

# Course Syllabus

**Department:** Science & Technology

**Date:** April 2012

**I. Course Prefix and Number:** CHM 212

**Course Name:** Organic Chemistry II

**Credit Hours and Contact Hours:** 5 credit hours and 7 (3:3:1) contact hours

**Catalog Description including pre- and co-requisites:**

A continuation of the study of the reactions, mechanisms, and synthesis of organic compounds including amines, aldehydes, ketones, amines, carboxylic acids, carbonyl-containing compounds and their derivatives as well as a brief introduction to bio-organic molecules. The basic spectroscopic methods and principles to determine the structure of organic compounds is developed. Laboratory techniques include functional group transformations, multi-step synthesis and a research project. Completion of Organic Chemistry I or equivalent with a grade of C or better is prerequisite.

**II. Course Outcomes and Objectives**

**Student Learning Outcomes:**

Upon completion of this course, the student will be able to:

- Demonstrate an understanding of basic principles of organic chemistry and how they relate to everyday experiences.
- Demonstrate problem solving and critical thinking skills
- Apply methods of scientific inquiry.
- Use instruments and laboratory techniques of organic chemistry
- Access information for lifelong learning (This includes use of textbooks and other resources).
- Apply problem solving techniques to real-world problems.
- Demonstrate an understanding of the chemical environment and the role that organic molecules play in the natural and the synthetic world.

**Relationship to Academic Programs and Curriculum:**

This course is required for majors in chemistry, chemical engineering, biology, biotechnology, pharmacology, and other pre-professional programs.

### College Learning Outcomes Addressed by the Course:

- |  |  |
|--|--|
| <input type="checkbox"/> writing             | <input type="checkbox"/> computer literacy |
| <input type="checkbox"/> oral communications | <input type="checkbox"/> ethics/values     |
| X reading                                    | <input type="checkbox"/> citizenship       |
| <input type="checkbox"/> mathematics         | <input type="checkbox"/> global concerns   |
| X critical thinking                          | X information resources                    |

### III. Instructional Materials and Methods

#### Types of Course Materials:

A standard two-semester organic textbook, and a laboratory manual with an emphasis on experimental techniques, are required.

#### Methods of Instruction (e.g. Lecture, Lab, Seminar ...):

Three hours of lecture, with a one hour recitation period for individual as well as group learning activities such as case studies and guided learning activities. This course also has a three hour laboratory.

### IV. Assessment Measures (Summarize how the college and student learning outcomes will be assessed):

Student learning outcomes will be assessed using a variety of assessment measures:

1. Unit exams, quizzes, and a comprehensive final will assess student knowledge of basic principles of organic chemistry and how they relate to everyday experiences.
2. Class assignments and active learning activities such as case studies and guided learning, will assess mastery of critical thinking, reading, information resources and applying content to solve real world problems.
3. Laboratory experiment reports will be used to assess student mastery of critical thinking skills, application of the scientific method, information resources, and use of instruments and lab techniques of organic chemistry.

## V. General Outline of Topics Covered:

### A. Spectroscopy

General Outcome:

- The student should be able to demonstrate an understanding of the principles of structure determination for organic molecules using the tools of ultra violet-visible spectroscopy, infrared spectroscopy, nuclear magnetic resonance spectroscopy and mass spectrometry.

Specific Learning Outcomes:

Upon completion of this material the student should be able to:

- Explain the origin of UV-visible absorptions in terms of electronic transitions between stable and unstable molecular orbitals.
- Predict which organic compounds should exhibit visible color based upon extent of conjugation.
- Recognize structures which should be transparent in the UV-visible range.
- Explain the origin of infrared absorptions in terms of vibrational modes of covalent bonds.
- Locate the general region of the infrared in either microns or wave numbers where various types of structural groups exhibit stretching and bending modes, and tell the specific wavelength or frequency where key groups absorb in the I.R.
- Account for the nuclear magnetic resonance "event" in terms of the precessional frequency of the nucleus as it relates to magnetic field strength and radio oscillator frequency.
- Predict direction of chemical shifts caused by various structural shielding or deshielding effects.
- Deduce complete structure of molecules which have fairly simple NMR spectra from interpretation of chemical shifts, peak areas and spin-spin coupling patterns, given the molecular formula.
- Describe how a mass spectrometer works.
- Describe how to find molecular weight, and base peak from a mass spectrum.
- Describe simple fragmentation patterns and rearrangements in simple molecules.
- ion patterns and rearrangements in simple molecules.

### B. Benzene and Aromaticity; Structure and Reactivity

General Outcome:

- The students should be able to demonstrate an understanding of the concept of aromaticity and relate it to the structure and chemistry of benzene.

Specific Learning Outcomes:

Upon completion of this material the student should be able to:

- Define and recognize aromatic compounds and the importance of resonance and aromaticity.

- Understand and apply Huckel's Rule
- Compare and contrast aromatic, antiaromatic and nonaromatic compounds.
- Name substituted derivatives of benzene.
- Write the detailed mechanisms of electrophilic substitution reactions.
- Predict the products of common aromatic reactions.
- Use IR, NMR, UV and mass spectra to determine the structures of aromatic compounds.

### C. Carbonyl Chemistry: Aldehydes and Ketones

#### General Outcome:

- The student should be able to demonstrate specific knowledge of the nomenclature, synthesis, and chemical properties of aldehydes and ketones, and should be able to explain the important reactions mechanistically.

#### Specific Learning Outcomes:

Upon completion of this material the student should be able to:

- Assign IUPAC names and some common names to typical aldehydes and ketones. Write equations illustrating several preparative methods for aldehydes and ketones.
- Write or complete equations showing examples of the more important reactions of aldehydes and ketones, including various nucleophilic additions, oxidations, reductions, and condensations involving enolate (carbanion) intermediates, such as the aldol reaction.
- Outline the mechanism steps for nucleophilic addition to the carbonyl group and for enolate condensations such as the aldol reaction.
- Outline multi-step synthesis problems based upon the new chemistry learned in this unit.
- Discuss the application of selected compounds to other fields, such as biology, medicine, or daily life.

### D. Carboxylic Acids and their Derivatives

#### General Outcome:

- The students should be able to demonstrate knowledge of the nomenclature, synthesis methods, and chemical properties of carboxylic acids and other compounds considered to be derived from them, and should be able to explain selected reactions mechanisms.

#### Specific Learning Outcomes:

Upon completion of this material the student should be able to:

- Assign common and IUPAC names to typical carboxylic acids, acyl halides, amides, esters, anhydrides, and nitriles.

- Write equations illustrating several general synthesis of typical nucleophilic acyl substitutions, reductions, salt formation, decarboxylation, alpha-halogenation reactions.
- Discuss the acidity of organic acids in terms of theory involving resonance and inductive effects
- Outline the mechanism for nucleophilic acyl substitution upon acyl derivatives.
- Discuss the application of selected substances to other fields, such as biology, medicine, or daily life.

## E. Amines

General Outcome:

- The students should be able to name, prepare and predict the reactions of amines, and discuss how structural factors influence the basicity of amines.

Specific Measurable Learning Outcomes:

Upon completion of this material the student should be able to:

- Assign IUPAC names to amines as well as recognize common names.
- Write equations for the synthesis of amines by reduction of nitro compounds.
- Complete equations showing major reactions of amines including salt formation, amide formation (carboxamides and sulfonamides), oxidation and formation and reactions of diazonium salts.
- Arrange a short list of amines in order of increasing basicity by evaluation of inductive and/or resonance effects.

## F. Selected Topics

General Outcome:

- The student should be able to define terms related to carbohydrates, proteins, lipids, polymers and heterocyclic compounds, to recognize their basic structures and to discuss the important chemical, biochemical or commercial aspects of each of these families of compounds.

Specific Learning Outcomes:

Upon completion of this material the student should be able to:

- Define and structurally classify carbohydrates as mono-, di- or polysaccharides and recognize some common examples of each class.
- Recognize alpha- and beta-isomers and D- and L- optical isomers.
- Describe briefly how a straight chain monosaccharide (Fisher projection) can form a ring structure (Haworth structure).
- Predict the results of some common reactions of simple carbohydrates such as oxidation, reduction, osazone formation, etc.
- Describe glycosidic bond formation as a type of dehydration reaction.
- Recognize the importance of carbohydrates as one of the key components in nucleic acids.

- Define what is meant by alpha-amino acids, isoelectric point for amino acids, L-configuration for natural amino acids and the "zwitterion" nature of amino acids.
- Draw the condensed structure for short peptides from a given sequence of amino acids.
- Recognize the differences among the various levels of molecular organization in proteins, i.e., primary, secondary, tertiary and quaternary structures.
- Describe the denaturation process and its biological effect on proteins.
- Define lipids and recognize them as simple or complex.
- Recognize the general structure of waxes and triacylglycerols.
- Describe hydrolysis or saponification of waxes and triacylglycerols.
- Recognize the general structure of phospholipids, steroids and terpenes.
- Recognize the two major classes of polymers, addition and condensation.
- Identify commercial polymers as present in typical consumer products.