**STUDY GUIDE For CHEM 116 Final**

 ***(Saturated Hydrocarbons***

* Classify hydrocarbons as either saturated or unsaturated
* Recognize the general formula for alkanes (CnH 2n +2 )
* Write the molecular formula, line-angle formula, and the condensed formula when given the name of a hydrocarbon or hydrocarbon derivative.
* Classify the C atoms in a hydrocarbon as either 1°, 2°, 3°, or 4°.
	+ When given two compounds, classify them as either constitutional isomers, or geometric-cis-trans , or unrelated, or identical
	+ Recognize or discuss the physical properties of hydrocarbons *. ( What is the…… solublility in water? .. the density compared to water? …. the trend in b.p. ?.... the physical state for C1-C4 alkanes vs C5 alkanes and higher?)*

 **Alkane Rxns- Be able to predict the major organic product or determine the reagents /reactants needed to prepare the product for the following reactions :**

* Halogenation, X2 *(i.e. Cl2 or Br2 light energy i.e., hυ is required to initiate this reaction)*
* Combustion , O2
* Recognize the functional groups within a given organic compound

 **(*Unsaturated Hydrocarbons* )**

* Give the name when given a line-angle or condensed formula *(or vice versa )* for alkenes, cycloalkenes, and alkynes
* Name cis-trans isomers for cycloalkanes and alkenes.
* Recognize the general type of rxns that **alkenes/alkynes** undergo
* Be able to recognize or explain the Markovnikov *(MKV)* rule for unsymmetrical alkenes

**Alkene/Alkyne Rxns- Be able to predict the major organic product or determine the reagents /reactants needed to prepare the product for the following reactions :**

* Halogenation, X2 *(i.e. Cl2 or Br2)*
* Hydrohalogenation , HX *( Be aware of the MKV rule for unsymmetrical alkenes)*
* Hydrogenation, H2  *( A Ni , Pt, or Pd/C catalyst is necessary in order for the rxn to work)*
* Hydration , H2O *( Be aware of the MKV rule for unsymmetrical alkenes; must have strong acid catalyst for the rxn to work)*
* Recognize or discuss the physical properties of hydrocarbons

**Aromatic Hydrocarbons**

* Give the name when given a line-angle or condensed formula *(or vice versa )* for phenols, and derivatives of benzene
* Recognize the general type of rxns that **aromatics** undergo . *( Which type is it, elimination, addition, substitution, rearrangement?)*
* Name disubstituted derivatives of benzene using the ortho, meta, and para system when give the structure or vice versa.
* Explain why benzene does not undergo the same class of reactions as alkenes and alkynes *(Recall the stability argument from lecture)*

**Aromatic Rxns- Be able to predict the major organic product or determine the reagents /reactants needed to prepare the product for the following reactions:**

* Halogenation, X2 *(i.e. Cl2 or Br2,an iron(II) halide catalyst is necessary for the rxn work.. should be the same iron halide as the halide used in the reactant)*

 ***(Alcohols, Ethers, Thiols and Phenols)***

* Give the name when given a line-angle or condensed formula *(or vice versa )* for alcohols, ethers, phenols and thiols
* Recognize or give examples or classify primary, secondary , and tertiary ROH (alcohols)
* Compare the properties between ROH, ROR, and PhOH ( e.g. PhOHs are acidic, ROH are neutral, ethers have low b.p. compared to ROHs)
* Recognize or give the ether constitutional isomer of an alcohol. *( e.g The ether isomer of CH3CH2OH is CH3OCH3)*
* Be able to recognize or explain the Zaitsev rule for the dehydration of ROH

**Alcohol Rxns- Be able to predict the major organic product or determine the reagents /reactants needed to prepare the product for the following reactions**

* Intramol-Dehydration , Higher Temperature ( 180 °C), *( H2SO4 catalyst is required, also be aware of Zaitsev rule is relevant when more than one alkene can be produced )*
* Intermol- Dehydration , Lower Temperature ( 140 °C), *( H2SO4 catalyst is required, two molecules of ROH required to* *produce the ether)*
* Oxidation, *( 3° ROHs do not react, 2° ROHs gives R2C=O and 1° gives RCHO or RCOOH)*
* Phenols - Acid-Base Rxn with a strong base like NaOH *( pKa of phenols is about 10 )*
* Recognize the three major uses of phenols *(i.e., antioxidants in packaged food products, antiseptics in consumer healthcare products, and as disinfectants in cleaning products)*
* Oxidation of RSH *( readily oxidized to form RSSR)*
* Reduction of RSSR *(… can be reduced back to RSH – recall chemistry used in hair perms)*

 ***(Aldehydes and Ketones )***

**Nomenclature**

* Give the name when given a line-angle or condensed formula ***(or vice versa )*** for aldehydes, ketones,
* Recognize or be able to write the following general symbols for these classes of organic compounds : RCHO (aldehyde), R2CO (ketone)
* Assign an IUPAC name to a derivative of benzaldehyde
* Recognize the common names for RCHO, C1-C3 *(i.e., formaldehyde, acetaldehyde, propionaldehyde)*
* Recognize the common name for R2CO, C3 *( i.e. acetone )*
* Use the common naming system to name a ketone *( e.g. name (CH3CH2CH*2*COCH2CH3))*
* Discuss the b.p. and solubility of RCHO/R2CO relative to other organic compounds in particular ROH and ROR

 **RCHO/R2CO** **Rxns- Be able to predict the major organic product or determine the reagents /reactants needed to prepare the product for the following reactions :**

* *Oxidation of ROH ( primary ROH goes to RCHO , secondary ROH goes to R2CO, and* ***tertiary ROH = no rxn)***
* Tollens Reagent *(recognize the reagent and the sign for a positive test )* and Benedict’s Reagent *( recognize the reagent and the sign for a positive test )* *( These reagents give a positive test with RCHO by oxidizing it to RCOOH but no reaction with R2C=O )*
* Reduction *( RCHO with to 1° ROHs and R2C=O to 2° ROH using H2 and Pt catalyst )*
* Formation of Hemiacetals *( Rxn of one mole of ROH with RCHO or R2CO in the presence of an acid catalyst)*
* Formation of a Cyclic Hemiacetal *( An intramolecular rxn between the hydroxyl group and the RCHO group)*
* Formation of Acetals *( Rxn of one mole of ROH with a hemiacetal in the presence of an acid catalyst)*

 **(Carboxylic Acids, Esters, Amides)**

* Give the name when given a line-angle or condensed formula ***(or vice versa )*** for carboxylic acids, esters, and amides
* Recognize or be able to write the following general symbols for these classes of organic compounds : RCOOH(carboxylic acid) , RCOOR ( esters) and RCONH2 (amides)
* Recognize the following functional groups within a given organic compound: carboxylic acids, esters
* Assign an IUPAC name to a derivative of benzoic acid)
* Recognize or write the chemical structure when given the common names for RCOOH C1-C3 *(i.e. formic, acetic and propionic acid )*
* Recognize RCOOH is the most acidic organic functional group with a pKa ~ 5
* Discuss b.p. , solubility *( relative to other organic compounds and solubility in water*) and dimerization of RCOOH
* Recognize or write the chemical structure when given the common names for RCOOR C1-C3 *(i.e. formate, acetate and propionate)*
* Evaluate a chemical structure and determine if it contains the amide functional group.
* Name a simple mono or disubstituted amide.
* Classify an amide as 1°, 2°, or 3°
* Recognize or discuss the properties of an amide. *( i.e.solubility, m.p., and acid-base properties)*

**RCOOH Rxns- Be able to predict the major product or determine the reagents /reactants needed to prepare the product for the following reactions :**

* Formation of Carboxylate Salts
* Esterification *( Rxn of RCOOH and ROH in the presence of a strong acid )*

**RCOOR - Be able to predict the major product or determine the reagents /reactants needed to prepare the product for the following reactions :**

* Acidic Hydrolysis *( The reverse of esterification )*
* Saponification *(Basic Hydrolysis.)*

**Rxns Involving Amides *(RCONH*2)**

* Predict the product when a carboxylic acid reacts with a 1°, 2°, or 3° amine at 100 °C with a catalyst
* Predict the products for either acidic or basic hydrolysis of amides *( acidic hydrolysis gives RCOOH and an amine salt; basic hydrolysis gives a carboxylate salt and an amine)*

 ***(Amines and Amine Salts )***

* Give the name when given a line-angle or condensed formula ***(or vice versa )*** for amines
* Recognize or be able to write the following general symbols for RNH2 (amines)
* Recognize the following functional groups within a given organic compound: amines, and amine salts
* Recognize or give examples or classify primary, secondary , and tertiary RNH2 (amines)
* Evaluate a chemical structure and determine if can be classified as a heterocyclic aliphatic amine , aliphatic amine, aromatic amine, heterocyclic aromatic amine
* Assign an IUPAC name to primary, secondary, or tertiary amines
* **Ass**ignthe common nametoaprimary, secondary, or tertiary amine
* Assign an IUPAC name to an aniline derivative Assign an IUPAC name to a compound where the amine functional group is a substituent, i.e., amino
* Relative to other organic compounds and in particular RCOOH , ROH, and H2O , recognize or discuss b.p., solubility, odor, basicity*(This includes being able to discuss how hydrogen bonding affect some of these properties, also , note that a 3° R3N does not have hydrogen bonding which affect its solubility relative to a 1° or a 2° amine, see lecture powerpoint slides on this topic )*
* Recognize the solubility properties of amine salts

***(Note: You should be able to arrange six organic compounds by b.p. or solubility based on an understanding of hydrogen bonding and structure…. which is similar to the exercise we did in class on the powerpoint slide*)**

* Explain why amine based drugs are administered as amine salts.

**Amine Rxns- Be able to predict the major product or determine the reagents /reactants needed to prepare the product for the following reactions**

* Formation of Amine Salts *( Rxn of amines with HCl, H2SO4 , or RCOOH to form amine salts )*

 **(Carbohydrates and Chirality)**

* Classify carbohydrates as either MS, DS, OGS, or PS *( M = mono, D = di, OG = oligo, S =saccharide)*
* Identify the number of chiral centers in a molecule

**Enantiomers and Optical Activity**

* Discuss in general terms the purpose and function of a polarimeter as it relates to enantiomers
* Recognize the meaning of the terms levorotatory and dextrorotatory and the corresponding symbols (+) and (-)
* Recognize that another name for enantiomers is optical isomers.
* Recognize or compare the properties of enantiomers ( e.g. Do they have the same or different b.p.? Would they have the same or different solubility in a chiral solvent? )
* Determine the number of stereoisomers possible for a molecule
* Assign R and S for a stereocenter (assuming the lowest priority group is in the back)
* Classify a monosaccharide (MS ) by functional group and by number of carbons ( e.g. aldohexose, or ketopentose, e.g.How would you classifythe MS ribose?)
* Given a Fischer projection of an enantiomer, draw the Fischer projection of the other enantiomer
* Evaluate two Fischer projections and classify the pair as either epimers, enantiomers, diastereomers or not stereoisomers.
* Evaluate a Fischer projection and classify the monosaccharide as the D or the L isomer
* Evaluate a Haworth projection and classify the monosaccharide as the α or the β isomer
* Evaluate a Haworth projection and classify the monosaccharide as the D or the L isomer
* Recognize the meaning of the terms pyranose and furanose.
* Identify the hemiacetal or anomeric carbon in a Haworth projection
* Recognize the number of carbon atoms and the functional groups in these important MS ; glyceraldehyde,dihydroxyacetone, fructose, glucose, galactose, ribose, and deoxyribose.

**Rxns of Monosaccharides .. Predict the functional group for the following reactions of glucose**

* Oxidation with weak oxidizing agents *(Tollens and Benedict’s )* , or strong oxidizing agents *( for a weak [O]… ( -CHO → -COOH) , for a strong [O]….(-CHO and CH2OH → COOH) [aldonic acid]*
* Oxidation with an enzyme *( CH2OH → COOH)* [uronic acid]
* Recognize or explain the terms reducing and non-reducing sugars
* Recognize reducing and non-reducing sugars
* Reduction with enzymes to form sugar alcohols *( -CHO → -CH2OH) [alditol]*
* Formation of glycosides *(glucose + alcohol → glycoside (which is an acetal)* *)*
* Formation of the glucose phosphate
* Give the hydrolysis products for lactose *( galactose & glucose)*, sucrose *(glucose and fructose),* maltose and cellobiose *(glucose and glucose)*.
* Classify a glycosidic linkage ) as either an α (1→4) or β (1→4) linkages
* Recognize that humans have enzymes that can hydrolyze α (1→4) glycosidic linkages but not β (1→4) linkages *( this is why we can metabolize maltose, starch, and glycogen but not cellobiose, lactose, and cellulose*
* Classify a polysaccharide as either storage *(starch and glycogen )* or structural *(cellulose and chitin)*
* Recognize that starch forms a blue-black complex with iodine.
* Recognize starch is a mixture of amylopectin and amylose

**Lipids**

**Fatty Acids**

* Recognize or describe the properties of fatty acids (FAs) *( i.e, the solubility, m.p. effect of cis versus trans double bonds)*
* Classify a FA as a SFA *(saturated fatty acid)* , MUFA *(monounsaturated fatty acid),* PUFA *(polyunsaturated fatty acid)* or EFA *(essential fatty acid)*
* Given its structure, recognize or state the delta bond notation for a SFA, MUFA, PUFA, or EFA
* Given its structure, recognize or state the omega bond notation for a SFA, MUFA, PUFA, or EFA
* Classify a lipid into one of the four major functional classes of lipids and if applicable into the individual sub-class

**TAGs(Triacylglycerols-Energy Storage Lipids)**

* Recognize the older name used for triacylglycerol *(i.e. triglycerides)*
* Compare the characteristics of a fat and oil, i.e., they both are TAGs but why is one a solid while the other is a liquid?
* Recognize or list the general class of hydrolysis products for acidic hydrolysis of a TAG *( fatty acids and glycerol)*
* Recognize or list the general class of hydrolysis products for basic hydrolysis of a TAG *(carboxylate salts and glycerol)*

*( Also note that basic hydrolysis is called saponification because soap in the form of these carboxylate salts is formed. These salts self-assemble in spherical aggregates called micelles..Be sure you know what a micelle is and how it functions)*

* Recognize or list the hydrogenation products of a TAG *(an unsaturated FA residue is reduced with H2/Pt to a saturated FA residue)*
* Recognize or list the oxidation products of a TAG *( TAGs with unsaturated FA residues become rancid when the triester is hydrolyze to FAs and the double bond is then oxidized to lower molecular weight RCOOH that have strong odors)*

**Membrane Lipids (Phospholipids and Glycolipids)**

* Given a block diagram, identify the platform residue and the other major residues in the diagram or classify the diagram as either a TAG, a glycerophospholipid, a sphingophospholipid, or a sphingoglycolipid…

(*e.g. name the platform residue and at least two other major residues in the molecules below and then classify the molecules in one of the categories stated above*.)



* Compare the polarity of TAGS to that of phospholipids. *( Note: TAGs are essentially nonpolar and would not be very useful as a membrane lipid.)*
* Discuss or recognize the term lipid bilayer. *(This would include being able to sketch a lipid bilayer and discussing the structure of the bilayer in terms of hydrophilic heads and hydrophobic tails.)*
* Recognize or discuss the structure of the lipid bilayer
* Recognize the meaning of the terms hydrophilic and hydrophobic .*(This includes identifying the parts of lipid molecules that maybe hydrophilic and/or hydrophobic.)*
* Recognize or discuss how membrane lipids function in the lipid bilayer of cell membrane in terms of the polar heads, nonpolar tails, saturated FA residues and unsaturated FA residues.
* Recognize the name given to the complex model of the cell membrane *( i.e. the fluid mosaic model)*
* Recognize the difference between a peripheral and an integral protein in the fluid mosaic model
* Recognize or discuss the difference between passive, facilitated, and active transport.
* Recognize or sketch a micelle.

**Cholesterol** *( A lipid that is an important membrane component and precursor molecule )*

* Recognize the backbone of a steroid
* Recognize the function of cholesterol in cell membranes .
* Recognize the role of cholesterol as a precursor molecule. *(…. required for the synthesis of bile salts and steroid hormones )*
* Recognize the role of HDL and LDL as carrier proteins for cholesterol in the blood and how they function. ( i.e., HDL = *Healthy(“good cholesterol”)* , High Density Lipoprotein carries excess cholesterol in the blood back to the liver,

LDL = *Less Healthy(“bad cholesterol”)* , Low Density Lipoprotein carries cholesterol to tissues)

**Bile Salts** *(Emulsification Lipids****)***

* Recognize the structure of a bile salt *(i.e. bile acid)*



**Waxes** *(Protective Coating Lipids)*

* Recognize or give examples of biological waxes *( e.g. beeswax, carnauba, sebum)* and discuss the general structure of waxes and their biological function

 **(Proteins )**

* Differentiate among the terms amino acid, peptide, polypeptide, and protein .
* Explain or recognize the definition of the term zwitterion.
* Predict the effect of pH on a zwitterion by drawing the product from a rxn of H+ or OH- with a zwitterion.
* Recognize what groups are protonated at low , neutral, or high pH .
* Discuss how the isoelectric point is used in electrophoresis.
* Identify the N-terminal and C-terminal end in a peptide . *( e.g. What is the N –terminus in Ser-Gln- Gly-Gly-Ala?)*
* Recognize what a peptide bond is and the principal functional group found in peptides and proteins.
* Recognize the definition or an example of a prosthetic group . *( e.g. T F Heme is a protein subunit found in the protein hemoglobin )*
* Given a model of a protein, identify or discuss the various structures observed….i.e. primary, secondary *(both types),* tertiary, and quaternary.
* Given a diagram, identify the type of force seen in proteins *( i.e. ion pair, H-bond, S-S, and hydrophobic)*
* Compare properties and the function of fibrous and globular proteins to include giving two common examples from each class.
* Explain or recognize the term denaturation .
* Give an example of each type of denaturing agent presented in lecture.
* Given the chemical structure of a peptide, give the chemical structure for the hydrolysis of either a tetra-, tri-, or dipeptide.

 *( e.g What would be the chemical structure for the hydrolysis of Ala-Cys-Gly-Ser ?* )

**Enzymes**

* Catalyst function: speed up rxn without being consumed in reaction (makes rxns occur quickly enough to support life)
* Classification:
1. oxidoreductase: reduction/oxidation reactions
2. tranferase: transfer functional grps
3. hydrolase: cleavage by water
4. lyase: addition to or creation of double bonds
5. isomerase: isomerization (D to L, cis to trans, propyl to isopropyl, etc.)
6. ligase: formation of bonds with ATP cleavage
* Given the name of an enzyme, determine the substrate and the reaction type it catalyzes. *( e.g. aspartate transaminase (AST))*
* How do Enzymes Work
	+ Recognize or discuss enzyme function in terms of the active site, lock-and-key model, and the induced-fit model.
	+ Differentiate between a cofactor and a coenzyme with an explanation and/or using an example. Differentiate between an apoenzyme and a holoenzyme.
	+ Recognize or discuss the effect of temperature, pH, [S], and [E] on an enzyme-catalyzed reaction.
	+ Recognize or discuss the three major types of inhibition to include reversible competitive, reversible noncompetitive, and irreversible as presented in lecture and in the class exercise.
* Regulation
	+ Recognize or discuss the function of an allosteric enzyme.
	+ Recognize or discuss the three major types of enzyme regulation to include allosteric control , feedback control , and zymogens.
	+ Differentiate between positive and negative allosteric control.

**Nucleic acids**

* type (DNA, RNA)
* function
* Bases (be able to recognize)
* DNA bases: A, G, C, T
* RNA bases: A, G. C, U
* Nucleotide
* building block of nucleic acids
* made up of a base, a monosaccharide and a phosphate
* be able to draw nucleotide structure if structure of base is provided
* Nucleoside
* made up of a base and a monosaccharide
* be able to draw nucleoside structure if structure of base is provided
* DNA primary structure
* know how nucleotides are linked together to form DNA (phosphodiesters)
* be able to locate 5’ end and 3’end
* DNA secondary structure
* characteristics of double helix
* know how the bases are paired up to form double helix structure (be able to show Hydrogen bonding between bases)
* if the sequence of one strand is known, be able to determine the sequence of the complimentary strand
* RNA structure
* know the differences between DNA and RNA structures (bases, sugar, secondary structure)
* Know the functions of m-RNA, t-RNA and r-RNA
* Know how to write a m-RNA code from a template of DNA
* Know how to transcribe m-RNA into protein sequence
* Know basic structure of t-RNA and where the amino acid binds and where the anticodon is located
* Know the two components of r-RNA
* DNA replication
* the concept of DNA replication (including the enzymes involved)
* know the process of replication (including okazaki fragments, leading and lagging strand, direction of replication)
* characteristics of replication (semiconservative)
* Protein Synthesis
1. mRNA made from DNA in nucleus (read 3'®5')
2. Introns and exons (know definitions and which is cut out of the m-RNA)
3. Final mRNA emerges from nucleus, enters cytoplasm, binds with small rRNA subunit
4. tRNA for f-met binds to mRNA
5. Large rRNA subunit combines with complex
6. Next tRNA with codon to match next three nucleotides enters scene
7. Amino acid. bound together w/ peptide bond (be able to draw a basic picture of protein synthesis in the ribosomes)
8. First tRNA leaves
9. Ribosome reads next codon
10. Next tRNA enters
11. etc until stop codon reached