Concepts:

1. Focus on recognizing structures and drawing structures from the component parts
2. Physical and Chemical characteristics
    a. Solubility
    b. Chemical Reactivity (standard chemical tests for Lipids and Proteins
    c. Hydrolysis/Dehydration
3. You will be given: Table 28.1, the structure of amino-alcohols and Table 29.1

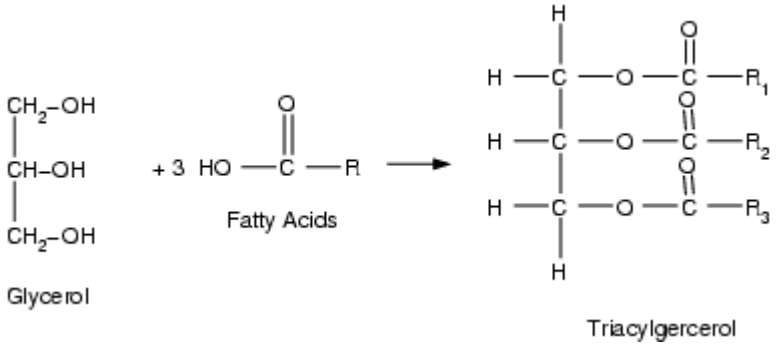
Chapter 28: Lipids

1. Lipid: Water insoluable class of molecules that can vary considerably in structure

2. Fatty Acids: long chain carboxylic acids
    a. Carboxy group: Polar, and soluable in water
    b. Aliphatic (R group): long and non-polar, thus insoluable in water, making overall molecule insoluable.
    c. Saturated: no C=C, mostly animal fats
    d. Unsaturated: one or more C=C present, mostly plant fats
    e. Cis/Trans Isomers: fatty acids with a C=C can form cis/trans isomers
        i. trans: most linear, not generally found in nature, can't digest
        ii. cis: bent shape, predominates in nature, lower Mp/Bp then trans isomers.
    f. Essential Fatty Acids: fatty acids that can't be synthesized by our bodies, we must
        i. Linoleic, Linolenic, Arachidonic
        ii. ω-3 vs ω-6 fatty acids (p 780, Chemistry in Action p809)
        iii. Arachidonic = precursor for "eicosanoid" class of molecules (Fig 28.2)

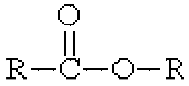
1. Prostaglandins, Leukotrienes, Prostacyclins, and Thromboxanes.
2. Responsible for swelling, inflammation etc
3. Asprin and other drugs can block the production
4. Read p 806-807 for more details.

3. Fats and Oils
    a. Composition: Glycerol + 3 Fatty acids.→ Triacylglycerol (Fatty Acid) + H_2O (p808)

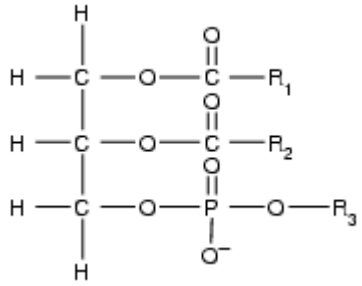


    b. Energy Storage:
        i. 25-50% of caloric intake, producing 9.5 kcal/g when oxidized completely
        ii. Excellent source of energy (2x) then carbohydrates and proteins
        iii. Carbon is in a more reduced form (therefore further to oxidize → more energy)
        iv. Fatty acids = 75% carbon vs 40% C for carbohydrates
    c. Components of complex membrane lipids

d. Olestra
e. Given "parts" you should be able to construct or hydrolyze a typical triacylglycerol

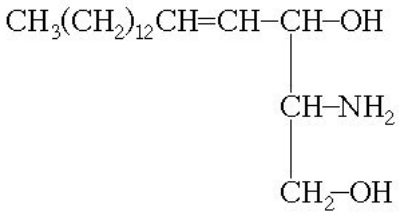
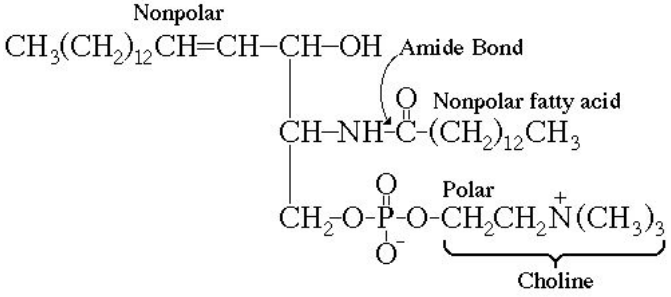
4. Waxes:
   a. Esters 
   b. Composition: Esters of long chain fatty acids and large (30+carbon) alcohols
   c. Used as water proof coating for fruits, fur, feathers, skin, plant leaves, cars.

5. Phospholipids (p811)
   a. Composition: Glycerol + 1 or more fatty acids (R_1 and R_2) + phosphate group + nitrogenous base (R_3)



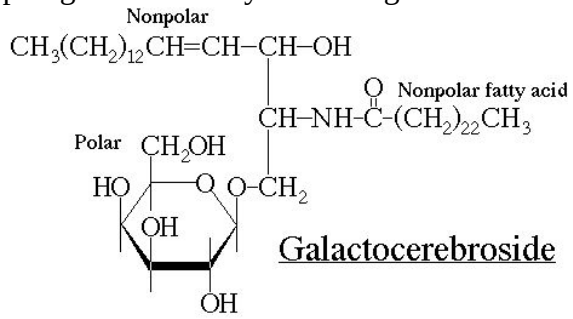
   b. The fatty acid portion of the molecule is hydrophobic/insoluable
   c. The phosphate/nitrogeneous base portion is hydrophilic/soluable
   d. Made in liver, used as protective sheath for nerve tissue, brain matter
   e. Given "parts" you should be able to construct or hydrolyze a typical phospholipid

6. Sphingolipids (p813)
   a. Composition: Sphingosine + 1 fatty acid + phosphate group + nitrogenous base (Choline)

	
Spingosine	Spingolipid

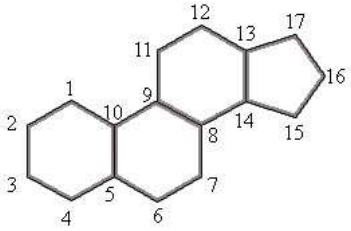
   b. Given "parts" you should be able to construct or hydrolyze a typical sphingolipid

7. Glycolipids (p814)
   a. Composition: sphingosine + 1 fatty acid + sugar



   b. Found in cerebrosides
   c. Given "parts" you should be able to construct or hydrolyze a typical glycolipid

8. Steroids
    a. Consists of a core steroid unit (17 carbons in 4 fused rings) modified by functional groups



    b. Many diverse functions (cholesterol, bile salts, adrenal cortex hormones, sex hormones)
    c. Precursor for most steroid hormones (see Fig 28.5 p 816)

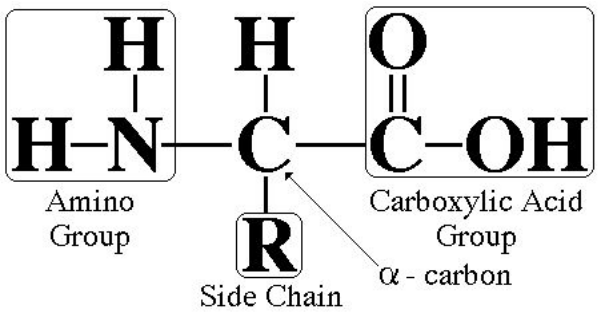
9. Lipids and Biology:
    a. Structure of micelle's and liposomes
    b. Micelle formation and drug delivery
    c. Atherosclerosis
    d. Lipid Distribution system (Fig 28.9, p 818)
    e. Formation of Lipid Bilayers and Fluid-Mosaic Model
        i. Facilitated diffusion
        ii. Active transport

10. Homework, lots and lots of good questions there.

Chapter 29: Amino Acids, Polypeptides, and Proteins

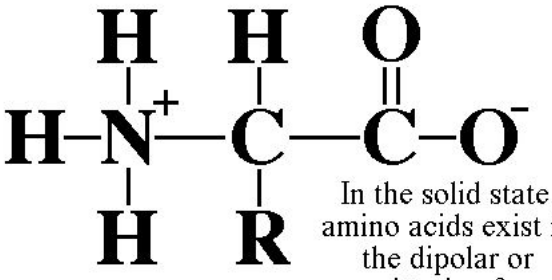
1. Proteins
    a. Variety of properties (transport O_2, enzymes, structural (hair, spider silk, hooves, feathers, eyes)
    b. Nutrition
        i. 8 Essential AA, because body can't synthesize
        ii. Complete vs. Incomplete foods
    c. Are polymers of AA's
    d. Over 200 AA, but only 20 are common to almost all living organisms
    e. Contain a high concentration of N (16%) compared to other classes of molecules

2. Structure of Amino Acids (AA's)



    a. Generally use common names or 3 letter abbreviations
    b. Can be grouped as Acidic, Basic or Neutral based on the ratio of amine to carboxylic acids groups found in the side chain.
    c. Optically active because the α-carbon is chiral (all except gylcine)
        i. Remember to draw projections with the most oxidized group at the top
        ii. D/L determined by location of amine group (Left = L, Right = D, just like carbohydrates)

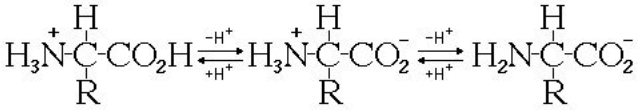
d. Amphoterism: AA's have the properties of acids and bases (p810)
   i. Zwitterions: Dipolar form of an amino acid (be able to draw AA's in zwitterions form)



In the solid state, amino acids exist in the dipolar or zwitterion form

   ii. Acid/Base forms (be able to draw AA's in acid or base forms)

In aqueous solution, an equilibrium exists between the dipolar ion and the anionic and cationic forms of the amino acid.

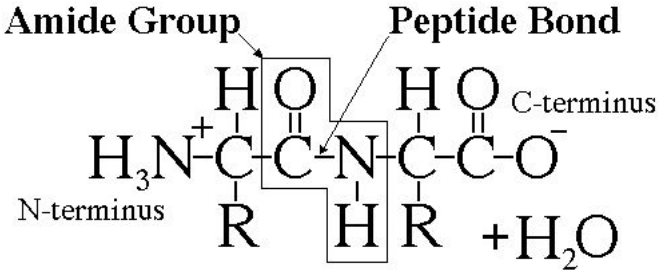


Cationic Form predominant in strongly acidic solutions

Anionic Form predominant in strongly basic solutions

   iii. Isoelectric point (pI): pH at which an AA has no net negative or positive charge (and thus will not migrate in an electric field)

3. Peptides: two or more AA's bonded together
   a. Formed by losing water from two proteins, the OH is lost by the carboxylic acid and a H is lost from the amine group.



   b. The bond formed between 2 AA's is called a Peptide Bond or Linkage, be able to identify peptide bonds in a protein.
   c. When drawing dipeptides, always orient your peptides with the amine (NH_2) end to the left and the carboxylic acid end (COOH) to the right.
   d. The order which peptides are bonded maters, thus for 2 peptides you can form 2 different dipeptides. The number of combinations of AA's is given by N!, thus even for 4 AA's you can make 24 different peptides.
   e. Naming: Always name from left to right, change the "ine" endings to "yl" endings for all AA's except the last one which retains its normal endin.

4. Protein Structure: Proteins have very specific structures in order to function, and even small changes in the sequence of AA's or even different stereoisomers can destroy the proper function of proteins.
    a. Primary: Sequence of AA's
    b. Secondary: Spatial arrangement of nearby AA's, leads to 3 main structures
        i. α-helix: H bonds between AA's 4 units apart lead to a slinky or telephone cord like structure, side chains are normally located outside the helix
        ii. β-pleated sheet: Long peptide chains are held together in a parallel structure by H-bonds between chains
        iii. Triple helix: 3 α-helix strands wrapped around each other
    c. Tertiary: larger scale structure determined by attractions and repulsions between side-chains and hydrophobic and hydrophilic interactions with water leading to a very specific 3D shape.
        i. Hydrogen bonding between carbonyl groups and alcohol groups of nearby AA's
        ii. Salt Bridges (ionic bonds) between carboxylic acid groups and amine groups
        iii. Disulfide bonds between Cystiene residues (R-S-S-R')
        iv. Hydrophobic interactions (non-polar side chains), generally causes these portions to be in the interior of the protein
        v. Hydrophilic interactions (polar side chains), generally causes these portions to be on the exterior of the protein.
    d. Quaternary: Many proteins are made up of several smaller proteins held together in a specific structure. A good example of this is Hemoglobin.
    e. Examples of protein structure (understand the interaction of the various structural units)
        i. Fiberous (p 848)
        ii. Globular (p848)
            1. Myoglobin (p849)
            2. Carboxypeptidase A (p850)
            3. Immunoglobin G (p851)
            4. Hemoglobin (p853). An excellent example of how a very small change (just one AA) can break a functional protein (Sickle cell anemia)
    f. Denaturation: Loss of 3D protein structure, can be caused by several things
        i. Heat (cooking foods)
        ii. Acid/Base reactions and Hydrolysis (digestion) – opposite of formation reaction for peptides, you should be able to draw the hydrolysis products of a peptide
        iii. Organic molecules (isopropyl alcohol, disinfectants)
        iv. Heavy metals (Hg and Pb poisoning)
        v. Agitation (whipped cream)
        vi. UV (sunlight)

5. Chemical Tests for Proteins (not including a lot of detail, read book carefully, also homework covered these topics reasonably well)
    a. Xanthoproteic Test: understand what gives a positive reaction
    b. Biuret Test: understand what gives a positive reaction
    c. Ninhydrin Test: understand what gives a positive reaction
    d. Chromatography: Understand the principles used to separate proteins based on affinity for a solid/liquid phase.
    e. Electrophoresis: Understand the principles used to separate proteins bases on mass, pH, and electrical potential
    f. Determination of Primary structure (order of AA's): Sanger and Edman process's.
    g. Synthesis of Proteins: machines are slow, biology is fast.

Chapter 30: Enzymes

1) Enzymes
    a. Catalysts of biological reactions
    b. Can accelerate reactions by a factor of 1 million to 100 million
    c. Cause reactions to occur at room temperature and neutral pH
    d. Most are proteins

2) Catalysts speed up a reaction by decreasing the activation energy by allowing a new, more favorable reaction intermediate. The lowering of the activation energy allows more molecules to react. Understand the process's going on in Figure 30.1 and 30.3.

3) Definitions: Know the definition and usage of the following:
    a. Apoenzyme
    b. Coenzyme
    c. Holoenzyme
    d. Activator
    e. Specificity
    f. Substrate

4) Types of Enzymes: Memorize the various types of enzymes and what each is used for
    a. Oxidoreductase
    b. Transferase
    c. Hydrolase
    d. Lysase
    e. Isomerase
    f. Ligase

5) Effect of Temperature and pH on Enzyme Catalysts

6) Industrial use of Enzymes: Examples given in book, specific benefits gained.

7) How Enzymes Function:
    a. Active Site
    b. Lock-and-key model
    c. Induced-fit model
    d. Dynamic Catalyst
        i. Proximity catalyst
        ii. Productive binding
        iii. Strain hypothesis

8) Enzyme Regulation
    a. Covalent modification (Enzyme inhibition and activation)
    b. Feedback inhibition
    c. Feedforward inhibition
    d. Examples given in book (Hexokinase, Prozac/Serotonin, Statin drugs)