# ORGANIC CHEMISTRY II (CH 324)
# COURSE OUTLINE
# SPRING SEMESTER 2002

**Bülent Terem**

**Required Textbook:** Carey, Francis A. Organic Chemistry, McGraw-Hill, 4th Ed., 2000.

**Supplementary Books:**

Carey, Francis A. and Atkins, Robert C. Student Study Guide l Solutions Manual to *Accompany* Organic Chemistry by *Francis A.* Carey, McGraw-Hill, 2000.
Bruice, P.Y. *Organic* Chemistry, Prentice-Hall, Inc., 1995.

**Software:** ChemDraw (for Windows); Chem 3-D, Cambridge Soft Corp.

**Supplementary Materials:** Molecular Models

**Web Pages:** http://bterem.pageout.net
Announcements; lecture highlights; exam solutions; sample exams
www.mhhe.com/carey
Carey Organic Chemistry Online Learning Center

## Course Objectives:

This is the second part of a two-semester course in organic chemistry. It is assumed that the students by now have a sound understanding of the basic concepts of organic reaction mechanisms. In the next sixteen weeks we will start with topics in physical organic chemistry and gradually move into biological organic chemistry. The chemistry of aromatic compounds will provide a framework where structure-reactivity relationships are clearly laid out. An introduction to spectroscopic techniques will show how physical methods can illustrate the properties of organic compounds. As we go into the chemistry of carbonyl compounds, and sample in-depth analyses of certain reactions, comparisons with biological pathways will stand out. Meanwhile, multi-step syntheses will elucidate common logical strategies. Finally, the chemistry of carbohydrates, amino acids and proteins will give the course a biological flavor. To summarize the course objectives in more tangible terms, at the end of the semester the students should be able to carry out the following tasks:

- Understand the concept of aromaticity and utilize resonance theory to be able to make predictions about the rates and regioselectivity of substituted aromatic compounds in electrophilic substitution reactions.
  Understand the basic principles of ultra violet and nuclear magnetic resonance spectroscoscopy, as well as mass spectrometry as tools to determine structures of organic molecules.
  Learn to develop synthetic strategies based on carbonyl group chemistry in an effort to propose regioselective multi-step syntheses of related molecules.
  Get familiar enough with carbohydrate chemistry to understand related metabolic pathways.
- Illustrate a knowledge of various classes of nitrogen-containing compounds with particular emphasis on the reactions of and preparative routes for amines.

General Comments:

The key to success in this course depends on the student's ability to put in time and effort to understand the material as it is presented, or shortly after. Overlaps between lab and lecture, as well as review sessions, are designed to emphasize this point. A number of text book problems will be recommended in the web page. It is hoped that at the end of the spring semester, each student will possess a sound molecular background to help him/her interpret what goes on in biological systems.

Exams and Grading: Three 60-minute midterms, quizzes and homework assignments, and a ninety minute comprehensive final.

Course Grade (all grades in percentages)

_ +.26 (average of the three midterms)
+ .26 (average of the two highest midterms)
+ .10 (average of the quizzes and assignments)
+ .38 (final)

*Make-up exams will be given only under exceptional circumstances on the basis of a written request accompanied by a written ver cation.*

Office Hours: TF 12:30 - 2:00; R 12:30 - 1:00 and/or by arrangement

Review Sessions To be arranged

Office: Henry Hall 45 (Ph: 735-4806)
e-mail: terem@gold.chem.hawaii.edu

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| 1 | 1/15 | 11 | A review of organic reactions... Resonance theory and the stability of benzene... Benzene derivatives and aromatic compounds... |
| 1 | 1/17 | 11 | Polycyclic aromatic compounds... Reactions of arenes: the Birch Reduction; Free-radical halogenation; Oxidation of alkylbenzenes... Reactions of benzyl halides: $S_N$ and E Reactions... Alken l benzenes... The concept of aromatici ... |
| 2 | 1/22 | 11<br>12 | Hückel's Rule... Annulenes... Heterocyclic aromatic compounds... Aromatic ions... Comparison of pyrrole and pyridine...<br>General mechanism of electro hilic aromatic substitution reactions... |
| 2 | 1/24 | 12 | Electrophilic aromatic substitution reactions: Nitration; Sulfonation; Halogenation; Friedel Craft's al lation and ac lation reactions... |
| | 1/29 | 12 | Rate and regioselectivity in electrophilic aromatic substitution reactions (substituent effects)... |
| 3 | 1/31 | 12 | Regioselective synthesis of disubstituted aromatic compounds... Review... |
| 4 | 2/5 | | FIRST MIDTERM EXAM |
| 4 | 2/7 | 13 | A general look into spectroscopy: an organic chemist's perspective... Nuclear Magnetic Resonance (NMR) Spectroscopy: The origin of NMR absorptions; $^1H$ NMR... |
| 5 | 2/12 | 13 | Chemical shifts ... Equivalence in NMR Spectroscopy... Integration... |
| 5 | 2/14 | 13 | Spin-spin coupling... Magnetic induction in a it-system ... Complex splitting patterns... $^{13}C$ NMR... Interpretation of NMR spectra... |
| 6 | 2/19 | 13 | UV-VIS Spectroscopy... Mass spectrometry... Instrumental features... Analysis of mass s tra: Resolution; Isotopes; Molecular ion peaks... |
| 6 | 2/21 | 13 | Fragmentation in mass spectrometry... Stable fragments... Structure determination using s trosco ic data... |
| 7 | 2/26 | 17 | Aldehydes and ketones: Structural classification and spectroscopic properties... Preparation of aldeh des and ketones: Oxidation of alcohols 15.10 and 15.11)... |
| 7 | 2/28 | 17<br>14 (in part) | Principles of nucleophilic addition to aldehydes and ketones... Reversible addition reactions: Hydration; Cyanohydrin formation... Oxygen Nucleophiles: Acetal formation; Acetals as protecting groups... Carbon nucleophiles: Grignard reagents (14.6); Organolithium reagents (14.7); Ace lides (14.8)... |
| 8 | 3/5 | 17 | Nitrogen nucleo hiles... The Wittig Reaction... |
| 8 | 3/7 | 17 | Baeyer-Villiger oxidation... Oxidation of aldehydes into carboxylic acids... Reduction of aldeh des and ketones (15.2)... |
| 9 | 3/12 | | SECOND MIDTERM EXAM |

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| 9 | 3/14 | 18 | Keto-enol tautomerism (acid and base catalyzed)... Reactions at the a-carbon: a-halogenation; Haloform reaction... Aldol Reaction... |
| 10 | 3/19 | 18 | α,β-Unsaturated aldehydes and ketones: Structural and spectroscopic features... Conjugate addition to a, -Unsaturated aldeh des and ketones... |
| 10 | 3/22 | 18<br>19 | Michael addition reactions... Robinson Annulation reaction...<br>Carboxylic acids: Structural and spectroscopic features; Nomenclature; Effects of substituents on acidity |
| 11 | 3/25<br>-3/29 | | SPRING BREAK |
| 12 | 4/2 | 19 | Preparation of carboxylic acids: Hydrolysis of nitrites; Carbonation of Grignard reagents, Oxidation reactions... Reactions of carboxylic acids: Fischer Esterification... |
| 12 | 4/4 | 19<br>25 | Reactions of carboxylic acids (cont.): Hell-Volhard-Zelinsky Reaction... Thermal decarboxylation of β-ketoacids…<br>Carbohydrates: Structural classifications; hemiacetal formation (cyclization) of monosaccharides... |
| 13 | 4/9 | 25 | Conformations of monosaccharides... Mutarotation... Acetal formation... N-glycosides: Nucleosides, nucleotides; linkages in nucleic acids... Disaccharides... Reactions of monosaccharides: Oxidation; Reduction; Chain extension; Alkylation; Ac lation… Fischer's roof of glucose structure... |
| 13 | 4/11 | 25<br>20 | Carbohydrates in biological systems: Glycolysis; Glycoproteins; Polysaccharides...<br>Carboxylic acid functional derivatives: Esters, Amides, Anhydrides, Acid halides, Nitrites: Nomenclature; Structural features... |
| 14 | 4/16 | 20 | Reactions of carboxylic acid derivatives: Mechanism of nucleophilic acyl substitution... Hydrolysis... Comparison of the reactivities of carboxylic acid derivatives... Interconversion of carboxylic acid derivatives... |
| 14 | 4/18 | 20 | The Hofmann Rearrangement... Carboxylic acid derivatives of biological interest... Sulfonamides... |
| 15 | 4/23 | | THIRD MIDTERM EXAM |
| 15 | 4/25 | 21<br>22 | Ester enolates: Claisen Condensation ; Dieckman reaction... Mixed Claisen condensation... Acetoacetic and malonic ester syntheses...<br>Amines: Nomenclature; structure and bonding; basici .. |
| 16 | 4/30 | 22 | Syntheses of amines: Gabriel Synthesis; Reductive routes; Reactions of amines: Hofmann Elimination…Arylamines: Nitrosation reactions... Aryl diazonium salts: Sandme er reactions... |
| 16 | 5/2 | 24 | Amino acids: Structural-stereochemical features; acid-base properties... Peptides and proteins... Peptide structure determination: End group analyses; partial hydrolyses... Synthetic strategies in tide syntheses... |
| | 5/8 | | FINAL EXAM (Wednesday; 08:00) |