Lecture Contact Hours: 48-54, Outside-of-Class Hours: 96-108,
Laboratory Contact Hours: 96-108, Outside-of-Class Hours: 0,
Total Student Learning Hours: 240-270

CUYAMACA COLLEGE
COURSE OUTLINE OF RECORD

Chemistry 232 – Organic Chemistry II

3 hours lecture, 3 units
6 hours laboratory, 2 units
Total units: 5

Catalog Description
Second of a two-semester sequence. The topics covered will include: structure and reactivity of carboxylic acids and their derivatives, amines and other nitrogen functional groups, aromatic compounds, heterocyclic compounds, polyfunctional compounds, conjugation and aromaticity, and multistep organic synthesis.

Prerequisite
"C" grade or higher or "Pass" in CHEM 231 or equivalent

Entrance Skills
Without the following skills, competencies and/or knowledge, students entering this course will be highly unlikely to succeed:
1) Distinguish among the numerous classes of organic compounds and predict their properties and reactivity.
2) Deduce the structures of the constitutional isomers corresponding to a given molecular formula.
3) Write a systematic name for an organic compound given its structure and vice-versa.
4) Deduce the principal conformations of open chain molecules and cyclohexane derivatives and determine their relative potential energies.
5) Deduce the structures of the stereoisomers possible for molecules with stereogenic centers.
6) Predict the operative mechanisms and the structures of the products in nucleophilic substitution, elimination, electrophilic addition, nucleophilic addition, radical substitution and addition, oxidation, and reduction reactions.
7) Design the synthesis and identify intermediates for an organic compound requiring multiple reaction steps.
8) In the laboratory, determine physical properties of melting points and boiling points of organic compounds.
9) In the laboratory, perform simple qualitative tests for detection of the different types of functional groups on compounds.
10) In the laboratory, characterize compounds based on modern spectrometric data including FTIR and NMR.
11) Determine the structure of molecules from their FTIR and NMR spectra.
12) Synthesize, isolate, purify and characterize both solid and liquid organic compounds.
13) Analyze and evaluate observations acquired in the laboratory by applying the theoretical principles being studied.

Course Content
1) Organometallic chemistry
2) Conjugated unsaturated systems
3) Aromatic compounds and their reactivity
4) Nucleophilic addition to carbonyl groups
5) Carboxylic acids and their derivatives

6) Reactions of enols and enolates
7) Amine chemistry
8) Nucleophilic aromatic substitution
9) Multistep organic transformations

Course Objectives

Students will be able to:

1) Predict products and mechanisms of oxidation-reduction reactions in organic chemistry.
2) Predict the products and mechanisms of organic reactions involving organometallic compounds.
3) Distinguish among the numerous types of conjugated unsaturated systems and their use in organic synthesis.
4) Determine whether an organic compound is aromatic and understand electrophilic aromatic substitution reactions.
5) Predict the mechanisms and products of nucleophilic addition and nucleophilic addition-elimination reactions involving carbonyl substrates.
6) Distinguish among the various mechanisms and reactions involving enols and enolates.
7) Distinguish among the various types of reactions and mechanisms involving amines.
8) Distinguish between nucleophilic substitution reactions involving phenols or aryl halides.
9) Design the synthesis and identify intermediates for an organic compound requiring multiple reaction steps.
10) In the laboratory, synthesize, isolate, and purify both solid and liquid organic compounds.
11) In the laboratory, characterize compounds based on modern spectrometric data including FTIR, NMR and GC/MS.

Method of Evaluation

A grading system will be established by the instructor and implemented uniformly. Grades will be based on demonstrated proficiency in subject matter determined by multiple measurements for evaluation, one of which must be essay exams, skills demonstration or, where appropriate, the symbol system.

1) Exams that measure students' ability to explain and apply the basic concepts of organic chemistry. General question types are short essay and problem solving. Specific question types include:
   a. Classification of organic compounds.
   b. Prediction of physical and chemical properties.
   c. Deduction of structures from molecular formulas, infrared spectra, and nuclear magnetic resonance spectra.
   d. Translation of structure to name and vice-versa.
   e. Prediction of reaction mechanisms and products.
   f. Synthesis of molecules.
2) Laboratory activities that evaluate students' ability to observe the properties of a wide range of organic compounds, to apply competent observational skills, to demonstrate proper collection and recording of data, to assemble and utilize complex glassware setups for synthesis and purification, and to operate modern laboratory instruments.
3) Written laboratory reports that measure students' ability to interpret and analyze both qualitative and quantitative data.

Special Materials Required of Student

Laboratory notebook, safety glasses, lab apron

Minimum Instructional Facilities

1) Lecture room with demonstration bench equipped with gas, air, vacuum, water, sink
2) Laboratory equipped with same utilities as lecture room, each student station having gas, air, vacuum, water, sink and fume hoods
3) Student lockers stocked with organic glassware kit in addition to standard laboratory glassware

4) Essential laboratory equipment: standard taper glassware kits, electronic top-loading balances, melting point apparatuses, hot plates, and vortexers
5) Two instruments which tremendously increase the quality of the course are a gas chromatograph, infrared spectrometer and NMR spectrometer
6) Variety of organic chemicals and solvents as well as thin layer chromatography supplies

Method of Instruction

1) Lectures are designed to explain basic concepts. As much as possible, concepts are introduced by presentation of data. Analysis and explanations of data are elicited from students by frequent and persistent questions. Demonstrations of chemical properties and reactivity are utilized where practical, either live or as video clips. Molecular models are used extensively to convey structures of molecules. Applications to the real world are incorporated as much as possible.
2) In the laboratory, short lectures are used to introduce the theory and design of the experiment, to demonstrate laboratory techniques and to review safety precautions. Individual instruction in lab technique is provided throughout the lab period.
3) Laboratories correlate with lectures and are designed to allow students to make observations of chemical phenomena. Students work individually for most experiments. Lab reports require students to explain their laboratory observations employing the concepts discussed in class.
4) The textbook is required reading and is essential to successful solution of homework problems, performance of laboratory experiments, and performance on exams.
5) Students are strongly encouraged to form study groups and to seek help through peer tutoring and instructor office hours.

Out-of-Class Assignments

1) Reading and homework problems, as assigned
2) Formal lab reports
3) Specialized project involving selected topics in chemistry, as required; this project may require the use of research on the internet, at the library, or other resources

Texts and References

1) Required (representative examples):
   a. Solomons & Fryhle. *Organic Chemistry*. 13th edition. Wiley, 2022.
   b. Lab book: Lehman. *Multiscale Operational Organic Chemistry*, 2nd Edition.
2) Supplemental: None

Student Learning Outcomes

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

1) Determine whether an organic compound is aromatic and understand electrophilic aromatic substitution reactions.
2) Predict the mechanisms and products of nucleophilic addition and nucleophilic addition-elimination reactions involving carbonyl substrates.
3) Distinguish among the various types of reactions and mechanisms involving amines.
4) Design the synthesis and identify intermediates for an organic compound requiring multiple reaction steps.
5) In the laboratory, synthesize, isolate, purify and characterize both solid and liquid organic compounds.