

### Course Outline

**COURSE:** CHEM 12B      **DIVISION:** 10      **ALSO LISTED AS:**

**TERM EFFECTIVE:** Fall 2016

**CURRICULUM APPROVAL DATE:** 03/14/2016

**SHORT TITLE:** ORGANIC CHEMISTRY

**LONG TITLE:** Organic Chemistry

<u>Units</u>	<u>Number of Weeks</u>	<u>Type</u>	<u>Contact Hours/Week</u>	<u>Total Contact Hours</u>
5	18	Lecture:	3	54
		Lab:	6	108
		Other:	0	0
		Total:	9	162

#### **COURSE DESCRIPTION:**

This is the second semester of a year-long organic chemistry course designed as a continuation of Chemistry 12A. Topics include nomenclature, stereochemistry, mechanism, reactions, and spectroscopic studies of the various organic functional groups. Lecture and laboratory methods will focus on synthesis, isolation, purification, elucidation and identification of organic structures as well as instrumental methods and data interpretation. (C-ID: CHEM 160S) **PREREQUISITE:** Chemistry 12A

#### **PREREQUISITES:**

Completion of CHEM 12A, as UG, with a grade of C or better.

#### **COREQUISITES:**

**CREDIT STATUS:** D - Credit - Degree Applicable

#### **GRADING MODES**

L - Standard Letter Grade

**REPEATABILITY:** N - Course may not be repeated

#### **SCHEDULE TYPES:**

02 - Lecture and/or discussion

03 - Lecture/Laboratory

04 - Laboratory/Studio/Activity

#### **STUDENT LEARNING OUTCOMES:**

1. Demonstrate knowledge of the structures, physical/chemical properties, preparation, and nomenclature of alcohols and phenols, chemical reactions including oxidation and reduction, protection, as well as the spectroscopy of alcohols and phenols.

Measure: Homework, Group activities, Quizzes and Exams

PLO:

ILO: 2, 1, 7

GE-LO: B1, B3, B5, B6, A6

Year assessed or anticipated year of assessment: 2012

2. Demonstrate knowledge of the structures, physical/chemical properties, preparation, and nomenclature of aldehydes and ketones, chemical reactions including nucleophilic addition reactions, as well as the spectroscopy of aldehydes and ketones. Measure: Homework, Group activities, Quizzes and Exams

PLO:

ILO: 2, 1, 7

GE-LO: B1, B3, B5, B6, A6

Year assessed or anticipated year of assessment: 2012

3. Demonstrate comprehension of the structures, physical/chemical properties, preparation, and nomenclature of ethers, epoxides, thiols and sulfides, chemical reactions including the Williamson ether synthesis, as well as the spectroscopy of ethers, epoxides, thiols and sulfides.

Measure: Homework, Group activities, Quizzes and Exams

PLO:

ILO: 2, 1, 7

GE-LO: B1, B3, B5, B6, A6

Year assessed or anticipated year of assessment: 2016

4. Demonstrate comprehension of the structures, physical/chemical properties, preparation, and nomenclature of carboxylic acids and nitriles, chemical reactions of carboxylic acids and nitriles, the substituent effects on acidity, as well as the spectroscopy of carboxylic acids and nitriles. Measure: Homework, Group activities, Quizzes and Exams

PLO:

ILO: 2, 1, 7

GE-LO: B1, B3, B5, B6, A6

Year assessed or anticipated year of assessment: 2016

5. Demonstrate knowledge of the structures, physical/chemical properties, preparation, and nomenclature of acid halides, anhydrides, esters, and amides, chemical reactions including nucleophilic acyl substitution reactions of carboxylic acids and derivatives.

Measure: Homework, Group activities, Quizzes and Exams

PLO:

ILO: 2, 1, 7

GE-LO: B1, B3, B5, B6, A6

Year assessed or anticipated year of assessment: 2016

6. Recognize and evaluate the keto-enol tautomerism, reactivity, and chemical reactions of enols and enolate ion molecules. Measure: Homework, Group activities, Quizzes and Exams

PLO:

ILO: 2, 1, 7

GE-LO: B1, B3, B5, B6, A6

Year assessed or anticipated year of assessment: 2016

7. Discuss, compare and contrast mechanisms of carbonyl condensation reactions including the Aldol and Claisen, intramolecular reactions, as well as using carbonyl condensation reactions in synthesis.

Measure: Homework, Group activities, Quizzes and Exams

PLO:

ILO: 2, 1, 7

GE-LO: B1, B3, B5, B6, A6

Year assessed or anticipated year of assessment: 2016

8. Demonstrate knowledge of the structures, bonding, physical/chemical properties, preparation of amines, chemical reactions, as well as the spectroscopy of amines. Measure: Homework, Group activities, Quizzes and Exams

PLO:

ILO: 2, 1, 7

GE-LO: B1, B3, B5, B6, A6

Year assessed or anticipated year of assessment: 2016

9. Discuss, compare and contrast the classification of carbohydrates, D / L configurations, Fischer Projections and stereochemistry of carbohydrates, chemical reactions of carbohydrates, as well as hemiacetal formation.

Measure: Homework, Group activities, Quizzes and Exams

PLO:

ILO: 2, 1, 7

GE-LO: B1, B3, B5, B6, A6

Year assessed or anticipated year of assessment: 2012

10. Be able to compose schemes for the synthesis of target compounds from a wide array of simple organic starting materials and reagents. Measure: Homework, Group activities, Quizzes and Exams

PLO:

ILO: 2, 1, 7

GE-LO: B1, B3, B5, B6, A6

Year assessed or anticipated year of assessment: 2012

11. Demonstrate knowledge of the classification, structures, physical/chemical properties and nomenclature of amino acids, peptides, and proteins, as well as the synthesis, resolution, and sequencing of amino acids, peptides, and proteins.

Measure: Homework, Group activities, Quizzes and Exams

PLO:

ILO: 2, 1, 7

GE-LO: B1, B3, B5, B6, A6

Year assessed or anticipated year of assessment: 2017

12. Discuss, compare and contrast lipid biomolecules including waxes, fats, oils, soaps, phospholipids, terpenes, and steroids, as well as their structures, physical/chemical properties, nomenclature, biosynthesis, and stereochemistry. Measure: Homework, Group activities, Quizzes and Exams

PLO:

ILO: 2, 1, 7

GE-LO: B1, B3, B5, B6, A6

Year assessed or anticipated year of assessment: 2017

13. Demonstrate knowledge of the structures, physical/chemical properties, and nomenclature of heterocyclic compounds, and nucleic acids, chemical reactions including electrophilic and nucleophilic substitution reactions, as well as base pairing, replication, sequencing, and synthesis of DNA and RNA..

Measure: Homework, Group activities, Quizzes and Exams

PLO:

ILO: 2, 1, 7

GE-LO: B1, B3, B5, B6, A6

Year assessed or anticipated year of assessment: 2017

14. Employ laboratory procedures to: i) Characterize organic compounds based on physical/chemical properties including IR, UV, MS, and NMR spectroscopy. ii) Purify organic compounds by methods including recrystallization, solvent extraction, sublimation, and distillation. iii) Synthesize, derivatize and degrade organic compounds, and characterize their physical/chemical properties. iv) Isolate, purify, and characterize the structures of natural products. v) Examine chemical concepts through peer interaction and written laboratory reports. vi) Relate classroom and laboratory experiences to phenomena outside the classroom. Measure: Homework, Group activities, Quizzes and Exams

PLO:

ILO: 2, 1, 4, 6

GE-LO: B4, B7, B8, A5

Year assessed or anticipated year of assessment: 2017

PROGRAM LEARNING OUTCOMES:

Employing the scientific method as a basis for evaluation theoretical and laboratory derived information, students will gain an understanding of the biological and/or physical worlds. Students will also gain a working familiarity with mathematics and an understanding of mathematics as it applies to modeling in the sciences.

## **CONTENT, STUDENT PERFORMANCE OBJECTIVES, OUT-OF-CLASS ASSIGNMENTS**

Curriculum Approval Date: 03/14/2016

5 Hours

Review of Organic Reactions

Summary of the kinds of organic reactions. Summary of organic reaction mechanisms.

Homework problems from text and instructor.

Laboratory Experiment: Locker Check-In and Safety

20 Hours

Chapter-17 Alcohols and Phenols

Naming alcohols and phenols. Properties of alcohols and phenols including hydrogen bonding, acidity and basicity. Preparation of alcohols from the reduction of carbonyl compounds and reaction of Grignard reagents with carbonyl compounds. Reactions of alcohols. Protection of alcohols. Preparation, reaction, and uses of phenols. Spectroscopy of alcohols and phenols.

Homework problems from text and instructor.

Chapter-18 Ethers and Epoxides; Thiols and Sulfides

Nomenclature of ethers. Structure, properties, and sources of ethers. The Williamsen Ether Synthesis. Alkoxymercuration of alkenes. Reactions of ethers including acidic cleavage and Claisen Rearrangement. Cyclic ethers: epoxides. Ring-opening reactions of epoxides. Spectroscopy of ethers. Thiols and Sulfides.

Homework problems from text and instructor.

Laboratory Experiment: Nucleophilic Aromatic Substitution

Demonstrate knowledge of the structures, physical/chemical properties, preparation, and nomenclature of alcohols and phenols, chemical reactions including oxidation and reduction, protection, as well as the spectroscopy of alcohols and phenols.

Demonstrate comprehension of the structures, physical/chemical properties, preparation, and nomenclature of ethers, epoxides, thiols and sulfides, chemical reactions including the Williamson ether synthesis, as well as the spectroscopy of ethers, epoxides, thiols and sulfides.

30 Hours

Preview of Carbonyl Compounds

Types of carbonyl compounds. Nature of the carbonyl group.

General reactions of carbonyl compounds.

Homework problems from text and instructor.

Chapter-19 Aldehydes and Ketones: Nucleophilic Addition Reactions

Naming aldehydes and ketones. Preparation of aldehydes and

ketones. Nucleophilic addition reactions of aldehydes and ketones.

Relative reactivity of aldehydes and ketones. Nucleophilic addition of

water, HCN, Grignard, and hydride reagents. Nucleophilic addition of

amines: imine and enamine formation. Nucleophilic addition of

hydrazine: the Wolf-Kishner reaction. Nucleophilic addition of

alcohols: acetal formation. Nucleophilic addition of phosphorus

ylides: the Wittig reaction. The Cannizzaro reaction. Conjugate

nucleophilic addition to alpha-, beta- unsaturated aldehydes and

ketones. Spectroscopy of aldehydes and ketones. Biological

nucleophilic addition reactions.

Homework problems from text and instructor.

Laboratory Experiment: Identification of Aldehydes and Ketones

Demonstrate knowledge of the structures, physical/chemical

properties, preparation, and nomenclature of aldehydes and ketones,

chemical reactions including nucleophilic addition reactions, as well

as the spectroscopy of aldehydes and ketones.

25 Hours

Chapter-20 Carboxylic Acids and Nitriles

Nomenclature of carboxylic acids. Structure and physical

properties of carboxylic acids. Dissociation of carboxylic acids.

Substituent effects on acidity. Substituent effects in substituted

benzoic acids. Preparation of carboxylic acids. Reaction of

carboxylic acids: an overview. Reduction of carboxylic acids.

Chemistry of nitriles. Spectroscopy of carboxylic acids and nitriles.

Homework problems from text and instructor.

Laboratory Experiment: Oxidation and Reduction

Demonstrate comprehension of the structures, physical/chemical

properties, preparation, and nomenclature of carboxylic acids and

nitriles, chemical reactions of carboxylic acids and nitriles, the

substituent effects on acidity, as well as the spectroscopy of

carboxylic acids and nitriles.

20 Hours

Chapter-21 Carboxylic Acid Derivatives and Nucleophilic Acyl

Substitution

Reactions

Naming carboxylic acid derivatives. Nucleophilic acyl

substitution reactions of carboxylic acids. Chemistry of acid halides

and acid anhydrides. Chemistry of esters and amides. Thiol esters,

biological carboxylic acid derivatives. Polyamides and polyesters:

step-growth polymers. Spectroscopy of carboxylic acid derivatives.

Homework problems from text and instructor.

Chapter-22 Carbonyl Alpha-Substitution Reactions

Keto-enol tautomerism. Reactivity of enols: the mechanism of

alpha-substituted reactions. Alpha halogenation of aldehydes and

ketones. Alpha bromination of carboxylic acids, the Hell-Volhard-Zelinskii reaction. Acidity of alpha hydrogen atoms, enolate ion formation. Reactivity of enolate ions. Halogenation of enolate ions, the haloform reaction. Alkylation of enolate ions.

Homework problems from text and instructor.

Laboratory Experiment: Preparation of Esters

Demonstrate knowledge of the structures, physical/chemical properties, preparation, and nomenclature of acid halides, anhydrides, esters, and amides, chemical reactions including nucleophilic acyl substitution reactions of carboxylic acids and derivatives.

Recognize and evaluate the keto-enol tautomerism, reactivity, and chemical reactions of enols and enolate ions.

20 Hours

Chapter-23 Carbonyl Condensation Reactions

Mechanism of carbonyl condensation reactions. Condensation of aldehydes and ketones: the aldol reaction. Carbonyl condensation reactions versus alpha-substitution reactions. Dehydration of aldol products, the synthesis of enones. Using aldol reactions in synthesis and mixed aldol reactions. Intramolecular aldol reactions. The Claisen condensation reaction and mixed Claisen condensations. Intramolecular Claisen condensations: the Dieckman Cyclization. The Michael reaction and the Stork Enamine reaction. Carbonyl condensation reactions in synthesis: the Robinson Anulation reaction. Biological carbonyl condensation reactions.

Homework problems from text and instructor.

Chapter-24 Amines

Nomenclature of amines. Structure and bonding in amines.

Properties and sources of amines. Basicity of amines and substituted arylamines. Synthesis of amines. Reactions of amines. Reactions of arylamines. Tetraalkylammonium salts as phase-transfer catalysts.

Spectroscopy of amines.

Homework problems from text and instructor.

Laboratory Experiment: Synthesis of Aspirin

Discuss, compare and contrast mechanisms of carbonyl condensation reactions including the Aldol and Claisen, intramolecular reactions, as well as using carbonyl condensation reactions in chemical synthesis.

Demonstrate knowledge of the structures, bonding, physical/chemical properties, preparation of amines, chemical reactions, as well as the spectroscopy of amines.

20 Hours

Chapter-25 Biomolecules: Carbohydrates

Classification of carbohydrates. Configurations of monosaccharides, the Fischer Projection. D and L sugars.

Configurations of the aldoses. Cyclic structures of monosaccharides, hemiacetal formation. Monosaccharide anomers and mutarotation.

Reactions of monosaccharides. Stereochemistry of glucose, the Fischer Proof. Disaccharides, polysaccharides and their synthesis. Cell-surface carbohydrates and carbohydrate vaccines.

Homework problems from text and instructor.

#### Chapter-26 Biomolecules: Amino Acids, Peptides, and Proteins

Structure of amino acids and isoelectric points. Synthesis of alpha-amino acids. Resolution of R and S amino acids. Peptides and proteins. Covalent bonding in peptides. Structure determination of peptides via amino acid analysis. Sequencing of peptides: the Edman Degradation and C-terminal residue determination. Synthesis of peptides. Automated peptide synthesis, the Merrifield solid-phase technique. Classification of proteins and protein structure. Enzymes and protein denaturation.

Homework problems from text and instructor.

#### Laboratory Experiment: Multistep Synthesis of Ionones

Discuss, compare and contrast the classification of carbohydrates, D and L configurations, Fischer Projections and stereochemistry of carbohydrates, chemical reactions of carbohydrates, as well as hemiacetal formation.

Demonstrate knowledge of the classification, structures, physical/chemical properties and nomenclature of amino acids, peptides, and proteins, as well as the synthesis, resolution, and sequencing of amino acids, peptides, and proteins.

20 Hours

#### Chapter-27 Biomolecules: Lipids

Waxes, fats, and oils. Soap, phospholipids, and prostaglandins.

Terpenes and the biosynthesis of terpenes. Steroids and the stereochemistry of steroids. The biosynthesis of steroids.

Homework problems from text and instructor.

#### Chapter-28 Biomolecules: Heterocycles and Nucleic Acids

Five-membered unsaturated heterocycles. Structure of pyrrole, furan, and thiophene. Electrophilic substitution reactions of pyrrole, furan, and thiophene. Pyridine, a six-membered heterocycle.

Electrophilic and nucleophilic substitution reactions of pyridine.

Fused-ring heterocycles. Nucleic acids, nucleotides and their structure. Base Pairing in DNA, the Watson-Crick Model. Replication of DNA. Structure and synthesis of RNA. Transcription, translation of RNA and protein biosynthesis. DNA sequencing and synthesis. The polymerase chain reaction.

Homework problems from text and instructor.

#### Laboratory Experiment: DNA Fingerprinting Scenario

Discuss, compare and contrast lipid biomolecules including waxes, fats, oils, soaps, phospholipids, terpenes, and steroids, as well as their structures, physical/chemical properties, nomenclature, biosynthesis, and stereochemistry.

Demonstrate knowledge of the structures, physical/chemical properties, and nomenclature of heterocyclic compounds, and nucleic acids, chemical reactions including electrophilic and nucleophilic substitution reactions, as well as base pairing, replication, sequencing, and synthesis of DNA and RNA.

Compose schemes for the synthesis and retrosynthesis of a wide

array of simple organic compounds.

2 Hours

Final Exam (cumulative)

Comprehensive over the entire course with evaluation of each of the areas previously encountered.

**ASSIGNMENTS:**

See content.

**METHODS OF INSTRUCTION:**

Instruction is by lecture, class discussion, lecture demonstration, small group problem solving, laboratory work projects and homework.

**METHODS OF EVALUATION:**

CATEGORY 1 - The types of writing assignments required:

Percent range of total grade: 20 % to 30 %

Written Homework

Lab Reports

Other: Extra Credit report on an organic chemistry topic.

CATEGORY 2 -The problem-solving assignments required:

Percent range of total grade: 70 % to 80 %

Homework Problems

Lab Reports

Quizzes

Exams

CATEGORY 3 -The types of skill demonstrations required:

Percent range of total grade: 0 % to %

CATEGORY 4 - The types of objective examinations used in the course:

**REPRESENTATIVE TEXTBOOKS:**

Required:

1.) McMurry, J., "Organic Chemistry," 9th ed., Cengage Learning Publishing, 2016

2.) Palleros, D.R., "Experimental Organic Chemistry," 2nd ed., J. Wiley Publishing 2012

Recommended:

1.) McMurry, S., Brady, A. Hyslop, "Study Guide & Solution Manual," 9th ed.. Cengage Learning Publishing, 2016

Or other appropriate college level text.

ISBN: 978-1-305-08048-5

978-0-471-28250-1

978-0-840-05445-6

(if available)

Reading level of text, Grade: 13            Verified by: D. Clark

Other textbooks or materials to be purchased by the student: None

**ARTICULATION and CERTIFICATE INFORMATION**

Associate Degree:

GAV B1, effective 201370

GAV B3, effective 201370



CSU GE:

CSU B1, effective 201370

CSU B3, effective 201370

IGETC:

IGETC 5A, effective 201370

IGETC 5C, effective 201370

CSU TRANSFER:

Transferable CSU, effective 201370

UC TRANSFER:

Transferable UC, effective 201370

**SUPPLEMENTAL DATA:**

Basic Skills: N

Classification: Y

Noncredit Category: Y

Cooperative Education:

Program Status: 1 Program Applicable

Special Class Status: N

CAN:

CAN Sequence:

CSU Crosswalk Course Department: CHEM

CSU Crosswalk Course Number: 12B

Prior to College Level: Y

Non Credit Enhanced Funding: N

Funding Agency Code: Y

In-Service: N

Occupational Course: E

Maximum Hours:

Minimum Hours:

Course Control Number: CCC000096753

Sports/Physical Education Course: N

Taxonomy of Program: 190500