GRANDE PRAIRIE REGIONAL COLLEGE

DEPARTMENT OF SCIENCE: CHEMISTRY

FORTY-THIRD SESSION 2008 – 2009

COURSE OUTLINE: ORGANIC CHEMISTRY

CH2630 A2

CHEMISTRY 2630 A2: Organic Chemistry II

PREREQUISITE: CH1610 or CH2610

INSTRUCTOR: Dr. John P. Sloan
Office # J207
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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 books are required:

Either,
1.1 Wade, L.G.(Jr), Organic Chemistry, 6th Edition, Pearson Prentice-Hall, 2006.

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

A Three Ring Binder to Hold: Sloan, J.P., Organic Chemistry Experiments
Chemistry 2610/2630, Grande Prairie Regional College, 2008/2009.

The following is highly recommended:

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

The following is a supplementary item:

Fernandez, J.E., and Solomons, T.W.G., Study Guide and Solutions Manual to Organic Chemistry, 8th Edition, 2004;
Simek, J.W., Wade L.G.(Jr), Solutions Manual to Organic Chemistry, 6th Edition,

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 10 ---------- 15%
2. Midterm Exam # 2, Friday November 14 ---------- 20%
2. Final Exam to be scheduled between December 10 - 19 ------ 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. 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 during the tutorial hour. To encourage general discussion and active student participation, assignment questions may be answered within "paired teams/study groups". 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% may be deducted from the mark for each college business day that an assignment is overdue.

5. Regular attendance in Lecture, Laboratory, and Tutorial Components is a Course Requirement.

Grande Prairie Regional College Calendar 2008 - 2009: Course Description (page 178).

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

CHEMISTRY 2630 A3 READING, STUDYING, AND PRACTICE PROBLEMS

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

WINTER SEMESTER

Weeks of Jan 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 Jan 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 Jan 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 Chlorobenzne
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 Jan 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 4 & 11: 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.

February 18 Family Day, No Classes

Week of Feb 19: Winter Break, No Classes.

Week of Feb 25: 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;

816 Reactions of Acyl Chlorides;
1. Conversion to Acids;
2. Conversion to Anhydrides;
3. Conversion to Esters;
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 $(i\text{-Bu})_2AlH$ (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 Mar 3: 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;

Week of Mar 10: 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 Mar 17: 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 Mar 24: CARBOHYDRATES 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 March 31: AMINO ACIDS AND PROTEINS (OPTIONAL).

Read Chapter 24.

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;
24.3 1115 Synthesis of □α-Amino Acids;

Week of April 7: NUCLEIC ACIDS AND PROTEIN SYNTHESIS

CHEMISTRY 2630 A3: READING, STUDYING, AND PRACTICE PROBLEMS

All references are to Wade, L.G.(Jr), Organic Chemistry, 6th Edition, Pearson Prentice-Hall, 2006.

WINTER SEMESTER

Weeks of Jan 3 & 7: SPECTROSCOPIC METHODS OF STRUCTURE DETERMINATION, Chapters 12/13.

Chapter 12: INFRARED SPECTROSCOPY AND MASS SPECTROSCOPY

Sect # Page # Read and Study Chapter12.

Chapter 13: NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY

Read and Study Chapter 13.

616 Study Problems: In Chapter 13.1 – 13.32; End of Chapter 13.33 – 13.52.

Week of Jan 14: AROMATIC COMPOUNDS.

Read and Study Chapter 14.

14.1 623 Introduction;
14.2 624 Nomenclature of Benzene Derivatives;
14.3 626 Reactions of Benzene;
14.4 627 The Kekulé Structure for Benzene;
14.5 628 The Stability of Benzene;
14.6 629 Modern Theories of the Structure of Benzene;
14.6A 630 The Resonance Explanation of the Structure of Benzene;
14.6B 631 The Molecular Orbital Explanation of the Structure of Benzene;
14.7 632 Hückel's Rule, the (4n+2) □ Electron Rule;
14.7A 633 The Annulenes;
14.7B 635 NMR Spectroscopy - Evidence of Electron Delocalization in Aromatic Compounds;
14.7C 636 Aromatic Ions;
14.7D 638 Aromatic, Antiaromatic, and Nonaromatic Compounds;
14.8 640 Other Aromatic Compounds;
14.8A 640 Benzenoid Aromatic Compounds;
14.8B 642 Nonbenzenoid Aromatic Compounds;
14.8C 642 Fullerenes;
14.9 644 Heterocyclic Aromatic Compounds;
14.10 645 Aromatic Compounds in Biochemistry;
14.11 648 Spectroscopy of Aromatic Compounds;
14.11A 648 H-1 NMR Spectra;
14.11B 648 C-13 NMR Spectra;
14.11C 651 Infrared Spectra of Substituted Benzenes;
14.11D 652 Visible-Ultraviolet Spectra of Aromatic Compounds;
14.11E 653 Mass Spectra of Aromatic Compounds;
653 Key Terms and Concepts;
654 Concept Map Aromatic Compounds
655 Study Problems: In-Chapter 14.1 - 14.15; End of Chapter14.16 - 14.38
662 Learning Group Problems.

Weeks of Jan 21: REACTIONS OF AROMATIC COMPOUNDS.

Read and Study Chapter 15.

15.1 665 Electrophilic Aromatic Substitution Reactions;
15.2 666 E+ Ar Subn., a General Mechanism, Arenium Ions;
15.3 668 Halogenation of Benzene;
15.4 669 Nitration of Benzene;
15.5 670 Sulfonation of Benzene;
15.6 671 Friedel-Crafts Alkylation;
15.7 673 Friedel-Crafts Acylation;
15.8 675 Limitations of Friedel-Crafts Reactions;
15.9 677 Synthetic Applications of Friedel-Crafts Acylations, the Clemmensen Reduction;
15.10 679 Effect of Substituents on Reactivity and Orientation;

15.10A 679 Activating Groups: Ortho-Para Directors;
15.10B 680 Deactivating Groups: Meta Directors;
15.10C 681 Halo Substituents: Deactivating Ortho-Para Directors;
15.10D 681 Classification of Substituents;
15.11 681 Theory of Substituent Effects on Electrophilic Aromatic Substitution;
15.11A 681 Reactivity: The Effect of Electron-Releasing and Electron-Withdrawing Groups;
15.11B 684 Inductive and Resonance Effects: Theory of Orientation;
15.11C 685 Meta-Directing Groups;
15.11D 686 Ortho-Para-Directing Groups;
15.11E 690 Ortho-Para Directing and Reactivity of Alkylbenzenes;
15.11F 692 Summary of Substituent Effects on Orientation and Reactivity;
15.12 693 Alkyl Benzenes, Side Chain Reactions;
15.12A 693 Benzylic Radicals and Cations;
15.12B 694 Halogenation of the Side Chain - Benzylic Radicals;
15.13 697 Alkenyl Benzenes;
15.13A 697 Stability of Conjugated Alkenylbenzenes;
15.13B 698 Additions to the Double Bond of Alkenylbenzenes;
15.13C 699 Oxidation of the Side Chain;
15.13D 698 Oxidation of the Benzene Ring;
15.14 699 Synthetic Applications;
15.14A 701 Use of Protecting and Blocking Groups;
15.14B 702 Orientation in Disubstituted Benzenes;
15.15 703 Allylic and Benzylic Halides in Nucleophilic Substitution Reactions;
15.16 705 Reduction of Aromatic Compounds;
15.16A 706 The Birch Reduction;
707 Key Terms and Concepts;
708 Concept Map: Summary of Mechanisms;
709 Concept Map: Some Synthetic Connections of Benzene and Aryl Derivatives.
710 Study Problems: In-Chapter 15.1 - 15.25; End of Chapter15.26 - 15.56
715 Learning Group Problems.

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

Read and Study Chapter 16.

16.1 717 Introduction;
16.2 717 Nomenclature of Aldehydes and Ketones;
16.3 719 Physical Properties;
16.4 720 Synthesis of Aldehydes;
16.4A 720 Aldehydes by Oxidation of Primary Alcohols;
16.4B 721 Aldehydes by reduction of Acyl Chlorides, Esters and Nitriles;
16.5 724 Synthesis of Ketones;
16.5A 724 Ketones from Alkenes, Arenes, and Secondary Alcohols;
16.5B 725 Ketones from Alkynes;
16.5C 726 Ketones from Lithium Dialkyl Cuprates;
16.5D 727 Ketones from Nitriles;
16.6 728 Nucleophilic Addition to the Carbon-Oxygen Double Bond;
16.6A 730 Reversibility of Nucleophilic Additions to Carbon-Oxygen Double Bond;
16.6B 730 Relative Reactivity: Aldehydes versus Ketones;

Weeks of Feb 4 & 11: ALDEHYDES AND KETONES II: ALDOL REACTIONS.

Read and Study Chapter 17.

17.5 784 Crossed Aldol Reactions;
17.5A 785 Practical Crossed Aldol Reactions;
17.5B 786 Claisen-Schmidt Reactions;
17.5C 788 Condensations with Nitroalkanes;
17.5D 789 Condensations with Nitriles;
17.6 789 Cyclization via Aldol Condensations;
17.7 791 Lithium Enolates;
17.7A 791 Regioselective Formation of Enolate Anions;
17.7B 792 Lithium Enolates in Directed Aldol Reactions;
17.7C 794 Direct Alkylation of Ketones via Lithium Enolates;
17.8 796 □-Selenation: A Synthesis of □ ,ß-Unsaturated Carbonyl Compounds;
17.9 797 Additions to □ ,ß-unsaturated Aldehydes and Ketones;
17.9A 799 Conjugate Addition of Organocopper Reagents;
17.9B 800 Michael Additions;
802 Summary of Mechanisms – Enolates: Formation and Reaction of Electrophiles by Substitution or Addition;
803 Synthetic Connections: Some Synthetic Connections Involving Enolates;
804 Key Terms and Concepts.
804 Study Problems: In-Chapter 17.1 - 17.27; End of Chapter17.28 - 17.45
809 Learning Group Problems.

February 18 Family Day, No Classes

Week of Feb 19: Winter Break, No Classes.

Week of Feb 25: CARBOXYLIC ACIDS AND THEIR DERIVATIVES: NUCLEOPHILIC ADDITION-ELIMINATION AT THE ACYL CARBON.

Read and Study Chapter 18.

18.1 814 Introduction;
18.2 814 Nomenclature and Physical Properties;
18.2A 814 Carboxylic Acids;
18.2B 816 Carboxylic Salts;
18.2C 816 Acidity of Carboxylic Acids;
18.2D 818 Dicarboxylic Acids;
18.2E 819 Esters;
18.2F 820 Carboxylic Anhydrides;
18.2G 820 Acyl Chlorides;
18.2H 820 Amides;
18.2I 821 Nitriles;
18.2J 821 Spectroscopic Properties of Acyl Compounds;
18.3 823 Preparation of Carboxylic Acids;
18.4 826 Nucleophilic Addition-Elimination at the Acyl Carbon;
18.4A 828 Relative Reactivity of Acyl Compounds;
18.4B 828 Synthesis of Acid Derivatives;
18.5 828 Acyl Chlorides;
18.5A 828 Synthesis of Acyl Chlorides;
18.5B 829 Reactions of Acyl Chlorides;
18.6 830 Carboxylic Acid Anhydrides;

18.6A 830 Synthesis of Carboxylic Acid Anhydrides;
18.6B 831 Reactions of Carboxylic Acid Anhydrides;
18.7 832 Esters;
18.7A 832 Synthesis of Esters: Esterification;
18.7B 835 Base-Promoted Hydrolysis of esters: Saponification;
18.7C 837 Lactones;
18.8 838 Amides;
18.8A 838 Synthesis of Amides;
18.8B 838 Amides from Acyl Chlorides;
18.8C 839 Amides from Carboxylic Anhydrides;
18.8D 840 Amides from Esters;
18.8E 840 Amides from Carboxylic Acids and Ammonium Carboxylates;
18.8F 841 Hydrolysis of Amides;
18.8G 843 Nitriles from Dehydration of Amides;
18.8H 843 Hydrolysis of Nitriles;
18.8I 845 Lactams;
18.9 846 Derivatives of Carbonic Acid
18.9A 846 Alkyl Chloroformates and Carbamates (Urethanes);
18.10 848 Decarboxylation of Carboxylic Acids;
18.10A 850 Decarboxylation of Carboxyl Radicals;
18.11 851 Chemical Tests for Acyl Compounds;
851 Summary of the Reactions of Carboxylic Acids and Their Derivatives;
856 Summary and Review Tools: Synthetic Connections of Carboxylic Acids and Related Functional Groups: A 3-D Array of Linked Functional Groups.
857 Key Terms and Concepts.
858 Study Problems: In-Chapter 18.1 - 18.18; End of Chapter 18.19 - 18.55
866 Learning Group Problems.
867 Special Topic B: Step Growth Polymers;
B.1 868 Polyamides;
B.2 870 Polyesters;
B.3 872 Polyurethanes;
B.4 873 Phenol-Formaldehyde Polymers;
B.5 874 Cascade Polymers.

Week of Mar 3: SYNTHESIS AND REACTIONS OF ß-DICARBONYL COMPOUNDS: MORE CHEMISTRY OF ENOLATE IONS.

Read and Study Chapter 19.

19.1 879 Introduction;
19.2 880 The Claisen Condensation: The Synthesis of ß-keto Esters;
19.2A 883 Crossed Claisen Condensation;
19.2B 885 Acylation of Other Carbanions;
19.3 885 The Acetoacetic Ester Synthesis: Synthesis of Methyl Ketones (Substituted Acetones);
19.3A 885 Alkylation;
19.3B 889 Acylation;
19.3C 890 Acetoacetic Ester Dianion: Alkylation at the Terminal Carbon
19.4 891 The Malonic Ester Synthesis: Synthesis of Substituted Acetic Acids;
19.5 895 Further Reactions of Active Hydrogen Compounds;
19.6 896 Direct Alkylation of Esters and Nitriles;

19.7 897 Alkylation of 1,3- Dithianes;
19.8 898 The Knoevenagel Condensation;
19.9 898 Michael Additions;
19.10 900 The Mannich Reaction;
19.11 902 Synthesis of Enamines: Stork Enamine Reactions;
19.12 907 Barbiturates;
19.13 908 Summary of Important Reactions;
911 Summary of Mechanisms: Some Synthetic Connections Involving ß-Dicarbonyl Compounds;
912 Key Terms and Concepts.
912 Study Problems: In-Chapter19.1 - 19.24; End of Chapter 19.25 - 19.51
919 Learning Group Problems.
922 Special Topic C: Thiols, Sulfur Ylides and Disulfides.
C.1 923 Preparation of Thiols;
C.2 924 Physical Properties of Thiols;
C.3 925 The Addition of Sulfur Ylides to Aldehydes and Ketones;
C.4 925 Thiols and Disulfides in Biochemistry;
927 Thiol Esters and Lipid Biosynthesis;
D.1 927 Thiol Esters;
D.2 929 Biosynthesis of Fatty Acids;
D.3 933 Biosynthesis of Isoprenoid Compounds;
D.4 935 Biosynthesis of Steroids;
D.5 939 Cholesterol and heart Disease.

Week of Mar 10: AMINES.

Read and Study Chapter 20.

20.1 941 Nomenclature;
20.1A 942 Arylamines;
20.1B 942 Heterocyclic Amines;
20.2 943 Physical Properties and Structure of Amines;
20.2A 943 Physical Properties;
20.2B 944 Structure of Amines;
20.3 945 Basicity of Amines, Amine Salts;
20.3A 946 Basicity of Aryl Amines;
20.3B 947 Basicity of Heterocyclic Amines;
20.3C 947 Amines versus Amides;
20.3D 948 Aminium Salts and Quaternary Ammonium Salts;
20.3E 949 Solubility of Amines in Aqueous Acids;
20.3F 950 Amines as Resolving Agents;
20.4 952 Some Biologically Important Amines;
20.5 954 Preparation of Amines;
20.5A 954 Through Nucleophilic Substitution Reactions;
20.5B 956 Preparation of Aromatic Amines through Reduction of Nitro Compounds;
20.5C 957 Preparation of Primary, Secondary, or Tertiary Amines through Reductive Amination;
20.5D 958 Preparation of Primary, Secondary, or Tertiary Amines through Reduction of Nitriles, Oximes and Amides;
20.5E 960 Preparation of Primary Amines through the Hofmann and Curtius Rearrangements;
20.6 962 Reactions of Amines;
20.6A 963 Oxidation of Amines;

20.7 963 Reactions of Amines with Nitrous Acid;
20.7A 963 Reactions of Primary Aliphatic Amines with Nitrous Acid;
20.7B 964 Reactions of Primary Arylamines with Nitrous Acid;
20.7C 965 Reactions of Secondary Amines with Nitrous Acid;
20.7D 966 Reactions of Tertiary Amines with Nitrous Acid;
20.8 966 Arene Diazonium Salts, Replacement Reactions;
20.8A 966 Synthesis Using Diazonium Salts;
20.8B 967 The Sandmeyer Reaction: Replacement of the Diazonium Group by -Cl, -Br, -CN;
20.8C 968 Replacement by -I;
20.8D 968 Replacement by -F;
20.8E 968 Replacement by -OH;
20.8F 968 Replacement by Hydrogen: Deamination by Diazotization;
20.9 969 Arene Diazonium Salts, Coupling Reactions;
20.10 972 Reactions of Amines with Sulfonyl Chlorides;
20.10A 972 The Hinsberg Test;
20.11 974 The Sulfa Drugs, Sulfanilamide;
20.11A 974 Chemotherapy;
20.11B 974 Sulfa Drugs;
20.11C 975 Essential Nutrients and Antimetabolites;
20.11D 976 Synthesis of Sulfa Drugs;
20.12 977 Analysis of Amines;
20.12A 977 Chemical Analysis;
20.12B 978 Spectroscopic Analysis;
20.13 979 Eliminations Involving Ammonium Compounds;
20.13A 979 The Hofmann Elimination;
20.13B 980 The Cope Elimination;
981 Summary of Preparations and Reactions of Amines;
984 Key Terms and Concepts;
895 Study Problems: In-Chapter 20.1 - 20.20; End of Chapter 20.21 - 20.53
992 Learning Group Problems.
994 Special Topic E: Alkaloids;
E.1 994 Alkaloids Containing a Pyridine or Reduced Pyridine Ring;
E.2 997 Alkaloids Containing an Isoquinoline or Reduced Isoquinoline Ring;
E.3 998 Alkaloids Containing Indole or Reduced Indole Rings.

Week of Mar 17: PHENOLS AND ARYL HALIDES: NUCLEOPHILIC AROMATIC SUBSTITUTION. ORGANIC HALIDES AND ORGANOMETALLIC COMPOUNDS IN THE ENVIRONMENT.

Read and Study Chapter 21.
Read Special Topics F, G, and H, pages 1041-1071.

21.1 1001 Structure and Nomenclature of Phenols;
21.A 1001 Nomenclature of Phenols;
21.2 1002 Naturally Occurring Phenols;
21.3 1003 Physical Properties of Phenols;
21.4 1003 Synthesis of Phenols;
21.4A 1003 Laboratory Synthesis;
21.4B 1005 Industrial Synthesis;

Week of Mar 24: CARBOHYDRATES AND LIPIDS (OPTIONAL).

Read Chapters 22 & 23.

	1072	Carbohydrate recognition in Healing and Disease;
22.1	1073	Introduction to Carbohydrates;
22.1A	1073	Classification of Carbohydrates;
22.1B	1074	Photosynthesis and Carbohydrate Metabolism;
22.2	1076	Monosaccharides;
22.2A	1076	Classification of Monosaccharides;
22.2B	1076	D and L Designation of Monosaccharides;
22.2C	1077	Structural Formulas of Monosaccharides;
22.3	1081	Mutarotation;
22.4	1082	Glycoside Formation;
22.5	1085	Other Reactions of Monosaccharides;
22.5A	1085	Enolization, Tautomerization, and Isomerization;
22.5B	1085	Use of Protecting Groups in Carbohydrate Synthesis;
22.5C	1086	Formation of Ethers;
22.5D	1087	Conversion to Esters;
22.5E	1088	Conversion to Cyclic Acetals
22.6	1088	Oxidation Reactions of Monosaccharides;
22.6A	1088	Benedict's or Tollens' Reagents: Reducing Sugars;
22.6B	1089	Bromine water: The Synthesis of Aldonic Acids;
22.6C	1090	Nitric Acid Oxidation: Aldaric Acids;
22.6D	1091	Periodate Oxidations: Oxidative Cleavage of Polyhydroxy Compounds;
22.7	1093	Reduction of Monosaccharides: Alditols;
22.8	1094	Reactions of Monosaccharides with Phenylhydrazine: Osazones;
22.9	1095	Synthesis and Degradation of Monosaccharides;
22.9A	1095	Kiliani-Fischer Synthesis;
22.9B	1097	The Ruff Degradation;
22.10	1097	The D family of Aldoses;
22.11	1099	Fischer's Proof of the Configuration of D-(+)-Glucose;
22.12	1102	Disaccharides;
22.12A	1102	Sucrose;
22.12B	1103	Maltose;
22.12C	1104	Cellobiose;
22.12D	1107	Lactose;
22.13	1107	Polysaccharides;
22.13A	1107	Starch;
22.13B	1109	Glycogen;
22.13C	1110	Cellulose;
22.13D	1111	Celluose Derivatives;;
22.14	1113	Other Biologically Important Sugars;
22.15	1114	Sugars That Contain Nitrogen;
22.15A	1114	Glycosylamines;
22.15B	1115	Amino Sugars;
22.16	1116	Glycolipids and Glycoproteins of the Cell Surface: Cell Recognition and the Immune System;
22.17	1119	Carbohydrate Antibiotics.
	1120	Summary of Reactions of Carbohydrates;
	1121	Summary and Review Tools: A Summary of Reactions Involving Monosaccharides;
	1122	Key Terms and Concepts.

Week of March 31: AMINO ACIDS AND PROTEINS (OPTIONAL).

Read Chapter 24.

Week of April 7: REVIEW.

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