GRANDE PRAIRIE REGIONAL COLLEGE

Department of Science

Discipline of Chemistry

Thirty-Eighth Session 2003 - 2004

CHEMISTRY 1610 A3: **Organic Chemistry I**

PREREQUISITE: **Chemistry 30 or equivalent**

INSTRUCTOR: **Dr. John P. Sloan**
Office # J207
Phone # 539-2004
E-mail SLOAN@GPRC.AB.CA

LECTURE: **CH1610 A3 T, R 13:00 - 14:20 in J227**

ALBERTA TRANSFER CREDIT for CH1610 plus CH1630:

U of Alberta:	CHEM 161/163	6 credits
U of Calgary:	CHEM 351/353	6 credits
U of Lethbridge:	CHEM 2100/2200	6 credits
Athabasca U:	CHEM 2xx/2xx	6 credits
Augustana U Col:	CHE 1xx/1xx	6 credits
Concordia Col:	CH 161/163	6 credits
The King's U Col:	CHEM 2xx/2xx	6 credits
Canadian Univ. C:	CHEM 1xx/1xx	8 credits

COURSE OUTLINE:

Lecture Component:
A study of the fundamental principles of the chemistry of carbon compounds. The study is based on a reaction mechanism approach to the functional group chemistry of alkanes, alkenes, alkynes, cycloalkanes, alkyl halides, alcohols and ethers. Topics include: structure and bonding; physical properties; acidity and basicity; conformations of molecules; stereochemistry; addition, elimination and substitution reactions; structure-reactivity relationships; and introduction to methods for structure determination.

A representative selection of molecules found in agricultural, biological, environmental, industrial, medical, and pharmatheutical applications of organic chemistry will be discussed, e.g., molecules found in agrochemicals, fibres, food additives, perfumes, polymers, and prescription drugs.

Laboratory Component:
Laboratory Techniques in organic chemistry; preparation of some organic compounds, and; methods of qualitative organic analysis.

Tutorial Component:
Problem solving and discussion sessions with weekly problem sets. Regular tests/assignments will be given and marked.

Notes:

1. Lectures, Time and Place
   CH1610 A3 T, R 13:00 - 14:20 in J227

2. Laboratory Component, Time and Place
   CH1610 L1 M, 14:30 - 17:20 in J116

3. Tutorial Component, Time and Place
   CH1610 S1 F, 12:00 – 12:50 in J229

TEXT BOOKS AND LABORATORY ITEMS:

The following books are required:

1. Solomons, T.W.G., and C.B. Fryhle*, Organic Chemistry,* 8th Edition, Wiley, 2004;

2. A Three Ring Binder to Hold: Sloan, J.P.*, Organic Chemistry Experiments, Chemistry 1610/1630,* Grande Prairie Regional College, 2003/2004.

The following is highly recommended:

3. Molecular Model Set for Organic Chemistry, Prentice Hall.

The following is a supplementary item:

1. Fernandez, J.E., and Solomons, T.W.G., *Study Guide and Solutions Manual to Organic Chemistry,* 8th Edition, 2004;

Note:

1. All required and supplementary books, molecular structure model sets, safety glasses, and lab coats are available at the College Bookstore. *Organic Chemistry Experiments,* by J.P. Sloan, will be given as handouts in advance of each lab period. These are to be inserted in a three ring binder.

LABORATORY FEE:

A laboratory Fee in the amount of $30.00 is payable to the cashiers office prior to commencement of the first organic chemistry lab. The fee is levied as an initial payment to cover the replacement cost of glassware and equipment items broken by the student. In the event of replacement costs of broken items being less than $30.00, the balance of the deposit will be returnable to the student. In the event of breakage costs being greater than $30.00, an equitable surcharge will be assessed and levied on the student.

EVALUATION:

Examination Schedule and Composition of the Final Grade:

1. Midterm Exam to be Scheduled for week of Feb 23 ------ 25%
2. Final Exam to be scheduled between April 19 & 28 ---------- 40%
3. Laboratory ---------- 25%
4. Tutorial Grading Component ---------- 10%

100%

The Grades are based on the alpha grading system. The Registrar's Office will convert alpha grades to four-point equivalence for the calculation of grade point averages. Alpha grades, 4-point equivalence, and grade descriptors are as follows:

Alpha Grade	4-Point Equivalence	Descriptor
A^+	4.0	Excellent
A	4.0	
A-	3.7	First Class Standing
B+	3.3	
B	3.0	Good
B-	2.7	
C+	2.3	Satisfactory
C	2.0	
C-	1.7	
D+	1.3	Poor
D	1.0	Minimal Pass
F	0.0	Failure

Notes:

1. The Mid-Term exam will be of 2 hours duration and the Final Exam will be of 3 hours duration.
2. Between 5 and 15% of exam content will be taken directly from weekly Tests/Assignments.
3. A pass grade is essential for the Laboratory Component.
4. The Tutorial Grading Component consists of tests/assignments and will contribute towards 10% of the final grade. A 10 question test/assignment will normally be given each week. To encourage general discussion and active student participation, test/assignment questions may be answered within "paired teams". Tests/assignments not completed during the tutorial period are due within 24 hours without penalty, or later at the discretion of the Instructor.
   The marking scheme is:
   - 4.1 1 mark per correct answer with full details;
   - 4.2 ½ mark per correct answer with incomplete details;
   - 4.3 20% shall be deducted from the mark for each college business day that a test/assignment is overdue.
5. Regular attendance in Lecture, Laboratory, and Tutorial Components is a Course Requirement.

Grande Prairie Regional College Calendar 2003 - 2004: Course Description (p 164).

CH1610 3(3-1-3)UT, 105 Hours, Organic Chemistry I

The study includes basic molecular structure and reactivity of organic compounds based on their functional groups. The course provides an introduction to nomenclature, three dimensional structure, physical properties, and reactivity of compounds of carbon. Special emphasis is placed on hydrocarbons (petroleum products), halogenated organic compounds (e.g. pesticides), and polymers of industrial importance which may be found in everyday life.

Prerequisite: Chemistry 30 or equivalent.

Note: Students with credit in CH 1010 and 1020 normally will proceed to CH2610. Such students may enrol in CH1610 only in consultation with an advisor and with written consent of the department chairperson.

CHEMISTRY 1610
READING, STUDYING, AND PRACTICE PROBLEMS

All references are to T.W.G. Solomons and C.B. Fryhle, *Organic Chemistry,* 8th Edition Upgrade, Wiley, 2004.

FALL SEMESTER

Weeks of
Jan 5 & 12: CARBON COMPOUNDS AND CHEMICAL BONDS.

Sect # Page # Read and Study Chapter 1 "We are Star Dust"

	1	Life is Organic Chemistry
1.1	2	Introduction
1.2	3	The Development of Organic Chemistry as a Science
1.3	4	The Structural Theory of Organic Chemistry
1.4	6	Chemical Bonds and the Octet Rule
1.5	8	Writing Lewis Structures
1.6	10	Exceptions to the Octet Rule
1.7	12	Formal Charge
1.8	14	Resonance Theory
1.8A	16	Summary of Rules for Resonance
1.9	19	Quantum Mechanics
1.10	20	Atomic Orbitals of Electron Probability Densities: the Aufbau Principle; the Pauli Exclusion Principle; Hund's Rule
1.11	22	Molecular Orbitals: Bonding and Antibonding
1.12	25	The Structure of Methane and Ethane: sp^3 Hybridization;
1.12A	25	The Structure of Methane
1.12B	28	The Structure of Ethane
1.13	28	The Structure of Ethene (Ethylene): sp^2 Hybridization
1.13A	32	Restricted Rotation and the Double Bond
1.13B	33	Cis-Trans Isomers
1.14	34	The Structure of Ethyne (Acetylene): sp Hybridization
1.14A	35	Bond Lengths of Ethyne, Ethene, and Ethane
1.15	36	A Summary of Important Concepts that Come from Quantum Mechanics
1.16	38	Molecular Geometry: The Valence Shell Electron-Pair Repulsion (VSEPR) Model.
1.16A-F	38	Molecular Geometry: VSEPR Models for Methane, Ammonia, Water, Boron Trifluoride, Berylium Hydride and Carbon Dioxide
1.17	41	Representation of Structural Formulas: Dash; Condensed; Cyclic Molecules; Bond Line; and the Three Dimensional Wedge, Dash, Line Representation
	46	Key Terms and Concepts
	47	Concept Map

Practice Problems: You are encouraged to work all of the in-chapter problems, and you are required to work all of the assigned weekly test problems. Routinely doing problems in organic chemistry leads to understanding of the theory, and good grades in organic chemistry. In the words of Solomons and Fryhle:

"*One way to check your progress is to work each of the in-chapter problems when you come to it. These problems have been written just for this purpose and are*

designed to help you decide whether or not you understand the material that has just been explained."

Problems: In-Chapter 1.1 to 1.16
48 End of Chapter 1.17 to 1.39
51 Learning Group Problem

Week of Jan 19: REPRESENTATIVE CARBON COMPOUNDS: Functional Groups, Intermolecular Forces, and Infrared (IR) Spectroscopy

Read and Study Chapter 2
52 Structure and Function: Organic Chemistry, Nanotechnology, and Bioengineering
2.1 53 Carbon-Carbon Covalent Bonds
2.2 53 Hydrocarbons: Representative, Alkanes, Alkenes, Alkynes, and Aromatic Compounds
2.3 56 Polar Covalent Bonds
2.4 59 Polar and Nonpolar Molecules
2.4A 61 Dipole Moments in Alkenes
2.5 61 Functional Groups
2.5A 62 Alkyl Groups and the Symbol R
2.5B 62 Phenyl and benzyl Groups
2.6 63 Alkyl Halides or Haloalkanes
2.7 63 Alcohols, including Classification as Primary, Secondary and Tertiary (1E, 2E, 3E)
2.8 65 Ethers
2.9 66 Amines, including classification as Primary, Secondary and Tertiary
2.10 67 Aldehydes and Ketones
2.11 68 Carboxylic Acids, Esters, and Amides
2.12 69 Nitriles
2.13 70 Summary of Important Families of Organic Compounds
2.14 70 Physical Properties and Molecular Structure with emphasis on Intermolecular Interactions, namely
2.14A 71 Ion-Ion Forces in ionic compounds, e.g. sodium acetate, sodium chloride
2.14B 72 Dipole-Dipole Forces resulting from permanent dipoles, e.g. acetone, chloromethane
2.14C 73 Hydrogen Bonds
2.14D 74 van der Waals Forces, or London forces or dispersion forces, e.g. methane
2.14E 76 Solubilities
2.14F 77 Guidelines for Water Solubility
2.14G 77 Intermolecular Forces in Biochemistry, and Organic templates Engineered to Mimic Bone Growth
2.15 78 Summary of Attractive Electrical Forces
2.16 79 Infrared Spectroscopy: An Instrumental Method for Detecting Functional Groups
2.16A 84 Hydrocarbons
2.16B 86 Other Functional Groups, including Carbonyl Functional Groups of Aldehydes, Ketones, Esters, Carboxylic Acids and Amides, plus Alcohols, Phenols and Amines
88 Key Terms and Concepts
89 Concept Map
Problems: In-Chapter 2.1 to 2.19
90 End of Chapter 2.20 to 2.48
93 Learning Group Problem

Week of Jan 26: AN INTRODUCTION TO ORGANIC REACTIONS: ACIDS AND BASES IN ORGANIC CHEMISTRY

		Read and Study Chapter 3
	94	Shuttling the Protons, or, from the Lewis and Sloan perspective, Shuttling the Electrons
3.1	95	Reactions and their Mechanisms - Substitution, Addition, Elimination and Rearrangement Reactions
3.1A	96	Homolysis and Heterolysis of Covalent Bonds, and Introduction to the Use of Curved Arrows
3.2	97	Acids and Bases
3.2A	97	The BrNnsted-Lowry Definition of Acids and Bases
3.2B	99	The Lewis Definition of Acids and Bases
3.2C	100	Opposite Charges Attract
	101	The Chemistry of ... HOMOs and LUMOs in Reactions
3.3	101	Heterolysis of Bonds to Carbon - Carbocations and Carbanions
3.4	102	The Use of Curved Arrows in Illustrating Reactions
3.5	104	The Strength of Acids and Bases, K_a and pK_a
3.5A	104	The Acidity Constant, K_a
3.5B	104	Acidity and pK_a
	105	Table 3.1: Relative Strength of Selected Acids and Their Conjugate Bases
3.5C	106	Predicting the Strength of Bases the Stronger the Acid, the Weaker the Conjugate Base
3.6	107	Predicting the Outcome of Acid-Base Reactions
3.6A	108	Water Solubility as a Result of Salt Formation
3.7	109	The Relationship between Structure and Acidity, i.e. Structural Effects on Acidity and Basicity, namely: 1. Size Effect, acidity increases upon descending a column in the Periodic Table, H-I am a stronger acid than H-F; 2. Electronegativity Effect, acidity increases from left to right in the Periodic Table, H-F is a stronger acid than CH_4.
3.7A	111	3. The Effect of Hybridization, more s-character means the anion has lower energy, is more stable, and is a weaker base
3.7B	112	4. Inductive Effects, from polarization by electron attracting and electron withdrawing groups
3.8	113	Energy Changes; higher potential and kinetic energy implies less stable, lower energy implies more stable
3.8A	114	Potential Energy and Covalent Bonds, exothermic reactions give out heat, endothermic reactions absorb heat
3.9	114	The Relationship Between the Equilibrium Constant and the Standard Free-Energy Change, ΔG^o; a negative value favours products at equilibrium
3.10	115	The Acidity of Carboxylic Acids, with explanations arising from Resonance Effects and Inductive Effects
3.10A	116	5. An Explanation based on Resonance Effects, due to resonance stabilization of the carboxylate anion
3.10B	117	An Explanation based on Inductive Effects, due to inductive withdrawal of electronic charge by –O and -C=O in carboxylate anions
3.10C	119	Inductive Effects of Other Groups
3.11	120	The Effect of Solvent on Acidity - Protic Solvents
3.12	121	Organic Compounds as Bases
3.13	122	A Mechanism for an Organic Reaction
	124	The Chemistry of carbonic Anhydrase
3.14	124	Acid and Base in Nonaqueous Solutions

Week of Feb 2: ALKANES AND CYCLOALKANES: Nomenclature, Conformational Analysis, and an Introduction to Synthesis

Read and Study Chapter 4

4.16	177	Chemical Reactions of Alkanes
4.17	178	Synthesis of Alkanes and Cycloalkanes
4.17A	178	Hydrogenation of Alkenes and Alkynes
4.17B	179	Reduction of Alkyl Halides
4.17C	179	Alkylation of Terminal Alkynes
4.18	180	Some General Principles of Structure and Reactivity: A Look Towards Synthesis, Introduction to the Terms Nucleophile and Electrophile
4.19	181	An Introduction to Organic Synthesis
4.19A	182	Retrosynthetic Analysis – Planning an Organic Synthesis
4.19B	183	Identifying Precursors
	185	The Chemistry of --- From the Inorganic to the Organic
4.19C	185	Raison d'Etre --- solving synthetic puzzles by application of retroactive synthesis is one of the joys of learning organic chemistry
	185	Key Terms and Concepts
	187/188	Concept Maps
Problems:		In-Chapter 4.1 to 4.18
	186	End of Chapter 4.19 to 4.56
	192	Learning Group Problems

Week of Feb 9:STEREOCHEMISTRY: CHIRAL MOLECULES

Read and Study Chapter 5

	193	The Handedness of Life
5.1	194	The Biological Significance of Chirality
5.2	195	Isomerism, Constitutional Isomers and Stereoisomers
5.3	196	Enantiomers and Chiral Molecules
5.4	200	More about the Biological Importance of Chirality
5.5	201	The Historical Origin of Stereochemistry
5.6	202	Tests for Chirality, Planes of Symmetry and Points of Symmetry
5.7	203	Nomenclature of Enantiomers, the R-S System
5.8	208	Properties of Enantiomers, Optical Activity
5.8A	209	Plane-Polarized Light
5.8B	209	The Polarimeter
5.8C	210	Specific Rotation
5.9	212	The Origin of Optical Activity
5.9A	213	Racemic Forms
5.9B	214	Racemic Forms and Enantiomeric Excess
5.10	215	The Synthesis of Chiral Molecules
5.10A	215	Racemic Forms
5.10B	216	Stereoselective Synthesis
5.11	217	Chiral Drugs
	218	The Chemistry of ... Selective Binding of Drug Enantiomers to Left- and Right-Hand Coiled DNA
5.12	219	Molecules with More Than One Stereocentre
5.12A	220	Meso Compounds
5.12B	222	Naming Compounds with More than One Stereogenic Carbon
5.13	223	Fischer Projection Formulas
5.14	224	Stereoisomerism of Cyclic Compounds
5.14A	225	Cyclohexane Derivatives
5.15	227	Relating Configurations Through Reactions in Which No Bonds to the Stereogenic are Broken

5.15A 228 Relative and Absolute Configurations
5.16 230 Separation of Enantiomers: Resolution
5.16A 230 Pasteur's Method for Separating Enantiomers
5.16B 231 Current Methods for Resolution of Enantiomers
5.17 231 Compounds with Stereogenic Centres Other than Carbon
5.18 231 Chiral Molecules that do not Possess a Tetrahedral Atom with Four Different Groups
233 Key Terms and Concepts
234 Concept Map
Problems: In-Chapter 5.1 to 5.29
235 End of Chapter 5.30 to 5.45
237 Learning Group Problems
Additional Problems - The CD accompanying the text book includes a set of computer molecular model stereochemistry exercises that are keyed to the text.

Week of Feb 16: Family Day and Winter Break: No Classes.

Weeks of Feb 23 & Mar 1: IONIC REACTIONS: NUCLEOPHILIC SUBSTITUTION AND ELIMINATION REACTIONS of ALKYL HALIDES

Read and Study Chapter 6

238 Breaking Bacteria Cell Walls With Organic Chemistry
6.1 239 Introduction
239 Table 6.1: Carbon-Halogen Bond lengths and Bond Strengths
6.1A 240 Physical Properties of Organic Halides
240 Table 6.2: Organic Halides
6.2 241 Nucleophilic Substitution Reactions
6.3 241 Nucleophiles
6.4 242 Leaving Groups
6.5 243 Kinetics of a Nucleophilic Substitution Reaction - a Substitution Nucleophilic Bimolecular, S_N2, Reaction
6.6 244 A Mechanism for the S_N2 Reaction
6.7 245 Transition State Theory - Free-Energy Diagrams
6.8 249 The Stereochemistry of S_N2 Reactions
6.9 251 The Reaction of Tert-Butyl Chloride with Hydroxide Ion - an S_N1 Reaction
6.9A 252 Multistep Reactions and the Rate determining Step
6.10 252 A Mechanism for the S_N1 Reaction
6.11 254 Carbocations
6.11A 254 The Structure of Carbocations
6.11B 255 The Relative Stabilities of Carbocations
6.12 256 The Stereochemistry of S_N1 Reactions
6.12A 256 Reactions That Involve Racemization
6.12B 257 Solvolysis – Cleavage of the Solvent by the Nucleophile
6.13 258 Factor's Affecting the Rates of S_N1 and S_N2 Reactions
6.13A 258 The Effect of the Structure of the Substrate
259 Table 6.4: Relative Rates of Reactions of Alkyl Halides in S_N2 Reactions
260 S_N1 Reactions and the Hammond-Leffler Postulate
6.13B 261 The Effect of the Concentration and the Strength of the Nucleophile
262 Nucleophilicity versus Basicity
6.13C 262 Solvent Effects on S_N2 Reactions: Polar Protic and Aprotic Solvents
6.13D 264 Solvent Effects on S_N1 Reactions: The Ionizing Ability of the Solvent

Week of Mar 8: ALKENES AND ALKYNES I: PROPERTIES AND SYNTHESIS.
Elimination Reactions of Alkyl Halides

Read and Study Chapter 7

Week of Mar 15: ALKENES AND ALKYNES II: ADDITION REACTIONS.

Read and Study Chapter 8.

Week of Mar 22: RADICAL REACTIONS

Read and Study Chapter 10

10.4 456 Chlorination of Methane: Mechanism of Reaction
1. Chain Initiation
2. Chain Propagation
3. Chain Termination
10.5 459 Chlorination of Methane: Energy Changes
10.5A 460 The Overall Free-Energy Change
10.5B 461 Activation Energies
10.5C 464 Reaction of Methane with other Halogens
10.6 466 Halogenation of Higher Alkanes
10.6A 468 Selectivity of Bromine, and Selectivity versus Reactivity
10.7 469 The Geometry of Alkyl Radicals
10.8 469 Reactions that Generate Tetrahedral Stereogenic Carbons
10.8A 470 Generation of a Second Stereogenic Carbon in a Radical Halogenation
10.9 472 Radical Addition to Alkenes:
The Anti-Markovnikov Addition of Hydrogen Bromide
10.9A 473 Summary of Markovnikov versus Anti-Markovnikov Addition of HBr to Alkenes
10.10 474 Radical Polymerization of Alkenes: Chain Growth Polymers
474 Radical Polymerization of Ethene
476 Other Common Chain-Growth Polymers
10.11 476 Other Important Radical Reactions
10.11A 476 Molecular Oxygen and Super oxide
10.11B 477 Nitric Oxide
10.11C 477 Combustion of Alkanes
10.11D 478 Autoxidation
10.11E 479 Antioxidants
10.11F 479 Ozone Depletion and Chlorofluorocarbons (CFCs)
481 Summary and Review Tools: Concept Map:
Mechanism Review of Radical Reactions
482 Key Terms and Concepts
485 Special Topic A: Chain-Growth Polymers
Problems: In-Chapter 10.1 to 10.18
482 End of Chapter 10.19 to 10.33
484 Learning Group Problems.

Week of Mar 29: ALCOHOLS AND ETHERS.

Read and Study Chapter 11.

492 Molecular Hosts
11.1 493 Structure and Nomenclature
11.1A 494 Nomenclature of Alcohols
11.1B 495 Nomenclature of Ethers
11.2 495 Physical Properties of Alcohols and Ethers
496 Tables 11.1 and 11.2: Physical Properties of Ethers and Alcohols
11.3 497 Important Alcohols and Ethers
11.3A-D 497 Methanol, Ethanol, Ethylene Glycol, Diethyl Ether
11.4 499 Synthesis of Alcohols from Alkenes
1. Acid-Catalyzed Hydration of Alkenes
2. Oxymercuration-Demercuration
3. Hydroboration-Oxidation
11.5 501 Reactions of Alcohols

11.6 502 Alcohols as Acids
11.7 503 Conversion of Alcohols into Alkyl Halides
11.8 503 Alkyl Halides from the Reactions of Alcohols with Hydrogen Halides
11.8A 504 Mechanisms of the Reactions of Alcohols with HX
11.9 506 Alkyl Halides from the Reactions of Alcohols with PBr_3 or $SOCl_2$
11.10 507 Tosylates, Mesylates and Triflates:
Leaving Group Derivatives of Alcohols
510 The Chemistry of --- Alkyl Phosphate
11.11 510 Synthesis of Ethers
11.11A 510 Ethers by Intermolecular Dehydration of Alcohols
11.11B 512 The Williamson Synthesis of Ethers
11.11C 513 Synthesis of Ethers by Alkoxymercuration-Demercuration
11.11D 513 tert-Butyl Ethers by Alkylation of Alcohols: Protecting Groups
11.11E 514 Silyl Ether Protecting Groups
11.12 515 Reactions of Ethers: Ether Cleavage by Strong Acids
11.13 516 Epoxides: Alkene Epoxidation
517 The Chemistry of ... The Sharpless Asymmetric Epoxidation
11.14 519 Reactions of Epoxides:
1. Acid Catalyzed Ring Opening
2. Base Catalyzed Ring Opening
521 The Chemistry of ... Epoxides, Carcinogens, and Biological Oxidation
11.14A 522 Polyether Formation
11.15 523 Anti 1,2-Dihydroxylation of Alkenes via Epoxides
525 The Chemistry of --- Environmentally Friendly Alkene Oxidation Methods
11.16 526 Crown Ethers: Nucleophilic Substitution Reactions in Relatively Nonpolar Aprotic Solvents by Phase-Transfer Catalysis
11.16A 527 Crown Ethers
11.16B 529 Transport Antibiotics and Crown Ethers
11.17 529 Summary of Reactions of Alkenes, Alcohols and Ethers
11.17A 529 Alkenes in Synthesis
530 Key Terms and Concepts.
531 Summary and Review Tool: Some Synthetic Connections of Alkynes, Alcohols, Alkyl Halides and Ethers
Problems: In-Chapter 11.1 to 11.24
532 End of Chapter 11.25 to 11.51
536 Learning Group Problems.

Week of April 5: ALCOHOLS FROM CARBONYL COMPOUNDS: OXIDATION-REDUCTION AND ORGANOMETALLIC COMPOUNDS.

Read and Study Chapter 12
537 The Two Aspects of the Coenzyme NADH
12.1 538 Introduction
12.1A 538 Structure of the Carbonyl Group
12.1B 539 Reactions of Carbonyl Compounds with Nucleophiles
12.2 539 Oxidation-Reduction Reactions in Organic Chemistry
12.3 541 Alcohols by Reduction of Carbonyl Compounds
544 The Chemistry of ... Alcohol Dehydrogenase
544 The Chemistry of ... Stereoselective Reduction of Carbonyl Groups
12.4 546 Oxidation of Alcohols
12.4A 546 Oxidation of Primary Alcohols to Aldehydes: RCH_2OH to RCHO

12.4B 547 Oxidation of Primary Alcohols to Carboxylic Acids: RCH_2 OH to RCO_2H
12.4C 547 Oxidation of Secondary Alcohols to Ketones: RCH(OH)R' to RCOR'
12.4D 547 Mechanism of Chromate Oxidations
12.4E 549 A Chemical Test for Primary and Secondary Alcohols
12.4F 550 Spectroscopic Evidence for Alcohols
12.5 550 Organometallic Compounds
12.6 551 Preparation of Organo Lithium and Organo Magnesium Compounds
12.6A 551 Organolithium Compounds
12.6B 552 Grignard Reagents
12.7 553 Reactions of Organolithium and Organomagnesium Compounds
12.7A 553 Reactions with Compounds Containing Acidic Hydrogen Atoms
12.7B 554 Reactions of Grignard Reagents with Oxiranes (Epoxides)
12.7C 555 Reactions of Grignard Reagents with Carbonyl Compounds
12.8 556 Alcohols from Grignard Reagents: Reaction of Grignard Reagents with:
1. Formaldehyde to Give Primary Alcohols
2. Other Aldehydes to Give Secondary Alcohols
3. Ketones to Give Tertiary Alcohols
4. Esters with 2 x RMgX to Give Tertiary Alcohols

12.8A 557 Planning a Grignard Synthesis
12.8B 561 Restrictions on the Use of Grignard Reagents
12.8C 562 The Use of Lithium Reagents
12.8D 562 The Use of Sodium Alkynides
12.9 564 Lithium Dialkylcuprates: The Corey-Posner, Whitesides-House Synthesis
12.10 566 Protecting Groups
567 Summary of Reactions
567 Synthetic Connections of Alcohols and Carbonyl Compounds
568 Key Terms and Concepts
Problems: In-Chapter 12.1 to 12.10
569 End of Chapter 12.11 to 12.29
572 Learning Group Problems.
573 First Review Problem Set 1 to 25.

Week of April 12: CONJUGATED UNSATURATED SYSTEMS.

Read and Study Chapter 13.

577 Molecules With the Nobel Prize in Their Synthetic Lineage
13.1 578 Introduction
13.2 578 Allylic Substitution and the Allyl Radical
13.2A 579 Allylic Chlorination (High Temperature)
13.2B 581 Allylic Bromination with N-Bromosuccinimide (Low Conc. of Br_2)
13.3 582 The Stability of the Allyl Radical
13.3A 582 Molecular Orbital Description of the Allyl Radical
13.3B 584 Resonance Description of the Allyl radical
13.4 586 The Allyl Carbocation
13.5 587 Summary of Rules for Resonance
13.5A 387 Rules for Writing Resonance Structures
13.5B 589 Estimating the Relative Stability of Resonance Structures
13.6 591 Alkadienes and Polyunsaturated Hydrocarbons
13.7 593 1,3-Butadiene: Electron Delocalization
13.7A 593 Bond Lengths of 1,3-Bitadiene

REFERENCES TO ORGANIC LECTURE AND LABORATORY TEXTS

1. Solomons, T.W.G., and Fryhle, C.B., *Organic Chemistry,* 8th Edition, Wiley, 2002. ISBN 0-471-41799-8, QD253.2.S65 2003

2. Solomons, T.W.G., *Organic Chemistry,* 5th/6th/7th Editions, Wiley, 1992/95/2000/02. QD251.2.S66.

3. Solomons, T.W.G., *Study Guide and Solutions Manual to Organic Chemistry,* 5th/6th/7th Editions, Wiley, 1992/95/2000/02. ISBN 0-471-83661-3.

4. Solomons, T.W.G., *Fundamentals of Organic Chemistry*, 3rd/4th/5th Editions, Wiley, 1990/94/97, ISBN 0-471-14649-8 QD251.2.S657 1997.

5. Wade, L.G.(Jr), *Organic Chemistry,* 1st/2nd/3rd/4th/5th Editions, Prentice-Hall, 1987/91/95/99/2003ISBN 0-13-033832-X, QD 251.2.W 33 2003.

6. Simek, J.W., *Solutions Manual to Organic Chemistry by Wade*, Prentice-Hall, 1991/95.

7. Morrison, R.T., and Boyd, R.N., *Organic Chemistry,* Allyn and Bacon, 1973, 1983, and 1987 Editions, QD 251.2.M 67.

8. Bailey, P.S., Jr, Bailey, C.A., *Organic Chemistry: A brief Survey of Concepts and Applications,* 6th Edition, Prentice Hall, 2000, ISBN 0-13-924119-1, QD251.2.B34 2000 547-dc21

9. Baker, A.D., Engel, R., *Organic Chemistry,* West, 1992, QD251.2.B345.

10. Boxer, R., *Essential of Organic Chemistry,* Wm. C. Brown, 1997, ISBN 0-697-14060-1.

11. Brown, W.H., *Introduction to Organic Chemistry,* Saunders College Publishing/Harcourt Brace College Publishers, 1997, ISBN 0-03-016914-3.

12. Brown, W.H., Foote, C.S., Organic Chemistry, 2nd Edition, Saunders College Publishing/Harcourt Brace College Publishers, 1998, ISBN 0-03-020458-5.

13. Bruice, P.Y., *Organic Chemistry,* 1st/2nd/3rd/4th Editions, 1995/98/2001/04, Prentice Hall, ISBN 0-13-017858-6, QD251.3.B78 2004.

14. Carey, F.A., *Organic Chemistry,* 1st/2nd/3rd/4th/5th Editions, 1987/92/96/2000/03 McGraw-Hill, ISBN 0-07-242458-3, QD 251.3.C37 2003.

15. Carroll, F.A., *Perspectives on Structure and Mechanism in Organic Chemistry,* Brooks/Cole, 1998, ISBN 0-534-24948-5, QD476.C375 1998 547-dc20.

16. Clayden, J., Greeves, N., Warren, S., Wothers, P., Organic Chemistry, Oxford University Press, 2001, ISBN 0 19 850346 6

17. Ege, S.N., *Organic Chemistry*, 2nd Edition, D.C. Heath, 1989, ISBN 0-669-18178-1.

18. Fessenden, R.J., and Fessenden, J.S., *Organic Chemistry,* 3rd/4th/5th/6th Editions, 1986/90/94/98, Brooks/Cole, QD 251.2.F 49.

19. Fox, M.A., Whitesell, J.K., *Organic Chemistry,* 2nd Edition, Jones and Barlett, 1997, ISBN 0-7637-0178-5, QD251.2.F69 1997.

20. Hornback, J.M., *Organic Chemistry,* 1998, Brooks/Cole, QD 253.H66 1998. ISBN 0-534-35254-5

21. Loudon, G.M., *Organic Chemistry*, 4th Edition, Oxford University Press, 2002, ISBN 0-19-511999-1, QD 252.3.L68 2001.

22. Lowry, T.H., and Richardson, K.S., *Mechanism and Theory in Organic Chemistry*, 3rd Edition, Harper & Row, 1987, QD471.L68, ISBN 0-06-044084-8.

23. March, J., *Advanced Organic Chemistry,* 4th Edition, Wiley, 1992, QD251.2.M37, ISBN 0-471-60180-2

24. Miller, B., *Advanced Organic Chemistry: Reactions and Mechanisms*, Prentice Hall, 1998, ISBN O-13-373275-4

25. Millam, M.J., *Reaction Guide for the Brief Organic Chemistry Course,* Heath, 1988, ISBN 0-669-13247-0

26. Mackie, R.K., Smith, D.M., and Aitken, R.A., *Guide Book to Organic Synthesis,* 2nd Edition, Longman Scientific and Technical, 1990, ISBN 0-582-03375-6.

27. McMurray, J., *Organic Chemistry*, 1984/88/92/96 Editions, Brooks/Cole, QD 251.2.M 43.

28. McMurray, J., *Fundamentals of Organic Chemistry,* 1990, 1998 (4th Edition), 2000 (5th Edition), Brooks/Cole, ISBN 0-534-37366-6, QD 251.2.M4.

29. McMurray, J., Castellion, M.E., *Fundamentals of General, Organic and Biological Chemistry,* 3rd Edition., ISBN 0-13-918517-3.

30. Ouellette, R.J., and Rawn, J.D., *Organic Chemistry*, Prentice Hall, 1996, QD 251.2.094.

31. Raber, D.J., and Raber, N.K., *Organic Chemistry*, West, 1988, QD251.2.R33.

32. Streitwieser, A.(Jr), and Heathcock, C.H., *Introduction to Organic Chemistry*, 3rd Edition, MacMillan, 1985, QD 251.2S 76.

33. Pine, S.H., *Organic Chemistry,* McGraw-Hill, 5th ed., 1987.

34. Vollhardt, K.P.C., Shore, N.E., *Organic Chemistry*, 2nd Edn. Freeman, 1994. QD 251.2.V 65.

35. Vollhardt, K.P.C., *Organic Chemistry,* Freeman, 1987. QD 251.2.V 65.

36. Sykes, *A Guidebook to Mechanisms in Organic Chemistry*, Longmans, 6th ed., 1987.

37. Pavia, D.L., Lampman, G.M., Kriz, G.S., and Engel, R.G. *Introduction to Organic Laboratory Techniques: a Microscale Approach,* 1st/2nd Editions, Saunders, 1990/95, ISBN 0-03-025418-3/0-03-006232-2.

38. Pavia, D.L., Lampman, G.M., and Kriz, G.S., *Introduction to Organic Laboratory Techniques*, Saunders, 3rd ed., 1988, QD 261.

39. Fessenden, R.J., and Fessenden, J.S., *Organic Laboratory Techniques,* 2nd Edition, 1993, Brooks/Cole, QD 261.F466 1993.

40. Mayo, D.W., Pike R.M., and Trumper, P.K., *Microscale Organic Laboratory: with Multistep and Multistep Syntheses,* 3rd Edition, Wiley, 1994, QD 261.M38.

41. Mayo, D.W., Pike R.M., and Butcher, S.S., *Microscale Organic Laboratory,* Wiley, 1986, QD 261.M38.

42. Mayo, D.W., Pike R.M., Butcher, S.S., and Trumper, P.K., *Microscale Techniques for the Organic Laboratory,* Wiley, 1991, ISBN 0471-62192-7 (pbk).

43. Most, C.F.(Jr), *Experimental Organic Chemistry,* Wiley, 1988, QD261.M78.

44. Wilcox, C.F.(Jr), *Experimental Organic Chemistry: a Small-Scale Approach,* 1st/2nd Editions, MacMillan, 1988/95, QD261.W497./QD261.W497, ISBN 0-02-427691-X.

45. Fieser, L.F., and Williamson, K.L., *Organic Experiments*, 7th edition, Heath, 1992, ISBN 0-669-24344-2.

46. Rappoport, Z., *CRC Handbook of Tables for Organic Compound Identification,* 3rd edition, CRC Press Inc, 1973, ISBN 0-8493-0303-6.

47. Svoronos, P., and Sarlo, E., *Organic Chemistry Laboratory Manual*, Wm. C. Brown, 1994, ISBN 0-697-14799-1.

48. Williamson, K.L., *Microscale Organic Experiments*, Heath, 1987.

49. Williamson, K.L., *Macroscale and Microscale Organic Experiments*, Heath, 1989, ISBN 0-669-19429-8.

50. Zanger, M., and McKee, J.R., *Small Scale Synthesis: A Laboratory Textbook of Organic Chemistry*, Wm. C. Brown, 1995, ISBN 0-697-20957-1.

51. Zubrick, J.W., *The Organic Chem Lab Survival Manual: A Student's Guide to Techniques,* 4th Edition, Wiley, 1997, ISBN 0-471-12948-8.

52. Rappoport, Z., *CRC Handbook of Tables for Organic Compound Identification,* 3rd Edition, CRC Press, 1964, ISBN 0-8493-0303-6.

53. Weast, R.C. (Editor), *CRC Handbook of Chemistry and Physics,* Annual Editions, CRC Press.

54. *The Aldrich Catalog/Handbook of Fine Chemicals,* Aldrich Chemical Company.

Note: These books are located in Room J207. Some of the texts are also located in the College Library. Additional items are located in J207, J211, the Chemistry Laboratories and the College Library, e.g.

50. Encyclopaedia's on Chemistry, Science and Technology;

51. Pouchert, C.J., *The Aldrich Library of Infrared Spectra*, 3rd Edition, Aldrich Chemical Co, 1981;

52. Pouchert, C.J., *The Aldrich Library of FT-IR Spectra*, Aldrich Chemical Co, 1985;

53. Pouchert, C.J., *The Aldrich Library of NMR Spectra,* Aldrich Chemical Co, 1983;

54. Pouchert, C.J., *The Aldrich Library C-13 and H-1 FT- NMR Spectra,* Aldrich Chemical Co, 1992;

55. *Chemical and Engineering News,* Jacobs M. (Editor), Published Weekly by the American Chemical Society (available on-line in J.P. Sloan's office);

56. *Journal of Agricultural and Food Chemistry,* Seiber, J.N., (Editor), Published Monthly by the American Chemical Society (available on-line in J.P. Sloan's office).

Document Reference: D\CH1600\CH1610A3-03-04out.wd