GRANDE PRAIRIE REGIONAL COLLEGE

DEPARTMENT OF SCIENCE: CHEMISTRY

FORTY-FOURTH SESSION 2009 – 2010

COURSE OUTLINE: ORGANIC CHEMISTRY

CH2630 A2

CHEMISTRY 2630 A2: Organic Chemistry II

PREREQUISITE: CH1610 or CH2610

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

LECTURE: CH2630 A2 T,R 8:30 – 9:50 in J204

ALBERTA TRANSFER CREDIT
(Ref: 2008-2009 Guide to Transfer Credit at Alberta Post-Secondary Institutions)

GPRC:	CH 2610	(3)	CH 2630	(3)
U of Alberta:	CHEM 261	(3)	CHEM 263	(3) or AUCHE 252 3
U of Calgary:	CHEM 351	(3)	CHEM 353	(3)
U of Lethbridge:	CHEM 2500	(3)	CHEM 2600	(3)
Athabasca U:	CHEM 350	(3)	CHEM 360	(3)
Canadian UC:	CHEM 241	(4)	CHEM 242	(4)
Concordia UC:	CHEM 261	(3)	CHEM 263	(3)
King's UC:			CHEM 351	(3)

COURSE OUTLINE:

Lecture Component:

A continuation of the study of the fundamental principles of the chemistry of carbon compounds as commenced in Chemistry 2610. The study is based on a reaction mechanism approach to the functional group chemistry of arenes, aldehydes, ketones, carboxylic acids, esters, amides, amino acids and carbohydrates. Topics include: structure and bonding; physical properties; acidity and basicity; conformations of molecules; stereochemistry; addition, elimination and substitution reactions; structure-reactivity relationships; aromaticity and aromatic substitution; and spectroscopic 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:

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 assignments will be given and marked.

Notes:

1. Lectures: Days, Time and Place
   CH2630 A3 T,R 8:30 – 9:50 in J204

2. Laboratory Component: Day, Time and Place
   CH2630 L1 M 14:30 - 17:20 in J116

3. Tutorial Component: Day, Time and Place
   CH2630 S1 F 11:30 - 12:20 in J229

TEXT BOOKS AND LABORATORY ITEMS:

The following text book is required:

CH2610

Solomons, T.W.G., and C.B. Fryhle, *Organic Chemistry*, 9th Edition, Wiley, 2008

And
A Three Ring Binder to Hold: Sloan, J.P., *Organic Chemistry Experiments, Chemistry 2610/2630*, Grande Prairie Regional College, 2009/2010.

Molecular Models are highly recommended, namely:

Molecular Model Set for Organic Chemistry, Prentice Hall.

Study Guides, Solutions Manuals, and Wiley Plus are supplementary items, namely:

1. Fernandez, J.E., and Solomons, T.W.G., *Study Guide and Solutions Manual to Organic Chemistry*, 9th Edition, 2008;
2. Wiley Plus.

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.

EVALUATION:

Examination Schedule and Composition of the Final Grade:

1. Midterm Exam # 1, Friday October 9 ---------- 15%
2. Midterm Exam # 2, Friday November 13 ---------- 20%
2. Final Exam to be scheduled between December 9 - 18 -------- 30%
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

* Other post secondary institutions may not award transfer credit for grades of D and D+.
Notes:

1. The Mid-Term exams will be of 1.5 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 assignments.
3. A pass grade is essential for the Laboratory Component.
4. The Tutorial Grading Component consists of assignments and will contribute towards 10% of the final grade. A 10 question assignment will normally be given each week.
5. Assistance with assignments will be given upon request.
6. Regular attendance in Lecture, Laboratory, and Tutorial Components is a Course Requirement.

Grande Prairie Regional College Calendar 2009 - 2010: Course Description (page 185).

CH 2630 3(3-1-3)UT 105 Hours Organic Chemistry II

Continuation of the study of structural and chemical properties of the basic functional groups of organic compounds including aromatic compounds, aldehydes, ketones, carboxylic acids and their derivatives and amines. Illustration of these functional groups in natural products such as carbohydrates, amino acids and proteins, nucleic acids and lipids and discussion of the application of spectroscopic methods for structure determination in simple organic molecules.

Prerequisites: CH1610 or CH 2610

Notes: Credit will be granted for only one of CH1630 or CH2630.

Engineering students who take this course will receive 4.5 credits of transfer to UofA.
Transfer: UA, UC, UL, AU, AF, CU, CUC, KUC

CHEMISTRY 2630 A2 READING, STUDYING, AND PRACTICE PROBLEMS

All references are to T.W.G. Solomons and C.B. Fryhle, Organic Chemistry, 9th Edition, Wiley, 2008.

FALL SEMESTER

Weeks of Sept 3 & 7: SPECTROSCOPIC METHODS OF STRUCTURE DETERMINATION.
NUCLEAR MAGNETIC RESONANCE (NMR) and MASS SPECTROSCOPY (MS): Tools for Structure Determination

Sect # Page # Read and Study Chapter 9.

9.1	364	Introduction;
9.2	364	Nuclear Magnetic Resonance (NMR) Spectroscopy;
9.2A	365	Chemical Shift (δ in parts per million, ppm);
	366	Table 9.1: Approximate proton Chemical Shifts;
9.2B	367	Integration of Signal Areas: Integral Step Heights;
9.2C	368	Coupling (Signal Splitting);
9.3	369	Interpreting Proton, ^{1}H, NMR Spectra;
9.4	371	Nuclear Spin: The Origin of the Signal;
9.5	373	Detecting the Signal: Fourier Transform NMR Spectrometers;
9.6	374	Shielding and Deshielding of Protons;
	375	Deshielding by Electronegative Groups;
	376	Shielding and Deshielding by Circulation of π Electrons;
9.7	376	The Chemical Shift;
9.7A	377	PPM and the δ Scale;
9.8	377	Chemical Shift Equivalent and Nonequivalent Protons;
9.8A	377	Homotopic Hydrogen Atoms;
9.8B	378	Enantiotopic and Diastereotopic Hydrogen Atoms;
9.9	379	Signal Splitting: Spin-Spin Coupling;
9.9A	380	Vicinal Coupling
9.9B	380	Splitting Tree Dagrams and the Origin of Signal Splitting;
	381	Splitting Analysis for the Doublet
	381	Splitting Analysis fort he Triplet;
	382	Splitting Analysis for the Quartet;
9.9C	385	Coupling Constants – Recognizing Splitting Paterns;
9.9D	385	The Dependence of Coupling Constants on Dihedral Angle;
9.9E	386	Complicating Features;
9.9F	387	Analysis of Complex Interactions;
9.10	388	Proton NMR Spectra and Rate processes
	388	Conformational Chnges;
	389	Chemical Exchange Causes Spin Decoupling;
9.11	390	Carbon-13, ^{13}C, NMR Spectroscopy;
9.11A	390	Interpretation of ^{13}C NMR Spectra;
9.11B	391	One Peak for each Unique carbon Atom;
9.11C	391	^{13}C Chemical Shifts;
	391	Figure 9.19: Approximate ^{13}C Chemical Shifts;
	392	Table 9.2: Approximate ^{13}C Chemical Shifts;
9.11D	393	Off-Resonance Decoupled Spectra;

9.11E 394 DEPT ^{13}C Spectra;
9.12 396 Two-Dimensional (2D) NMR Techniques;
9.12A 396 COSY Cross-Peak Correlations;
9.12B 398 HETCOR Cross-Peak Correlations;
399 The Chemistry of Magnetic Resonance Imaging in Medicine;
9.13 399 An Introduction to Mass Spectroscopy;
9.14 400 Formation of Ions: Electron Impact Ionization;
9.15 400 Depicting a Molecular Ion;
9.16 401 Fragmentation;
9.16A 402 Fragmentation by Cleavage at a Single Bond;
9.16B 403 Fragmentation of Longer Chain and Branched Alkanes;
9.16C 404 Fragmentation to Form Resonance-Stabilized Cations;
9.16D 406 Fragmentation by Cleavage of Two Bonds;
9.17 407 Determination of Molecular Formulas and Molecular Weights;
9.17A 407 Isotopic Peaks and the Molecular Ion;
408 Table 9.4: Principal Stable Isotopes of Common Elements;
9.17B 411 High-Resolution Mass Spectroscopy;
412 Table 9.6: Exact Masses of Nuclides;
9.18 412 Mass Spectrometer Instrument Designs;
9.18A 412 Ionization Techniques: Electron Impact, Electrospray, and MALDI;
412 Electron Impact Ionization;
413 Electrospray Ionization- A Technique Especially Useful for Biomolecules;
414 MALDI- A Technique Useful for Both Biomolecules and Synthetic Polymers;
9.18B 414 Mass Analysis: Ion Sorting and Detection;
414 Magnetic Focusing;
414 Quadrupole, Ion Trap, and Time-of-Floght (TOF) Mass Analyzers;
9.19 415 GC/MS (Gas Chromatography/Mass Spectrometry) Analysis;
9.20 416 Mass Sprectometry of Biomolecules;
416 Key Terms and Concepts.
417 Concept Map ^{1}H NMR Spectroscopy
418 Concept Map ^{13}C NMR Spectroscopy
419 Concept Map Mass Spectroscopy
Problems: In-Chapter 9.1 to 9.23
420 End of Chapter 9.24 to 9.44
425 Learning Group Problems.

Week of Sept 14: AROMATIC COMPOUNDS.

Read and Study Chapter 14:
14.1 596 Aromatic Compounds: Why the Name?
14.2 597 Nomenclature of Benzene Derivatives;
14.3 599 Reactions of Benzene;
14.4 600 The Kekulé Structure for Benzene;
14.5 601 The Stability of Benzene;
14.6 602 Modern Theories of the Structure of Benzene;
14.6A 603 The Resonance Explanation of the Structure of Benzene;
14.6B 604 The Molecular Orbital Explanation of the Structure of Benzene;
14.7 605 Hückel's Rule, the $4n + 2\ \pi$ Electron Rule;
14.7A 606 The Annulenes;

14.7B 608 NMR Spectroscopy: Evidence of Electron Delocalization in Aromatic Compounds;
14.7C 609 Aromatic Ions;
14.7D 611 Aromatic, Antiaromatic, and Nonaromatic Compounds;
14.8 613 Other Aromatic Compounds;
14.8A 613 Benzenoid Aromatic Compounds;
14.8B 615 Nonbenzenoid Aromatic Compounds;
14.8C 615 Fullerenes;
616 The Chemistry of Nanotubes;
14.9 617 Heterocyclic Aromatic Compounds;
14.10 618 Aromatic Compounds in Biochemistry;
14.11 620 Spectroscopy of Aromatic Compounds;
14.11A 620 ^{1}H NMR Spectra;
14.11B 621 ^{13}C NMR Spectra;
14.11C 623 Infrared Spectra of Substituted Benzenes;
623 Table 14.1; Infrared Absorptions in the 680-860 cm^{-1} Regions;
14.11D 624 Visible-Ultraviolet Spectra of Aromatic Compounds;
624 The Chemistry of Sunscreens (Catching the Sun's Rays and What Happens to Them);
14.11E 625 Mass Spectra of Aromatic Compounds;
625 Key Terms and Concepts;
626 Concept Map Aromatic Compounds
Problems: In-Chapter 14.1 to 14.16
627 End of Chapter 14.17 to 14.39
634 Learning Group Problems.

Weeks of Sept 21: REACTIONS OF AROMATIC COMPOUNDS.

Read and Study Chapter 15.

15.1 637 Electrophilic Aromatic Substitution Reactions;
15.2 637 E+ Ar Subn., a General Mechanism, Arenium Ions;
15.3 640 Halogenation of Benzene;
640 A Mechanism for the Reaction of Electrophilic Aromatic Bromination;
15.4 641 Nitration of Benzene;
641 A Mechanism for the Reaction of Nitration of Benzene;
15.5 642 Sulfonation of Benzene;
642 A Mechanism for the Sulfonation of Benzene;
15.6 643 Friedel-Crafts Alkylation;
644 A mechanism for the Reaction of Friedel-Crafts Alkylation;
15.7 645 Friedel-Crafts Acylation;
646 A Mechanism for the Reaction of Friedel-Crafts Acylation;
15.8 647 Limitations of Friedel-Crafts Reactions;
15.9 649 Synthetic Applications of Friedel-Crafts Acylations, the Clemmensen Reduction;
15.10 650 Effect of Substituents on Reactivity and Orientation;
15.10A 651 Activating Groups: Ortho-Para Directors;
15.10B 652 Deactivating Groups: Meta Directors;
15.10C 653 Halo Substituents: Deactivating Ortho-Para Directors;
653 Table 15.1: Electrophilic Substitutions of Chlorobenzene
15.10D 653 Classification of Substituents;
653 Table 15.2: Effect of Substituents on Electrophilic Aromatic Substitution;
15.11 653 Theory of Substituent Effects on Electrophilic Aromatic Substitution;

15.11A 653 Reactivity: The Effect of Electron-Releasing and Electron-Withdrawing Groups;
15.11B 655 Inductive and Resonance Effects: Theory of Orientation;
15.11C 656 Meta-Directing Groups;
15.11D 658 Ortho-Para-Directing Groups;
15.11E 661 Ortho-Para Directing and Reactivity of Alkylbenzenes;
662 The Chemistry of Iodine Incorporation in Thyroxine Biosynthesis
15.11F 663 Summary of Substituent Effects on Orientation and Reactivity;
15.12 664 Reactionss of the Side Chain of Alkyl Benzenes;
15.12A 664 Benzylic Radicals and Cations;
665 The Chemistry of Industrial Styrene Synthesis;
15.12B 665 Halogenation of the Side Chain - Benzylic Radicals;
666 A mechanism for the Reaction of Benzylic Halogenation;
15.13 668 Alkenyl Benzenes;
15.13A 668 Stability of Conjugated Alkenylbenzenes;
15.13B 669 Additions to the Double Bond of Alkenylbenzenes;
15.13C 669 Oxidation of the Side Chain;
15.13D 670 Oxidation of the Benzene Ring;
15.14 670 Synthetic Applications;
15.14A 672 Use of Protecting and Blocking Groups;
15.14B 673 Orientation in Disubstituted Benzenes;
15.15 674 Allylic and Benzylic Halides in Nucleophilic Substitution Reactions;
674 Table 15.3: A Summary of Alkyl, Allylic, and Benzylic Halides in S_N2 and S_N1 Reactions,
15.16 676 Reduction of Aromatic Compounds;
676 A mechanism for the Reaction of Birch Reduction;
677 Key Terms and Concepts;
678 Concept Map: Summary of Mechanisms;
679 Concept Map: Some Synthetic Connections of Benzene and Aryl Derivatives.
Problems In-Chapter 15.1 to 15.25
680 End of Chapter 15.26 to 15.56
685 Learning Group Problems.

Week of Sept 28: ALDEHYDES AND KETONES I: NUCLEOPHILIC ADDITION TO THE CARBONYL GROUP.

Read and Study Chapter 16.

16.1 687 Introduction;
16.2 687 Nomenclature of Aldehydes and Ketones;
16.3 689 Physical Properties;
689 Table 16.1: Physical Properties of Aldehydes and Ketones;
690 The Chemistry of Aldehydes and Ketones in Perfumes;
16.4 690 Synthesis of Aldehydes;
16.4A 690 Aldehydes by Oxidation of Primary Alcohols;
16.4B 691 Aldehydes by reduction of Acyl Chlorides, Esters and Nitriles;
692 A Mechanism for the Reaction of Reduction of an Acyl Chloride to an Aldehyde;
693 A Mechanism for the Reaction of Reduction of an Ester to an Aldehyde;
693 A mechanism for the Reaction off Reduction of a Nitrile to an Aldehyde
16.5 694 Synthesis of Ketones;
16.5A 694 Ketones from Alkenes, Arenes, and Secondary Alcohols;
16.5B 694 Ketones from Nitriles;

723 Summary of Mechanisms: Nucleophilic Addition to Aldehydes and Ketones under Basic Conditions;
724 Synthetic Connections: Some Synthetic Connections of Aldehydes, Ketones, and Other Functional Groups;

Problems: In-Chapter 16.1 to 16.18
725 End of Chapter 16.19 to 16.46
730 Learning Group Problems.

Weeks of Feb Oct 5 & 12: ALDEHYDES AND KETONES II: ENOLS AND ENOLATES.

Read and Study Chapter 17.

17.1 733 The Acidity of the □α Hydrogens of Carbonyl Compounds, Enolate Anions;
17.2 735 Keto and Enol Tautomers;
17.3 736 Reactions via Enols and Enolate Ions;
17.3A 736 Racemization;
737 A Mechanism for the Reaction of Base-Catalyzed Enolization
737 A Mechanism for the Reaction of Acid-Catalyzed Enolization
17.3B 738 Halogenation of Aldehydes and Ketones;
738 A Mechanism for the Reaction of Base-Promoted Halogenation of Aldehydes and Ketones;
739 A Mechanism for the Acid-Catalyzed Halogenation of Aldehydes and Ketones;
17.3C 739 The Haloform reaction;
740 A Mechanism for the Reaction of Halogenation Steps of the Haloform Reaction;
741 A Mechanism for the Reaction of Cleavage Step of the Haloform Reaction;
17.3D 741 Environmental Concerns;
17.4 742 The Aldol Reaction, the Addition of Enolate Anions to Aldehydes and Ketones;
742 A Mechanism for the Reaction of The Aldol Reaction;
17.4A 743 Dehydration of the Aldol Addition Product;
743 A Mechanism for the Reaction of Dehydration of the Aldol Addition Product;
17.4B 743 Synthetic Applications of the Aldol Reaction;
745 The Chemistry of A Retro-Aldol Reaction in Glycolysis – Dividing Assets to Double the ATP Yield;
17.4C 746 The Reversibility of Aldol Additions;
17.4D 746 Acid-Catalyzed Aldol Condensations;
A Mechanism for the Reaction of The Acid-Catalyzed Aldol Reaction;
17.5 747 Crossed Aldol Reactions;
17.5A 748 Practical Crossed Aldol Reactions;
749 Table 17.1: Crossed Aldol Reactions;
17.5B 749 Claisen-Schmidt Reactions;
750 A mechanism for the Reaction of The Claisen-Schmidt Reaction;
17.5C 751 Condensations with Nitroalkanes;
17.5D 752 Condensations with Nitriles;
17.6 752 Cyclization via Aldol Condensations;
753 A Mechanism for the Reaction of The Aldol Cyclyzation;
17.7 754 Lithium Enolates;
17.7A 754 Regioselective Formation of Enolates;
17.7B 755 Lithium Enolates in Directed Aldol Reactions;
17.7C 757 Direct Alkylation of Ketones via Lithium Enolates;
758 The Chemistry of Silyl Enol Ethers;

17.8 759 α -Selenation: A Synthesis of α□,ß-Unsaturated Carbonyl Compounds;
17.9 760 Additions to α□,ß-unsaturated Aldehydes and Ketones;
761 A mechanism for the Reaction of The Conjugate Addition to HCN;
762 A Mechanism for the Reaction of The Conjugate Addition of an Amine;
17.9A 762 Michael Additions;
763 The Chemistry of Calicheamicin γ_1^I Activation for Cleavage of DNA;
17.10 764 Summary of Enolate Chemistry;
766 Key Terms and Concepts.
767 Summary of Mechanisms: Enolates: Formation and Reaction with Electrophiles by Substitution or Addition;
768 Synthetic Connections: Some Synthetic Connections Involving Enolates;
Problems: In-Chapter 17.1 to 17.27
769 End of Chapter 17.28 to 17.44
774 Learning Group Problems.

Week of Oct 29 & 26: CARBOXYLIC ACIDS AND THEIR DERIVATIVES:
NUCLEOPHILIC ADDITION-ELIMINATION AT THE ACYL CARBON.

Read and Study Chapter 18, and Special Topic B.

18.1 779 Introduction;
779 Table 18.1: Carboxylic Acid Derivatives
18.2 779 Nomenclature and Physical Properties;
18.2A 779 Carboxylic Acids;
780 Table 18.2: Carboxylic Acids;
18.2B 781 Carboxylic Salts;
18.2C 781 Acidity of Carboxylic Acids;
18.2D 783 Dicarboxylic Acids;
783 Table 18.3: Dicarboxylic Acids;
18.2E 784 Esters;
784 Table 18.4: Carboxylic Esters
18.2F 785 Carboxylic Anhydrides;
18.2G 785 Acyl Chlorides;
18.2H 785 Amides;
18.2I 786 Nitriles;
18.2J 786 Spectroscopic Properties of Acyl Compounds;
786 IR Spectra;
788 ^{1}H NMR Spectra;
788 ^{13}C NMR Spectra;
18.3 823 Preparation of Carboxylic Acids;
789 1. By Oxidation of Alkenes;
789 2. By Oxidation of Aldehydes and Primary Alcohols;
789 3. By Oxidation of Alkyl Benzenes;
789 4. By Oxidation of the Benxene Ring;
789 5. By Oxidation of Methyl Ketones;
790 6. By Hydrolysis of Cyanohydrins and Other Nitriles;
790 7. By Carbonation of Grignard Reagents;
18.4 791 Nucleophilic Addition-Elimination at the Acyl Carbon;
792 A Mechanism for the Reaction of Acyl Transfer by Nucleophilic Addition-Elimination;
18.4A 793 Relative Reactivity of Acyl Compounds;

4. Conversion to Amides;
5. Conversion to Ketones;
6. Conversion to Aldehydes;

817 Reactions of Acid Anhydrides;
1. Conversion to Acids;
2. Conversion to Esters;
3. Conversion to Amides;
4. Conversion to Aryl Ketones;

817 Reactions of Esters;
1. Hydrolysis;
2. Conversion to Other Esters: Transesterification;
3. Conversion to Amides;
4. Reaction with Grignard Reagents;
5. Reduction;

818 Reactions of Amides;
1. Hydrolysis;
2. Conversion to Nitriles;

808 Reactions of Nitriles;
1. Hydrolysis to Carboxylic Acid or Carboxylate Anion;
2. Reduction to an Aldehyde with (*i*-Bu)$_2$AlH (DIBAL-H);
3. Conversion to a Ketone by a Grignard or Organolithium Reagent;

819 Summary and Review Tools: Synthetic Connections of Carboxylic Acids and Related Functional Groups: A 3-D Array of Linked Functional Groups.

821 Key Terms and Concepts.

Problems: In-Chapter 18.1 to 18.18

821 End of Chapter18.19 to 18.55

829 Learning Group Problems.

830 Special Topic B: Step Growth Polymers;

B.1 830 Polyamides;

832 The Chemistry of a Green Feedstock for Nylon;

B.2 833 Polyesters;

835 The Chemistry of a PET Green Recycling Method

B.3 835 Polyurethanes;

B.4 836 Phenol-Formaldehyde Polymers;

B.5 837 Cascade Polymers.

Week of Nov 2: SYNTHESIS AND REACTIONS OF ß-DICARBONYL COMPOUNDS: MORE CHEMISTRY OF ENOLATE IONS.

Read and Study Chapter 19, and Special Topics C and D.

19.1 841 Introduction;

19.2 842 The Claisen Condensation: The Synthesis of ß-Keto Esters;

843 A Mechanism fort he Reaction of The Claisen Condensation;

845 The Dieckmann Condensation;

845 A Mechanism for the Reaction of The Dieckmann Condensation;

19.2A 846 Crossed Claisen Condensation;

19.2B 847 Acylation of Other Carbanions;

19.3 847 The Acetoacetic Ester Synthesis: Synthesis of Methyl Ketones (Substituted Acetones);

Week of Nov 9: AMINES.

Read and Study Chapter 2., and Special Topic E.

20.1 900 Nomenclature;
20.1A 901 Arylamines;
20.1B 901 Heterocyclic Amines;
20.2 902 Physical Properties and Structure of Amines;
20.2A 902 Physical Properties;
902 Table 20.1: Physical Properties of Amines;
20.2B 902 Structure of Amines;
20.3 903 Basicity of Amines, Amine Salts;
20.3A 904 Basicity of Aryl Amines;
20.3B 906 Basicity of Heterocyclic Amines;
20.3C 906 Amines versus Amides;
20.3D 907 Aminium Salts and Quaternary Ammonium Salts;
20.3E 908 Solubility of Amines in Aqueous Acids;
20.3F 908 Amines as Resolving Agents;
910 The Chemistry of HPLC Resolution of Enantiomers;
910 The Chemistry of Biologically Important Amines;
1. 2-Phenylethylamines;
2. Vitamins and Antihistamines;
912 3. Tranquilizers;
4. Neurotransmitters;
20.4 912 Preparation of Amines;
20.4A 912 Through Nucleophilic Substitution Reactions;
1. Alkylation of Ammonia;
913 A Mechanism for the Reaction of Alkylation of NH_3;
913 2. Alkylation of Azide Ion and Reduction;
3. The Gabriel Synthesis;
914 Alkylation of Tertiary Amines
20.4B 914 Preparation of Aromatic Amines through Reduction of Nitro Compounds;
20.4C 914 Preparation of Primary, Secondary, or Tertiary Amines through Reductive Amination;
915 A Mechanism for the Reaction of Reductive Amination;
20.4D 916 Preparation of Primary, Secondary, or Tertiary Amines through Reduction of Nitriles, Oximes and Amides;
20.4E 917 Preparation of Primary Amines through the Hofmann and Curtius Rearrangements;
918 A Mechanism for the Reaction of The Hofmann Rearrangement;
20.5 919 Reactions of Amines;
919 1. Acid-Base Reactions;
920 2. Alkylation;
3. Acylation;
4. Electrophilic Aromatic Substitution;
20.5A 920 Oxidation of Amines;
20.6 921 Reactions of Amines with Nitrous Acid;
20.6A 921 Reactions of Primary Aliphatic Amines with Nitrous Acid;
20.6B 921 Reactions of Primary Arylamines with Nitrous Acid;
922 A mechanism for the Reaction of Diazotization;
922 The Chemistry of N-Nitrosoamines;
20.6C 923 Reactions of Secondary Amines with Nitrous Acid;
20.6D 923 Reactions of Tertiary Amines with Nitrous Acid;

Week of Nov 16 PHENOLS AND ARYL HALIDES: NUCLEOPHILIC AROMATIC SUBSTITUTION.

Read and Study Chapter 21.
Read Special Topics F, G, and H, pages 992-1019.

21.1 955 Structure and Nomenclature of Phenols;
21.A 955 Nomenclature of Phenols;
21.2 956 Naturally Occurring Phenols;
21.3 957 Physical Properties of Phenols;
957 Table 21.1: Physical Properties of Phenols;
21.4 957 Synthesis of Phenols;
21.4A 957 Laboratory Synthesis;
958 The Chemistry of Polyketide Anticancer Antibiotic Biosynthesis;
21.4B 959 Industrial Synthesis;
1. Hydrolysis of Chlorobenzene (Dow Process).
2. Alkali Fusion of Sodium Benzenesulfonate.
3, From Cumene Hydroperoxide.
21.5 961 Reactions of Phenols as Acids;
21.5A 961 Strengths of Phenols as Acids;
961 Table 21.2: Acidity Constants of Phenols;
21.5B 962 Distinguishing and Separating Phenols from Alcohols and Carboxylic Acids;
21.6 963 Other Reactions of the O-H Group of Phenols;
21.6A 963 Phenols in the Williamson Synthesis;
21.7 964 Cleavage of Alkyl Aryl Ethers;
21.8 964 Reactions of the Benzene Ring of Phenols;
964 1. Bromination;
965 2. Nitration;
3. Sulfonation;
4. Kolbe Reaction;
966 A Mechanism for the Kolbe Reaction;
21.9 967 The Claisen Rearrangement;
21.10 968 Quinones;
21.11 969 Aryl Halides and Nucleophilic Aromatic Substitution;
970 The Chemistry of The Bombardier Beetle's Noxious Spray;
21.11A 971 Nucleophilic Aromatic Substitution by Addition-Elimination: The S_NAr Mechanism;
971 A Mechanism for the Reaction of The S_NAr Mechanism;
972 The Chemistry of Bacterial Dehalogenation of a PCB Derivative;
21.11B 973 Nucleophilic Aromatic Substitution through an Elimination-Addition Mechanism, The Benzyne Mechanism;
974 A Mechanism for the Reaction of The Benzyne Elimination-Addition Mechanism;
21.11C 976 Phenylation;
21.12 977 Spectroscopic Analysis of Phenols and Aryl Halides;
1. Infrared Spectra;
2. 1H NMR Spectra;
3. 13C NMR Spectra;
4. Mass spectra;
978 Concept Map: Some Synthetic Connections of Phenols and Related Aromatic Compounds;
979 Key Terms and Concepts.

Problems: In-Chapter 21.1 to 21.12
979 End of Chapter 21.13 to 21.38
984 Learning Group Problems

986 Second Review Problem Set 1 to 24.

992 Special Topic F: Aryl Halides: Their Uses;
F.1 992 Aryl Halides as Insecticides;
F.2 993 Organic halides as Heerbicides;
F.3 994 Polychlorinated Biphenyls (PBCBs);

995 Special Topic G: Electrocyclic and Cycloaddition Reactions.
G.1 995 Introduction;
G.2 995 Electrocyclic Reactions;
G.2A 997 Electrocyclic Reactions of 4n π-Electron Systems;
G.2B 1001 Electrocyclic Reactions of (4n + 2) π-Electron Systems;
1001 Table G.1: Woodward-Hoffmann Rules for Electrocyclic Reactions;
G.3 1004 Cycloaddition Reactions;
G.3A 1005 [2 + 2] Cycloadditions;
G.3B 1007 [4 + 2] Cycloadditions.
1008 Special Topic H: Transition Metal Organometallic Compounds;
H.1 1008 Introduction
H.2 1009 Electron Counting in Metal Complexes;
1010 Table H.1: Common Ligands in Transition Metal Complexes;
H.3 1011 Metallocenes: Organometallic Sandwich Compounds;
H.4 1012 Reactions of Transition Metal Complexes;
H.5 1014 Homogeneous Hydrogenation;
H.6 1015 Carbon-Carbon Bond-Forming Reactions;
H.6A 1016 Coupling Reactions;
1. The Heck Reaction;
2. The Suzuki Reaction;
3. The Stille Coupling;
4. The Sonogashira Reaction;
H.6B 1017 Ruthenium Alkylidene (Ruthenium Carbene) Complexes: Olefin Metathesis and Grubbs' Catalysts;
H.7 1019 Vitamin B_{12}: A Transition Metal Biomolecule;

Week of Nov 23: CARBOYDRATES AND LIPIDS (OPTIONAL).

Read Chapters 22 & 23.

1020 Carbohydrate Recognition in Healing and Disease;
22.1 1021 Introduction to Carbohydrates;
22.1A 1021 Classification of Carbohydrates;
22.1B 1022 Photosynthesis and Carbohydrate Metabolism;
22.2 1023 Monosaccharides;
22.2A 1023 Classification of Monosaccharides;
22.2B 1024 D and L Designation of Monosaccharides;
22.2C 1025 Structural Formulas of Monosaccharides;
22.3 1028 Mutarotation;

1073 LIPIDS (Chapter 23)

1073 Insulation for Nerves;
23.1 1074 Introduction to Lipids;
23.2 1075 Fatty Acids and Triacylglycerols;
1076 Table 23.1: Common Fatty Acids;
1077 Table 23.2: Fatty Acid Composition Obtained by Hydrolysis of Common Fats and Oils;
23.2A 1077 Hydrogenation of Triacylglycerols;
23.2B 1077 Biological Functions of Triacylglycerols;
1078 The Chemistry of Olestra and Other Fat Substitutes;
23.2C 1079 Saponification of Triacylglycerols;
23.2D 1081 Reactions of Carboxyl Groups of Fatty Acids;
23.2E 1081 Reactions of the Alkenyl Chain of Unsaturated Fatty Acids;
1082 The Chemistry of Self-Assembled Monolayers – Lipids in Materials Science and Bioengineering;
23.3 1083 Terpenes and Terpenoids;
23.3A 1086 Natural Rubber;
23.4 1087 Steroids;
23.4A 1087 Structure and Systematic Nomenclature of Steroids;
23.4B 1089 Cholesterol;
23.4C 1090 Sex Hormones;
23.4D 1092 Ardrenocortical Hormones;
23.4E 1092 D Vitamins
23.4F 1093 Other Steroids;
23.4G 1094 Reactions of Steroids;
23.5 1095 Prostaglandins;
23.6 1097 Phospholipids and Cell Membranes;
23.6A 1097 Phosphatides;
1099 The Chemistry of STEALTH Liposomes for Drug Delivery;
23.6B 1100 Derivatives of Sphingosine;
23.7 1100 Waxes;
1101 Summary of the Reactions of Lipids;
1101 Key Terms and Concepts.
Problems: In-Chapter 23.1 to 23.11
1101 End of Chapter 23.12 to 23.26
1107 Learning Group Problems.

Week of Nov 30: AMINO ACIDS AND PROTEINS & NUCLEIC ACIDS AND PROTEIN SYNTHESIS (OPTIONAL).

Read Chapter 24: Amino Acids and Proteins

1107 Catalytic Antibodies: Designer Catalysts
24.1 1108 Introduction;
24.2 1109 Amino Acids;
24.2A 1109 Structures and Names;
24.2B 1109 Essential Amino Acids;
1110 Table 24.1: L-Amino Acids Found in Proteins;
24.2C 1112 Amino Acids as Dipolar Ions;

25.4A 1166 Primary Structure;
25.4B 1167 Secondary Structure;
25.4C 1171 Replication of DNA;
25.5 1173 RNA and Protein Synthesis;
25.5A 1173 Messenger RNA Synthesis;
25.5A 1173 Messenger RNA Synthesis-Transcription;
25.5B 1174 Ribosomes-rRNA
25.5C 1176 Transfer RNA;
25.5D 1177 The Genetic Code;
25.5E 1178 Translation;
25.6 1180 Determining the Base Sequence of DNA:
The Chain-Terminating (Dideoxynucleotide) Method;
25.6A 1181 DNA Sequencing by the Chain-Terminating (Dideoxynucleotide) Method;

December 7: Review Class, e.g. review of a Practice Final Exam.

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