

## **COURSE OUTLINE**

### **Chemistry 121 Fundamentals of Organic and Biochemistry**

#### **I. Catalog Statement**

Chemistry 121 is the second half of the year sequence and covers the fundamentals of organic and biochemistry Units - 3.0

Lecture Hours - 4

Laboratory/Discussion Hours - 3

Prerequisite: Chemistry 120 with a grade of "C" or better.

Note: This course is not for science majors

#### **II. Course Entry Expectations**

Skills Expectations: Reading - 5; Writing - 5; Listening/Speaking - 5 Math - 5

Prior to enrolling in the class the student should be able to:

1. describe the scientific method and apply it to the development of the science of chemistry;
8. utilize bonding theories to describe the chemical nature of ions and molecules;
9. demonstrate an understanding of intermolecular forces and apply those forces to the nature of solids and liquids;
10. demonstrate the proper use of laboratory equipment and the ability to handle chemicals safely.

#### **III. Course Exit Standards**

Upon successful completion of the required course work, the student will be able to:

1. practice safe and effective organic laboratory skills, including the ability to: identify basic equipment and know its function or use, know basic organic laboratory techniques such as filtration, crystallization, extraction, TLC,
2. given the IUPAC names for organic reactants, students will identify or draw the structural formulas and for the reaction, predict products, provide organic structures and their IUPAC names,
3. differentiate physical and chemical properties of organic functional families and correlate them with the structure.
  
4. construct models of organic molecules using ball and stick models,

5. differentiate composition, properties, and chemical reactions of the biologically important compounds: carbohydrates, lipids, proteins, and nucleic acids,
6. students will identify the functions of biomolecules in biological systems and their metabolic pathways.

#### IV. Course Content

A.	Introduction	2 hours
	1. Overview	
	2. Geometry of molecules	
	3. Bonding	
	4. Structure	
B.	Alkanes	3 hours
	1. IUPAC nomenclature	
	2. Structure	
	3. Physical and Chemical Properties	
	4. Cycloalkanes	
	5. Alkyl Halides	
C.	Unsaturated Hydrocarbons	3 hours
	1. Alkenes	
	2. Alkynes	
	3. Aromatic Compounds	
D.	Functional Groups I	4 hours
	1. Alcohols	
	2. Phenols	
	3. Ethers	
	4. Thiols	
E.	Functional Groups II	4 hours
	1. Aldehydes	
	2. Ketones	
F.	Functional Groups III	5 hours
	1. Carboxylic Acids	
	2. Esters	
	3. Acyl Chlorides	
	4. Polymers and Polymerization Reactions	
G.	Functional Groups IV	4 hours
	1. Amines	
	2. Amides	
H.	Carbohydrates	4 hours
	1. Classification	
	2. Simple Carbohydrates	
	3. Disaccharides	
	4. Polysaccharides	
I.	Lipids	5 hours
	1. Classification	

- 2. Hydrolyzable Lipids
- 3. Non-Hydrolyzable Lipids
- 4. Hormones
- 5. Biological Membranes
- J. Proteins 4 hours
  - 1. Amino Acids
  - 2. Polypeptides
  - 3. Structure of Proteins
  - 4. Classification of Proteins
- K. Enzymes 3 hours
  - 1. Classification of Enzymes
  - 2. Enzyme Mechanisms
  - 3. Vitamins and Coenzymes
  - 4. Enzyme Regulation
- L. Nucleic Acids 5 hours
  - 1. Classification
  - 2. Structure of Nucleotides
  - 3. Nucleic Acids
  - 4. Replication, Translation, and Transcription of Nucleic Acids
- M. Metabolism 12 hours
  - 1. Carbohydrate Metabolism
  - 2. Lipid Metabolism
  - 3. Protein Metabolism
- N. Nutrition 3 hours
  - 1. Nutritional Requirements
  - 2. Macronutrients and Micronutrients
  - 3. Energy Carriers
- O. Body Fluids 4 hours
  - 1. Classification of Body Fluids
  - 2. Chemical Transport
  - 3. Buffer Control of Blood pH

## V. Methods of Presentation

The following instructional methodologies may be used in the course:

- 1. Traditional white board and Power Point combination for lecture
- 2. Molecular Models
- 3. Laboratory demonstrations

## VI. Assignments and Methods of Evaluation

- 1. Five one hour exams
- 2. Quizzes and laboratory reports
- 3. Supplementary readings from handouts
- 4. Group Power Point Presentation on given assignments.
- 5. Final Exam of 2 1/2 hours that contains multiple-choice questions.

## **VII. Textbook**

Seager, S.L., Slabaugh, M.R., Chemistry for Today: General, Organic, and Biochemistry, with Survival Guide

Brooks/Cole, 6/2008

13<sup>th</sup> Grade Reading Textbook Reading Level. ISBN: 0-495-77797-8

## **VIII. Student Learning Outcomes**

Detailed Student Learning Outcomes

Upon successful completion of this course, the students will be able to

### ***ALKANES***

1. Differentiate organic and inorganic compounds.
2. State the general properties of organic compounds.
3. Draw Lewis, condensed, carbon skeleton, and line structural formulas for alkanes, given their formulas or names.
4. Given structural formulas for alkanes and cycloalkanes, give their names.
5. Name the first ten alkanes.
6. Write chemical reactions of alkanes.

### ***UNSATURATED HYDROCARBONS***

1. Define and classify alkenes, alkynes, and aromatic compounds and name them given their structural formulas.
2. Write the structural formulas of alkenes, alkynes, and benzene compounds, given their names.
3. Write names and structural formulas for cis- and trans- geometric isomers.
4. Write equations for chemical reactions of unsaturated hydrocarbons such as addition, polymerization, etc.
5. Write equations for addition polymerization, given the monomers; give the monomer for an addition polymer.

### ***ALCOHOLS, PHENOLS, ETHERS, AND THIOLS***

1. Name and draw structural formulas for alcohols, phenols, ethers, and thiols.
2. Classify alcohols as primary, secondary, or tertiary, given their structural formulas.
3. Describe hydrogen bonding in alcohols, and discuss how it influences the physical properties of alcohols.
4. Write equations for alcohol dehydration and oxidation reactions.
5. Write names and structures for thiols.
6. Write the oxidation reaction for thiols, and the reduction reaction for disulfides.

### ***ALDEHYDES AND KETONES***

1. Define the carbonyl, aldehyde and ketone groups.
2. Describe the bonding in a carbonyl group.
3. Give names and structural formulas of aldehydes and ketones.
4. Write reactions for aldehydes and ketones.

### ***CARBOXYLIC ACIDS AND ESTERS***

1. Give names and structural formulas for carboxylic acids and esters.
2. Describe the bonding and the acidity of the carboxylic acid group.
3. Write the reaction between carboxylic acid and alcohol to produce an ester.
4. Write the hydrolysis reaction for esters.
5. Identify the structures of phosphate esters.

### ***AMINES AND AMIDES***

1. Describe the amine and amide functional groups.
2. Given structural formulas, classify amines as primary, secondary, or tertiary.
3. Give names and structural formulas for amines and amides.
4. Describe the basicity of amines.
5. Write reactions of amines and amides.

### ***CARBOHYDRATES***

1. Define carbohydrates, and identify them, given their formulas.
2. Describe the four major functions of carbohydrates in living organisms.
3. Classify carbohydrates as monosaccharides, disaccharides or polysaccharides.
4. Identify chiral carbons in molecules.
5. Draw Fischer projections of D and L compounds.
6. Classify monosaccharides in terms of numbers of carbon atoms, and by type of carbonyl group.
7. Describe sources and uses for important monosaccharides, disaccharides, and polysaccharides.
8. Identify and classify glucose, fructose, galactose, sucrose, maltose, lactose, starches, cellulose, and glycogen.
9. Identify alpha and beta glycosidic linkages, given names or Haworth structures of carbohydrates.
10. Describe the hydrolysis reactions of carbohydrates.
11. Identify the pyranose and furanose cyclic monosaccharide structures.

### ***LIPIDS***

1. Define lipids.
  2. Define saponifiable and nonsaponifiable lipids and list members of these classes.
  3. Describe five major functions of lipids.
  4. Describe four general characteristics of fatty acids.
  5. Draw the structural formula of a fatty acid molecule and label the polar/nonpolar, head/tail, hydrophobic/hydrophilic regions.
  6. Compare and contrast fats and oils.
  7. Write key reactions for fats and oils.
  8. Describe saturated versus unsaturated fatty acids.
  9. Describe the major features of cell membrane structure.
  10. Describe the biological importance of prostaglandins.
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1. Given structural formulas, identify steroids, fatty acids, triglycerides, and prostaglandins.
  2. Describe the importance and problems of cholesterol in the body.

### ***PROTEINS***

1. Draw the structure of amino acid molecule, identifying its characteristic parts.
2. Draw structural formulas for the various ionic forms of amino acids in acidic, neutral and basic solutions.
3. Write reactions to represent the formation and hydrolysis of peptides.
4. Describe proteins in terms of the following characteristics: size, function, classification as fibrous or globular, and classification as simple or conjugated.
5. Describe the primary, secondary, tertiary, and quaternary levels of protein structure.

### ***ENZYMES***

1. Describe the general characteristics of enzymes, and explain why enzymes are vital to life.
2. Describe the structure of a holoenzyme in terms of its apoenzyme, coenzyme, and metal ion activator; define enzyme cofactor.
3. Describe the interaction between enzyme and substrate to form product in structural terms.

4. Describe the lock-and-key and the induced-fit theories of enzyme-substrate binding.
5. Describe enzyme activity.
6. Identify the factors that affect enzyme activity.
7. Compare the mechanisms of competitive and noncompetitive inhibition.

### ***NUCLEIC ACIDS***

1. Identify the components of nucleotides and correctly classify sugars and bases.
2. Describe the structure of DNA and RNA.
3. Outline the process of DNA replication.
4. Describe transcription and translation in gene expression.
5. Describe how genetic mutations occur and how they influence organisms.

### ***METABOLISM OF CARBOHYDRATES, LIPIDS, AND PROTEINS***

1. Identify the products of carbohydrate digestion.
2. Explain the importance of the body's maintenance of blood glucose levels.
3. Explain the role of the glycolytic pathway in terms of its starting material and products.
4. Describe the regulation of the glycolytic pathway.
5. Identify the two major functions of the citric acid cycle.
6. Explain the processes of glycogenesis and glycogenolysis.
7. Describe gluconeogenesis.
8. Describe how hormones regulate carbohydrate metabolism.
9. Explain the process of amino acid metabolism: transamination, deamination, and formation of urea.
10. Explain the fate of carbon skeleton of amino acids.
11. Describe the catabolism of lipids.
12. Explain the metabolism of glycerol.
13. Explain the spiral degradation of fatty acids.
14. Compare the energetic values of lipids and carbohydrates.